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**Southern Governors Conference
on
TRANSPORTATION OF NUCLEAR SPENT FUEL.**

**PRESENTED BY
SOUTHERN INTERSTATE NUCLEAR BOARD**

**Atlanta, Georgia
February 5-6, 1970**

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"Conference on Nuclear Fuel -- Exploration
to Power Reactors," Oklahoma City, Oklahoma,
Published: September 15, 1968
Price: \$5.00

"Conference on Science, Technology and
State Government," Louisville, Kentucky,
Published: February 1, 1969
Price: \$3.00

"Conference on Financing of Emerging High
Technology Industries," Oak Ridge, Tennessee,
Published: November 15, 1969
Price: \$3.00

Southern Interstate Nuclear Board

**ADDENDUM TO PROCEEDINGS
OF
SOUTHERN GOVERNORS' CONFERENCE
ON
TRANSPORTATION OF NUCLEAR SPENT FUEL**

July 15, 1970

Subsequent to publication of the proceedings of the Conference on Transportation of Nuclear Spent Fuel, Mr. A. E. Johnson, Executive Director, American Association of State Highway Officials (AASHO), sent the attached letter and engineering analysis to all state highway administrators. As indicated in the "Sequel" to the proceedings, the vehicle design for which the engineering analysis was made, was developed in cooperation with AASHO.

Reproduction of the letter and analysis and distribution as an addendum to the proceedings was approved by the Executive Director, AASHO.

The Southern Interstate Nuclear Board concurs in Mr. Johnson's recommendation that highway transportation of nuclear spent fuel be viewed and treated on a national basis rather than as an individual state or regional problem.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS

GENERAL OFFICES
341 National Press Building
Washington, D. C. 20004
Telephone: NAational 8-2438

June 19, 1970

To the Chief Administrative Officers
of the Member Departments of the
American Association of State
Highway Officials

Gentlemen:

In my letter to you of June 5th, 1970, Item 3, pertaining to the design and specifications for the nuclear transporter which had been developed through discussions between the Southern Interstate Nuclear Board and this office, in accordance with instructions from the AASHO Executive and Administrative Committees, I transmitted the drawings and specifications at that time and indicated that Mr. Goodman of Arkansas would supply an analysis of the effects of the transporter on the basic H15 bridge at a later time.

That has now been received and is attached, hereto. The most significant of the charts is Figure 3 of Mr. Goodman's material, and you will remember that AASHO developed its official vehicle weight and size policy on the basis of a 30% allowable overstress on our H15 bridges, mainly, because of the allowable stresses for steel and concrete that were used in their design.

I would recommend that any of the States being contacted by the Nuclear people would view this matter, not as a State or regional problem, but as a national problem and as an AASHO matter, and it is my opinion that the transporter design that we have developed and submitted to you is as acceptable as any one that we are likely to get.

Yours very truly

A. E. Johnson
Executive Director

AEJ:nh
Attach.

**ARKANSAS
STATE HIGHWAY COMMISSION**

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June 15, 1970

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B. K. COOPER
CHIEF ENGINEER

Mr. A. E. Johnson
Executive Director
American Ass'n. of State Highway Officials
341 National Press Building
Washington, D. C. 20004

Re: Nuclear Spent
Fuel Transporter

Dear Alf:

In accordance with your request, we have made an engineering analysis of the loads caused by the Nuclear Spent Fuel Transporter as shown in Figure 4. Our analysis is based on the assumption that there will be a satisfactory articulation of loads to the wheels so that there is equal distribution.

I enclose for your information the following five documents:

1. A brief statement concerning our analysis.
2. A chart comparing maximum reaction of the Transporter and the H15 Truck.
3. Chart comparing moments for the Transporter with those caused by the H15 Truck.
4. A chart showing the overstress on simple spans caused by the Transporter as compared to the H15 Truck.
5. Schematic diagram of the Transporter on which our analysis was made.

Sincerely,

Ward Goodman, Chairman
AASHO Committee on
Bridges and Structures

5 Enc.

INVESTIGATION OF NUCLEAR FUEL TRANSPORTER LOADING ON BRIDGES

An investigation was made of the moments and reactions that the Spent Fuel Transporter would produce on simple span bridges. Figure 1 compares the reactions for H15 and the Transporter. The Transporter produces reactions approximately double those for H15. Figure 2 compares the moments for H15 and the Transporter. The Transporter produces moments approximately double those for H15. Figure 3 shows percent overstress on a girder due to the Transporter on a typical steel Composite I-Beam bridge designed for H15 loading. The Transporter produces a maximum overstress of 38%. This is very close to the allowable stress of $0.75 F_y$ as allowed in Section 11 of the Standard Specifications. Figure 4 shows the axle loading for the Transporter.

An investigation was made of the effects of the Transporter loading on transverse members such as floor beams. It is felt that this loading would not produce excessive stresses in floor beams, since they are usually designed for trucks in more than one lane and only one of the Transporters should be on a structure at one time.

Since the wheel loads are not excessive, the Transporter should not cause any problems for deck slabs.

An important question is whether loads will stay equally distributed to axle loads shown in Figure 4.

Initialed by Ward Goodman
6-15-70

Figure 1

Max. Reaction for
Transporter and H15

Figure 2

Max. Moment for
Transporter and H15

Simple Span (ft.)

PROCEEDINGS

CONFERENCE ON
"TRANSPORTATION OF NUCLEAR SPENT FUEL"

Atlanta, Georgia
February 5 and 6, 1970

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Presented by:

Southern Interstate Nuclear Board
800 Peachtree Street, N. E.
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Atlanta, Georgia 30308

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TABLE OF CONTENTS

	<u>Page</u>
FOREWORD	iv
OPENING REMARKS	
Robert H. Gifford	1
IMPACT OF THE NUCLEAR FUEL CYCLE INDUSTRIES ON THE ECONOMIC AND CULTURAL DEVELOPMENT OF THE SINB REGION	
Henry C. Schultze	7
THE NUCLEAR FUEL CYCLE AND ITS TRANSPORTATION REQUIREMENTS	
Harold E. Walchli	10
CONTAINER LOADING AT A NUCLEAR POWER PLANT	
Carl A. Larson	25
CONTAINER UNLOADING AT A REPROCESSING PLANT	
Edward D. North	37
SHIPPING CONTAINER DESIGN AND TRANSPORTATION	
Reuben W. Peterson and C. Wesley Smith	46
TOTAL SHIPPING REQUIREMENTS	
John D. McDaniels, Jr. (Read by Sanford P. Hellman)	74
COMMITTEE RECOMMENDATIONS	
James W. Lee	82
PANEL DISCUSSION	
Sterling W. Cole, Moderator	101
INTRODUCTION OF LUNCHEON SPEAKER	
Allen T. Peyton, Jr.	129
NUCLEAR ENERGY AND TRANSPORTATION	
Ernest B. Tremmel	130
CONCLUDING REMARKS	
Robert H. Gifford	151
PARTICIPANTS	153
ATTENDEES	159
SEQUEL	165

FOREWORD

This is a compilation of papers presented at a Conference on Transportation of Nuclear Spent Fuel and a transcript of the panel discussion and luncheon address. The conference was sponsored by the Southern Interstate Nuclear Board (SINB) for highway administrators from the seventeen member states; however, the information presented had nationwide significance. Accordingly, the Division of Technical Information, Atomic Energy Commission, Oak Ridge Extension, Tennessee published the proceedings so that they would be available nationally.

Spent fuel will be shipped over the majority of the state's highway systems, necessitating involvement of the highway departments. Therefore, SINB has kept Mr. A. E. Johnson, Executive Director, American Association of State Highway Officials (AASHO) advised of SINB's activities prior to and since the conference so he could keep state highway administrators informed and so he would have information upon which to base recommendations to them. Mr. Johnson and members of the AASHO bridge committee have met with SINB staff and project committee members on several occasions and have provided invaluable advice and assistance which was appreciated greatly.

SINB is indebted to many companies, agencies, institutions, associations and individuals for their counsel and help. A list of these participants is included.

Allen T. Peyton, Jr.
Deputy Director - SINB
Project Director

OPENING REMARKS

Robert H. Gifford
Executive Director
Southern Interstate Nuclear Board
Atlanta, Georgia

On behalf of Governor Winthrop Rockefeller, Chairman of the Southern Governors' Conference and Governor Russell Peterson of Delaware, Chairman of the Nuclear Energy and Space Committee, I would like to welcome you to Atlanta and to this conference and to express Governor Rockefeller's, Governor Peterson's, and my appreciation to you for attending. Because of the emphasis that is being placed on design and construction of highways and the demands on your time, I am sure that all of you are here at a considerable personal sacrifice.

The format of the conference and the subjects to be covered are outlined in the printed program. You will note that this afternoon is devoted to presentations by recognized experts in the nuclear industry.

There will be a reception in Lancaster Room C from 5:30 p.m. to 7:00 p.m. We have not planned a banquet or other activities for the evening because we felt many of you might want to visit some of the outstanding places of interest in Atlanta.

The session tomorrow morning, which will begin at 9:30 a.m., will be an informal panel discussion. All speakers will be on the panel and you will have an opportunity to ask questions - and we hope that you will give us your ideas at that time. The session tomorrow will conclude with lunch at 12:00 noon in the Club Atlantis.

The Southern Interstate Nuclear Board is a statutory, regional advisory and developmental agency, serving the states of the Southern Governors' Conference in nuclear and space affairs, and is sponsoring this conference at the behest of the Chief Executives of those States. The Governors, at their annual meeting in Williamsburg, Virginia last September, unanimously approved - in principle - a position paper concerning transportation of nuclear spent fuel and endorsed this meeting. The position paper had been prepared by SINB, with the assistance of a group of eminently qualified experts in the nuclear field.

The South has, for many years, led the nation in meeting its responsibilities and acting to obviate problems in the nuclear field, rather than

waiting for problems to arise and then reacting to correct them. We again have a chance for national leadership. The cohesive mechanisms of the Southern Interstate Nuclear Board and Southern Governors' Conference make it reasonable to undertake establishment of a cooperative pattern within this community of contiguous states. Successful application here could serve as an index for other regions and possibly national extrapolation. As nuclear power plants come "on stream" in the South, every state in the Region will be affected -- and because it serves this community of states, the Southern Interstate Nuclear Board is in a unique position to address itself to the matter, and to act as a catalyst in coordinating the varied interests which are or will be affected. We felt that a meeting such as this, where we could talk with you and discuss the situation on a vis-a-vis basis, would be the most effective means of approaching the matter. As I pointed out in my letter of September 12, 1969, by which I transmitted a copy of the aforementioned position paper to each of the Highway Departments, there is no intention to give consideration to any special interest group. The prime motivation for this meeting is enhancement of economic and industrial growth in the South, with no adverse effect to the highway systems.

Were it not for nuclear power, there would not be any reason for this meeting. So, the questions arise -- and they are valid -- "Why nuclear power?" and "What is wrong with the fossil fuels on which we have depended for so many years?" I would not attempt to discuss the relative merits of fossil and nuclear fuels. First, that is not why we are here and secondly the discussion would be academic because we know that even with the increase in nuclear power generation, the United States is going to be using a growing amount of coal over the next few decades for generation of electricity.

However, Dr. Glenn Seaborg, Chairman of the U. S. Atomic Energy Commission, stated recently that with all due respect to fossil fuels, upon which our industrial age has been built and flourished, and with due regard to the known and projected undiscovered reserves of these fuels, he did not believe that they alone could sustain the energy consuming world that we may expect over the next 100 to 200 years -- Not if we wish to accomplish all we believe we should - or even a major portion of it.

The seventeen states which make up the Southern Governors' Conference and which are served by the Southern Interstate Nuclear Board, is the fastest growing region in the United States with respect to nuclear power. There are 27 nuclear power plants scheduled for the region in the early to mid 1970's, representing a capital investment of well over \$3 billion and over 22,000 megawatts of generating capacity. Recent forecasts indicate that some 50 to 65 nuclear power plants will be required in the region by 1980; and these plants, along with the fossil fuel and hydro

plants, will provide the power that is so necessary to the industrial and economic growth of the South. Please note that "27 nuclear power plants are scheduled" although the Position Paper listed only 25. Two additional plants were announced by Duke Power Company within the last 90 days. This is an indication of the rapid growth of the nuclear power industry in our region.

I would like to digress and point out that some of the other information which will be presented will be slightly at variance with information contained in the Position Paper. The reason for this is, that as we have studied this matter further and refined the data, new facts have been brought to light and incorporated into the presentations.

To continue -- Duke Power has not publicly revealed the locations of the last two nuclear power plants they announced. However, of the 25 plants for which locations are known, over 50% are not served by railroads and will be entirely dependent upon motor carriers for inbound and outbound shipments. And because of nuclear power plant siting criteria, it is probable that this condition will prevail for future plants. The fact that these plants will not be served by rail would not pose any particular problems were it not for nuclear spent fuel.

One to two years after a nuclear power plant begins commercial operation, one-fourth to one-third of the nuclear fuel must be removed and a like amount of fuel is removed and replaced each year thereafter. The spent fuel which is removed from the nuclear reactors is taken to a reprocessing plant where valuable plutonium, uranium and isotopes are recovered. Two companies have announced plans to build reprocessing plants in South Carolina, and it is noteworthy that, if both of these plants are built, this capability will constitute over half of the reprocessing capacity in the United States.

Although nuclear power plants are not scheduled for all states in the region at the present time, and fuel reprocessing facilities are planned only for the State of South Carolina, the region as a whole will benefit economically. For example, each nuclear power plant will cost upwards of \$165 to \$175 million and will employ over 100 people. One fuel reprocessing plant will cost over \$50 million and will provide employment for about 200 individuals. This does not take into consideration the capital investment and the employment in fuel cycle industries to support these plants and in service industries which provide goods and services to the nuclear power plants and reprocessors -- or the economic and industrial benefits which will be gained from abundant, low-cost electric power. Every state in the region stands to gain.

Spent fuel is a unique commodity. It is highly irradiated and must be shipped in heavily shielded containers to meet Atomic Energy Commission and Department of Transportation requirements. The containers are extremely heavy, and create a gross vehicle weight of about 90,000 pounds when transporting only one unit. The ratio of payload to total vehicle weight is considerably less than most commodities; and unlike most commodities, payload is not linear with gross vehicle weight. That is to say, considering a commodity such as steel for example, the addition of one ton of steel on a vehicle increases the gross vehicle weight by one ton. In the case of spent fuel, increasing the payload by one ton, increases the gross vehicle weight by considerably more than a ton because of the additional shielding required. Despite the high gross vehicle weights, the shipments do not exceed allowable axle weights, in most cases.

Another unique feature of spent fuel is that while most overweight loads are also overdimensional, spent fuel shipments are not. They are well within allowable size limits. Many much lighter loads such as mobile homes, which do not exceed maximum allowable gross vehicle weights, are overdimensional and create safety hazards on the highways. This is not the case with spent fuel.

In addition to normal highway safety considerations, some of you may wonder what radiation hazards the public would be subjected to. Based on experience, we can safely say, "practically none." The Atomic Energy Commission and industry safety experience to date is that -- "There has never been an accident involving irradiated fuel where the public was exposed to radiation."

Let me briefly outline some of the problems the nuclear industry is faced with and will be faced with in the future in the shipment of this commodity, and to explain why we feel that this matter is of considerable urgency.

Utility companies in the SINB Region have requested fuel reprocessors to quote firm prices for the movement and reprocessing of spent fuel into the 1980's. Fuel reprocessors are unable to furnish firm prices without knowing what gross vehicle weights the highway departments will authorize by overweight permits. In the first place, the gross vehicle weight for shipping the lowest divisible load of one fuel unit would be 90,000 pounds and container manufacturers and reprocessors believe that the cost of containers for shipping one fuel unit would be prohibitive.

Future nuclear power plants are currently being considered in several states and an otherwise suitable site might be rendered unsuitable

if spent fuel cannot be shipped by highway, economically. In addition, the types of containers and the number of units shipped in each container, will affect design and cost of shipping container loading facilities at the power plants.

By the same token, fuel reprocessors planning new reprocessing plants cannot fully design their shipping container unloading facilities without knowing the types of containers to be unloaded and the number of units in the containers.

Further, it is necessary for shipping container manufacturers to know the modes of transportation by which the spent fuel will move as well as the number of units which will be shipped in a container so that they can design and manufacture the shipping containers to meet the requirements.

And lastly, companies providing shipping services and vehicle manufacturers need information as to the design and weight of containers so that they can design transportation equipment to carry them.

Nuclear power plants will begin commercial operation in the SINB area in the early 1970's and nuclear spent fuel will start moving from these plants to the reprocessing plants in 1973 and 1974. We are discussing this matter with you now because it is necessary that there be agreed upon guidelines with respect to these movements in order to facilitate siting and design of power plant and reprocessing facilities, and design and manufacture of equipment in 1970 and 1971 to meet 1973 and 1974 requirements. For example, utility companies need about a seven year lead time from the time site selection starts, to operation of the plant. They must make decisions based on facts and the decisions they make now will affect the economy of the region seven years from now.

Fuel reprocessors require at least a three year lead time to design container unloading facilities; and shipping container and vehicle manufacturers need at least a three year lead time for design and manufacture of shipping containers and vehicles to transport them.

During the balance of this afternoon, you will hear from several speakers who are intimately involved, on a day to day basis, in planning for movement of nuclear spent fuel and in design and manufacture of equipment and facilities. We respectfully request that you consider the facts that will be brought out by them and during the panel discussion tomorrow morning, perhaps you could give us your ideas and suggestions.

We believe it is quite important that the nuclear industry knows what requirements the states will impose with respect to highway shipments

of spent fuel so they can proceed with design and manufacture of facilities and equipment. Specifically, we would like for you to consider authorizing, under your present permit procedures, movements of 115,000 pound gross vehicle weights over routes designated by the Highway Departments. Please note that we feel the Highway Departments should designate the routes over which these loads can move. Because these shipments are not overdimensional, we would also appreciate consideration of allowing them to move during hours of darkness and on non-holiday weekends, the same as any other load of like size. We do not ask that you change your methods of issuing permits, nor do we feel that those states which charge for overweight permits should discontinue those charges.

The nuclear industry is an emerging, growing industry and we believe its growth should be encouraged. Many states offer tax incentives, tax free industrial development revenue bonds, and build access roads, as well as offer other incentives, to new and expanding industries in order to create a better climate for industrial and economic development. We believe that a request for consideration of allowing overweight spent fuel shipments would fall in this category and is not without precedent.

IMPACT OF THE NUCLEAR FUEL CYCLE INDUSTRIES ON THE
ECONOMIC AND CULTURAL DEVELOPMENT OF THE SINB REGION

Henry C. Schultze, Ph.D.
Vice President
Chem-Nuclear Services, Inc.
Columbia, South Carolina

The excellent highway systems we enjoy in our southern region of the United States have been planned carefully years in advance by state highway engineers using considerable foresight to meet the impact of the exploding transportation problems of today and the future. These highways have been called "pathways to progress" by Theron J. Hendrix, South Carolina's chief highway engineer.¹ They are contributing appreciably to the economic and cultural development of our individual states and the region. During the past two decades we have advanced from largely an agricultural society to a broader and sounder economic base that includes diversified agriculture as an essential entity and also sophisticated industries of a highly technical nature. Our people have been freed from many arduous tasks. They now enjoy more fully the good things of life. Their increased tax dollars are enabling our communities and our states to supply more of the services an enlightened public demands. Each of us, I am sure, is more satisfied with his present status. Would we trade it for the life we enjoyed or failed to enjoy as fully ten to twenty years ago?

Pathways to progress! Look carefully along our excellent highways and also across the fields and woodlands these highways traverse. Those heavy-duty electric transmission lines, those new electric generating stations are also pathways to progress for our region. They have contributed much to the burgeoning and diversified economy we enjoy today. Our electric utilities are strong effective partners for the economic and cultural development of our communities, our states, and our region.

Energy is a basic fundamental commodity. Utilities must plan diligently seven to ten years ahead of time to meet projected energy demands. These are now doubling every seven years in our region. Where once largely textile plants, furniture factories, paper and pulp industries dotted our landscapes, we now have very modern synthetic fiber plants, diversified chemical and large metal-working facilities, factories specializing in transistors, capacitors, digital computers, and other electronic systems. We have the space industry and also the atomic energy industry,

a great new growth industry of the 1970's. All of these industries use large blocks of power. Each is contributing significantly to a better way of life for us and for our children. Without your foresight for supplying better transportation, and without the foresight of the electric utilities for anticipating and supplying the power needs of such industries, we would not be where we are today.

To continue to develop our resources and to use our manpower in an optimum manner, our region will require lower-cost power than that we now enjoy. We will continue to use coal and fossil fuels as well as hydroelectric facilities to supply large blocks of power. However, not one of these methods of power generation offers the potential for lower cost electricity that is available to us from nuclear electric generating stations. Twenty-seven of these nuclear stations have been announced for our region. Their capacity exceeds 22,000,000 kilowatts. The investment of capital to build them exceeds \$3 billion. They are expressions of confidence by the electric utilities in our region's further economic and cultural development. Their capital investments are termed "patient money" by the utilities -- money invested for the long range future from which more favorable returns will be realized than those by other alternative means.

The pace of diversified industrial acquisitions is accelerating markedly in each of our southern states. Many of our citizens are developing new skills and are using these skills to better personal advantage than was true a decade ago. Graduates in science and engineering, in various professions, in business administration activities, and other remunerative service fields are gaining worthwhile employment opportunities at home. Our highly-trained personnel are not migrating out of the southern region in large numbers as was true a decade ago. Our tax revenues, our opportunities to have more leisure time and to enjoy the many natural resources of our region are also expanding at a favorable rate.

Those of you whose principal interests are transportation and the supply of energy must continue to look ahead as partners for our future optimum development. You have mutual problems and challenges to be met and solved collectively such as the problem of transportation of spent nuclear fuels we face at this important conference. The south is on the move to a greater, more bountiful future. From your cooperative efforts at this conference and from your continuing cooperative efforts in the days ahead, will rise new industries that we do not have today. The atom as an effective partner in industrial development is at work today in the south at a pace more rapid than that of any other region. You have in your future not only nuclear electric generating stations and the diversified highly technical industries using large blocks of power. You are

gaining directly many valuable spin-off industries of nuclear power supply such as those for the fabrication and reprocessing of nuclear fuel elements; for the construction of nuclear reactors and their components; for instruments and control devices; for the use of irradiation procedures in industrial processes and in medicine; for the use of radioisotopes in food preservation, for space, oceanographic and other applications. From these industrial gains will come revenues in greater amounts and also opportunities for our people to enjoy a fuller life in an environment that has no parallel elsewhere in the United States. The challenge is now yours to accept. The problems you face today, I am confident, will be solved effectively for your mutual interests, for the states and region you represent, and most importantly for the public to whom your best efforts are always dedicated.

¹Theron J. Hendrix. The Columbia Record, Columbia, South Carolina, Section B. Friday, January 2, 1970.

NUCLEAR FUEL CYCLE AND ITS TRANSPORTATION REQUIREMENTS

Harold E. Walchli
Manager, Fuel Service
Nuclear Fuel Division
Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

To provide a background for the presentations today and our discussions tomorrow, permit me to describe to you the general nature of nuclear utility plants and the supply of nuclear fuel to these plants. This supply of fuel we call the nuclear fuel cycle.

What is a nuclear power plant? It is simply a steam driven electrical generator which obtains its steam by using the heat generated through the destruction of uranium atoms in a large pressure vessel rather than from destruction of hydro-carbons, in a furnace-boiler. What do these plants look like? In general, they're efficient, clean, quiet, and are respectable community citizens as can be seen from these views of plants already in existence.

To supply the nuclear fuel for these plants, there are many operations that require transportation. The basic steps in the fuel cycle consist of raw materials, refinement, fabrication, power production, spent fuel shipment, reprocessing and recycling. (Figure 1) Uranium starts as an ore in the ground. It is hauled to a mill and purified into a uranium compound called yellow cake. The yellow cake is packaged and transported to a facility where it is converted to uranium hexafluoride which is then suitable for use in the AEC-operated facilities where U-238 atoms are removed and the fuel becomes enriched in the fissionable atom U-235. This enriched uranium gas is then transported again to a factory where it is converted to a solid and installed in fuel. The fuel is then brought to the reactor. Energy is removed from the fuel. During this

energy removal stage, the fuel undergoes a change. As with coal which burns to soot, ashes, gas and heat, uranium ends up with ashes (called fission products), gas and heat. Unlike other fuels, the gas of nuclear fuel is retained within the fuel tubes. The fission product ashes also are contained within these tubes. Now, however, the fuel contains a considerable amount of radioactivity gained during the burning process. There is one additional major difference. The nuclear fuel is not yet a waste product for it contains many unused uranium atoms, plutonium, and other useful products that must be recovered because of their high economic value. After allowing the radioactivity to decrease for a period of a few months, the fuel is ready to be transported to the reprocessing plant. Because of the high radioactivity, the containers used for this operation are made of steel and lead or other heavy metals. At the reprocessing plant the useful uranium and plutonium are separated from the true wastes and are returned to the fuel cycle for the generation of more power.

To show these steps in more detail, Westinghouse has prepared a film entitled "Mass Into Energy." I hope you will find it to be both informative and enjoyable.

Now that you know generally about the fuel cycle, let's take a look at what this means to the southern states. (Figure 2) In this figure, you will note that all phases of the fuel cycle are present. Mines and mills are found in Texas. Conversion to natural UF_6 occurs in Oklahoma and soon in the Carolinas. Enrichment is performed in Kentucky and Tennessee. Manufacturing facilities are found in Tennessee, Virginia, Florida, North and South Carolina, and a reprocessing facility is to be constructed soon in South Carolina.

Most important of all, however, are the energy producing nuclear power plants which as already announced will be found in 27 locations in nine of your southern states, and more will come in future years. Of these 27 plants, two sites have not yet been selected. Twelve of these sites have access by railroad and highway, but the remaining thirteen sites must be reached by truck to transport spent fuel over land from the plants to the reprocessor. Herein lies our concern, for the economics of spent fuel shipping are by far the most unfavorable of any shipments made in the whole fuel cycle and poorer than for most other commodities.

Let me review for you the transportation requirements for this industry. In the mining operation, (Figure 3) ore can be placed on trucks of any size. Yellow cake is packaged in drums which can be loaded to provide optimum economics. (Figure 4) UF_6 cylinders (Figure 5) are sized such as to prevent accidental criticality and are relatively small. New fuel assemblies (Figure 6) are in packages weighing about three tons each making a full truck load of six containers. Recovered uranium is transported (Figure 7) in tank wagons, and plutonium in drums (Figure 8). All of these have one property in common. The load size can be adjusted to meet existing highway limits without change. In only one phase, the shipment of spent fuel (Figure 9) which requires shipping in heavy containers is this not true.

Let's examine the growth of the shipping problem associated with spent fuel. Nuclear power plants in the United States are usually either a boiling water reactor (BWR) or a pressurized water reactor (PWR). In the early years, the plant sizes were relatively small and the size of the fuel was also small. As the demand for more power increased, it became necessary for the size and quantity of fuel to do likewise.

This figure (Figure 10) shows graphically the relative increase in size of BWR and PWR assemblies over the past 15 years. For purposes of our discussion we have selected the PWR fuel because of its larger size and weight.

Except for the radiation and decay heat, a fuel unit looks the same as the assembly shown here (Figure 11). This unit, a PWR assembly of current vintage, is 8-1/2 inches on a side and is about 14 feet long. It weighs almost 1500 pounds and contains 1,000 pounds of uranium. The fuel unit cannot be disassembled or otherwise modified before shipment due to its integral construction. You may study the construction of this further by examining the model we have provided. The next generation of fuel will likely be longer. Because of the shielding required, it must be transported in a heavy container commonly referred to as a cask. If two of these are placed in a container and transported on a vehicle having a total weight of 115,000 pounds, the ratio of commodity to gross vehicle weight is only 2.5%.

Let us examine the growth of the need for transportation of spent fuel. This figure (Figure 12) shows the projected number of shipments required for transportation of spent fuel if we assume all shipments can be made in containers which will hold the equivalent of two PWR type assemblies or about one metric tonne of fuel.

Although this figure shows the total USA needs, a large portion of these could fall in the southern states since a major reprocessing center will be in South Carolina.

By 1980 approximately 4,000 shipments per year will be required. If we assume that a shipment can be completed in two weeks, approximately one hundred and sixty (160) containers will be required to do the job.

By 1987, on the same basis, 1,000 containers will be required by the industry. It is estimated, in 1970 dollars, that one container will cost between \$150,000 and \$450,000. Of course, we can expect that some fuel will go by means other than truck. Even if only 50% is by truck, we are still talking \$12-\$25 million of investment in containers by 1980. To ship less than two fuel units will almost double this investment, the cost for which can only be recovered by utilities through increased cost of electrical energy, because unlike trucks or rail cars, these containers have no other economical use. Because of this large investment, it is important that the proper sized casks be constructed in the early years.

I hope I have given you a view of the needs of the nuclear fuel cycle. It gives me pleasure at this time to introduce our next speaker who will describe to you the problems and procedures for container handling at nuclear power plants.

1. Saxton--Pennsylvania

2. Yankee Atomic Electric--Massachusetts

3. Connecticut Yankee Atomic Power--Connecticut

4. Zorita--Spain

5. Consolidated Edison—New York

6. Big Rock Point—Michigan

7. Oyster Creek—New Jersey

8. Tarapur—India

NUCLEAR FUEL CYCLE

Figure 1 Steps in Fuel Cycle

COMMERCIAL NUCLEAR-ELECTRIC POWER PLANTS PLANNED OR UNDER CONSTRUCTION S.I.N.B. REGION

Figure 2 S.I.N.B. Area Nuclear Industry

Figure 3 Mining Operation

Figure 4 Yellow Cake Shipment

Figure 5 Enriched Uranium Hexafluoride

Figure 6 New Fuel—H.B. Robinson Plant, South Carolina

Figures 7 and 8 were not
available for reproduction

Figure 9 Single Element Spent Fuel Container (1960)

Figure 10 Fuel Size

Figure 11 PWR Fuel Element

SPENT FUEL AVAILABLE FOR SHIPMENT ASSUMING 1 MTU/LOAD

NO. OF SHIPMENTS

Figure 12 Growth of Fuel Shipping

CONTAINER LOADING AT A NUCLEAR POWER PLANT

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Presently designed light-water power reactors in nuclear power plants normally shut down about once a year to remove a portion of the fuel units that have served their useful life. This portion is about one-fourth to one-third of the total number of fuel units in the reactor which depends on whether it is a pressurized water reactor or a boiling water reactor. Consolidated Edison's Indian Point Unit No. 1, which has been in operation since 1962, utilizes a pressurized water reactor containing 120 fuel units. The core of the reactor is divided into three regions of 40 units each, and at refueling the oldest region is discharged and replaced by a fresh one. Each unit, therefore, is in the reactor for about three years.

There are two more nuclear reactors under construction at Indian Point Station which are expected to be completed in 1971 and 1973 (Figure 1). The Station is located about 35 miles north of New York City on the Hudson River. Each of the new reactors will discharge 64 fuel units a year and, therefore, a total of 168 fuel units per year will be discharged from three units at the Indian Point site. There is no rail siding into the plant and none is currently planned. Studies have shown that the cost of a rail siding, which would have to include a bridge across a road, cannot be economically justified when compared to truck shipping.

To illustrate a typical spent fuel loading at a nuclear plant Indian Point No. 1 will be used as an example. The fuel units are about 12 feet long and 6 inches square with a nozzle on each end (Figure 2). Each unit consists of a bundle of uranium filled stainless steel tubes surrounded by a perforated container.

During refueling the fuel units must always be surrounded by water, which serves a two-fold purpose: radiation shielding and cooling. The top of the reactor

vessel is removed and the pool over the reactor is filled with water (Figure 3). Fuel units are lifted out of the reactor vessel using an overhead hoist handled by personnel located at floor level. The fuel unit is transferred from the pool at the reactor, through a canal, and into a spent fuel storage pool in a separate building. After the region of spent fuel is removed from the reactor, the remaining two regions of fuel units are moved to new locations in the reactor and the fresh region is installed in the vacant spaces. Each unit is positioned according to a specific plan to assure an even burn-up of fuel.

The spent fuel units must be stored for a time prior to shipment. This storage allows the short-lived fission products to radioactively decay and, as a result, the heat generated and radiation level decrease. The shipping container is designed to dissipate heat at a certain rate and must also provide adequate radiation shielding. In the case of Indian Point fuel and the shipping container presently utilized, the fuel must be stored for about 120 days prior to shipment.

AEC and DOT shipping regulations require that no shipment is released until it can be ascertained that the temperature of the container is stabilized and below the cask design value. Also, from a reprocessing standpoint, enough time must elapse between removing the fuel from the reactor to the start of reprocessing so that it can be accomplished within regulations established by the AEC. The primary limitation is Iodine 131 activity which must be allowed to radioactively decay to a reasonable level. Using slides, the steps involved in loading fuel units into a truck container will be illustrated.

Figure 4 shows one of the containers used to ship Indian Point No. 1 spent fuel units. The container is essentially constructed with an inner container made of stainless steel, an outer container made of stainless steel with cooling fins, and about 8" of lead between the two steel containers. The weight is approximately 30 tons fully loaded. Some of the dimensions are as follows: the inside cavity is 15" in diameter by 140" long and the outside, including the fins, is 44" in diameter by 160" long. The fins are for heat dissipation since the container is cooled by natural circulation of air around the outside. Water fills the inner cavity around fuel units to act as

a heat transfer medium and, to a lesser degree, for radiation shielding. The container will hold two Indian Point 1 spent fuel units that weigh a total of 1,300 pounds. The payload, therefore, is about 2% of the total container shipping weight. The container is loaded on a standard low-bed trailer with a powered gooseneck and is pulled by a standard three axle tractor (Figure 5). The gross vehicle weight, including the loaded container, is approximately 94,000 pounds. This, of course, is an overweight shipment requiring a special permit from the State of New York.

The truck is backed into the Fuel Storage Building and the tie-downs are removed (Figure 6). A special lifting yoke is attached and the container is then elevated to an upright position utilizing a tilt-table attached to the trailer (Figure 7). When the container is in a vertical position and clear from the trailer (Figure 8) it is moved to a specially designed de-contamination pit for cleaning road dirt from the outer surface. At Indian Point, there is a steam-cleaning device through which the container is passed utilizing the over-head crane. The container must be clean of road dirt before being placed in the unloading pool to maintain clarity of the water. The fuel storage pools are filled with about 30 feet of water and any slight contamination of the water makes it difficult to see to the bottom. The container is positioned over the loading pool (Figure 9), and then lowered to a platform in the pool. Figure 10 shows the container positioned on the platform during a test when the pool was not filled with water. Figure 11 shows the container in this position during actual operations with just the top above the surface of the water. At this stage, the cover plate bolts are loosened and wire slings are attached to the yoke to permit the container to be lowered to the bottom of the pool without submerging the crane's hook. Slings are also connected between the yoke and the cover plate. The container is then lowered to the bottom of the pool, the yoke is disengaged from the container, and as the yoke is lifted the cover plate is taken off. The container is now ready to receive spent fuel units.

Spent fuel units are stored in a separate pool in baskets which hold four units. In the center of Figure 12, which is looking down into the water-filled pool, can be seen one of the baskets containing four fuel units. The unit is hoisted out of the basket in a vertical position

with a long boom hung from the crane hook (Figure 13). A TV monitor is utilized to inspect each unit before it is shipped and to read the serial number engraved on the top of the unit. After identification, the unit is transferred to the container loading pool through a canal connecting the pools (Figure 14). Figure 15 shows the unit being inserted into the empty container. The open rectangular space in the container is the top of the internal cavity which holds two fuel units. When the top cover plate is bolted down, springs within the fuel units exert pressure to hold them in place during shipping.

The container handling procedures are reversed once it is loaded. The yoke is lowered, the container cover plate replaced and the yoke attached to the container. The container is lifted up to the holding platform, the slings removed and the cover plate is bolted down. The container is then moved to the de-contamination pit and there it is steam-cleaned and the water in the container is flushed out and replaced with fresh water. The container is equipped with a pressure relief valve which would empty into an overflow tank on the trailer if for some unforeseen reason water pressure in the container exceeded a preset point. The container is checked for external radioactivity and cleaned as required to assure there is no contamination. It is then moved to the trailer, placed in a horizontal position and tied down. Water samples are withdrawn from the container and sampled for radioactivity which would indicate a defective fuel unit. Water temperature is recorded for a few hours before the truck begins its trip to the reprocessing plant to insure that the fuel unit heat load is within design limits of the container. The container is again checked to assure that it is within the radioactivity limits required by Department of Transportation regulations. Our staff uses a check list for all of the above steps which is signed and approved by Company representatives before shipping.

There have been 102 shipments of this type between Indian Point Station and West Valley, N. Y., a distance of about 450 miles. We have never experienced any problems and are quite satisfied with the container design and shipping service. Three containers, three trailers, and one tractor are used during shipment. With this equipment one container and trailer are at Indian Point for loading, one in transit to or from the reprocessing plant, and one being unloaded at the reprocessing

plant. The total container turn-around time at Indian Point is about 16 hours and requires a minimum work force of one foreman and two mechanics. If only one unit were loaded into a container, there would be no reduction in manpower and the actual time saving would be about 15 to 30 minutes since the majority of the time is used to handle the container. We would be concerned, therefore, if the container were limited to one unit per container for this type of fuel. The manhours required to ship a region of fuel would be essentially doubled, and unless the number of containers was increased, the total time required to ship all the fuel out of a reactor could be significantly increased. Limiting the container to one unit would almost double shipping costs. First, handling at our plant would be doubled. Second, the cask designed for one unit would be slightly smaller, but that would not significantly reduce the manufacturing cost. Third, truck shipments would be doubled. Fourth, the shipping time would be extended which means our inventory costs would be increased. Truck shipping is important to our nuclear plant operations, therefore, and future plants are being designed accordingly.

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

FIG.8

FIG.9

FIG. 10

FIG. 11

FIG.12

FIG.13

FIG.14

FIG.15

CONTAINER UNLOADING AT A REPROCESSING PLANT

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Director, Technical Administration
Nuclear Fuel Services, Inc.
Wheaton, Maryland

Nuclear Fuel Services, Inc. operates the only privately owned fuel reprocessing plant in the United States. The plant, located at West Valley, New York, has been in operation since 1966 and has been operated at its design rate of one metric ton per day. An expansion program, now in the early engineering design stages, will increase the capacity of the plant to three tons per day by 1972.

General Electric Company, at Morris, Illinois, is presently constructing a one ton per day plant which is expected to be on stream in 1971.

Allied Chemical and Atlantic Richfield each have plans to construct a five ton per day plant in South Carolina. It is expected that the Allied Plant will be on stream in 1973.

The NFS West Valley Plant has received to date some 520 tons of spent fuel. Most of this was handled in rail containers for only 40 tons or 8% of the total arrived in over-the-road truck containers. This high proportion of rail shipments is not expected to continue, however, for many of the reactors now under construction are not served by rail roads, and for short hauls it is believed that highway transport is more economical and thus trucks will be used with increasing frequency.

There are several government owned reprocessing plants which have been in operation for many years. These plants, located in South Carolina, Tennessee, and Washington state, have received many tons of spent fuels in trucks. I am informed that the Savannah River Plant, operated by Dupont for the AEC, has received 24 truck shipments with gross vehicle weights of over 100,000 pounds. One of these shipments passed through ten Southern states. Another shipment came all the way from California to the Savannah River Plant.

The Savannah River people tell me that it requires almost the same time to turnaround a 30,000 pound truck container as for a 100 ton rail container. Savannah River as well as NFS would prefer to have shipping containers hold as many fuel units as possible, consistent with reasonable weight limitations for over-the-road use.

The problem of transporting spent nuclear fuels, while some-

what minor at this time, will increase immensely during the next two to five years and the decisions which must be made at this time, because of the long lead times involved, will have a far reaching effect on the economics of fuel reprocessing and ultimately on the economics of the nuclear fuel cycle.

We have seen the procedures that take place at the reactor site to load the spent fuel units into the transport container. We shall now show the procedures that must be followed to unload the spent fuel units at the reprocessing plant.

The procedures vary slightly from one container to another since at this time no two containers are alike. The basic principles, however are the same for all containers; only the details vary due to differences in construction, method of tie-down, and transport carrier. It will be apparent that the unloading operation, while straight forward, requires from 14 to 24 hours in time and many man-hours of labor of each container. It is a complicated and tedious procedure requiring a great amount of skill on the part of our operators. It also involves a certain amount of unavoidable exposure to radiation. For these reasons we would like to minimize the number of unloading operations insofar as possible.

The first few slides show various containers now in use and illustrate the evolution which has been taking place in container design.

Slide 1 is the Westinghouse rail container. It weighs 120,000 pounds and can carry $2\frac{1}{2}$ tons of fuel in 9 units.

Slide 2 is the NFS X-2 rail container. It weighs 140,000 lbs. and can carry two tons of fuel in 15 units. This container was put into service in 1969 and represents the latest design in rail containers.

Slide 3 is the ATCOR truck container. It weighs 50,000 lbs. and can hold up to ten small units. It was not designed for the longer fuel units that are now standard in the industry.

Slide 4 is the Oak Ridge truck container weighing 70,000 lbs. with a gross vehicle weight of 105,000 pounds.

Slide 5 is the Hallam truck container weighing 78,000 pounds with a gross vehicle weight of 113,000 pounds. This container is 15 feet long and is suitable for present day fuel units.

The first step in the unloading procedure is to survey the outside of the container for contamination. While the container was cleaned and surveyed at the reactor site prior to shipment it is necessary to survey it again before taking it into the plant. If

significant contamination is discovered, it will be necessary to decontaminate the container before further handling.

After the outside has been surveyed, a sample of the internal coolant is removed. The purpose of this sample is to determine that the fuel has not ruptured during shipment. If a rupture has occurred, the internal coolant will be grossly contaminated and special precautions must be taken to dispose of the coolant in a safe manner and to package the ruptured fuel for storage in the pool. We have been very fortunate in that fuel ruptures have been infrequent. We have had only one shipment in four years that contained a ruptured unit. It should also be noted that the ruptured fuel was a special fuel that did not come from a power reactor. Fuels from power reactors are completely different in construction and no ruptures have been encountered in these fuels.

After it has been determined that the container meets specifications both inside and outside, the container unloading can begin.

A sling or yoke is attached to the container, and the container is moved to the decontamination pit where road dust and grime are removed. The water in the storage pool is kept clean by constant circulation through ion-exchange units and filters to remove any radioactivity, and it is desirable to eliminate any dirt from the container before it is placed in the pool.

The container is then raised to the vertical position and the head bolts are loosened. The bolts are not removed at this point, however, because several handling steps remain and we must insure that the head remains in place should a mishap occur.

The container is then lowered to the surface of the pool where guide lines are attached to permit proper positioning of the container. The head bolts are removed at this point, and the container is then lowered to the bottom of the pool. The crane used in handling the container has a capacity of 100 tons and, therefore, it moves very slowly. It requires some 30 minutes to lower the container 40 feet to the bottom of the pool, where the yoke is disengaged and moved out of the way of subsequent operations.

The head is then picked up by a small auxiliary crane and stored either on a shelf in the pool or in the decontamination pit adjacent to the pool. In slide 6 the head has been removed and set aside on a shelf in the unloading pool. The inner cover is being removed to provide access to the fuel units. Slide 7 shows the opened container ready for removal of the fuel units. A specially designed grappler hook is then attached to the small crane and lowered into the pool where it is engaged with a boss on the top of the fuel unit. The fuel unit is then carefully removed and placed

in a cannister located nearby. The remaining units are then removed in like manner and stored in separate cannisters. Each cannister contains a single fuel unit and the number and location in the storage pool is recorded in the pool inventory records. This permits the fuel to be inventoried at any time and also permits the units to be processed in any desired sequence. Slide 17 shows fuel units in cannisters in the storage area ready for processing.

After the fuel has been removed, the heavy container yoke is again lowered into the pool and engaged with the trunnions on the container. The container is lifted out of the pool and rinsed with demineralized water before being moved into the decontamination pit where the head is placed on the container and decontaminated. This usually goes smoothly, however, the container has fins and various other protruding members which make decontamination difficult, and it sometimes becomes necessary to repeat the procedure to insure that the container meets contamination specifications for release to the carrier.

The decontaminated container is replaced on the transport carrier and tied down. Health and safety personnel make a final check for contamination and the container is released for shipment back to the power plant for another load.

It can be seen that the unloading procedure is fairly complicated and time consuming.

A typical time schedule for unloading a container is as follows:

1. Remove tie-downs and transfer to decontamination pit	1 hour
2. Monitor for radiation and contamination, sample coolant, decontaminate if necessary	4 hours
3. Loosen bolts, place container in pool and remove head.	3 hours
4. Unload two fuel units	2 hours
5. Remove container from pool, replace head, and decontaminate	4 hours
6. Place container on vehicle and tie down	1 hour
TOTAL	15 hours

The actual removal of the fuel requires only a small proportion of the total turnaround time. If we assume two fuel units per container, the fuel removal time would be two hours or less out of 15 hours or 14% of the total time involved. If the container holds only a single unit, the unloading time would be one hour or less out of a total of 14 hours. The average turnaround time would increase from 7½ hours per unit to 14 hours per unit if the load limit is decreased from two units per container to one unit per container. For this reason we would like to have as many fuel units in the container as weight and design limitations will permit.

The addition of only one or two fuel units per container will greatly reduce both the number of containers to be unloaded and the number of shipments moving over the highways each year. The design capacity of the West Valley plant is presently one ton per day or 300 tons per year. At one unit per container, 600 shipments per year would be required compared to 300 shipments at two units per container. The difference becomes even more significant when the plant capacity is increased to three tons per day or 900 tons per year. At one unit per container, 1800 shipments would be required compared to 900 shipments for two units. This means we would be unloading six containers per day if only one unit per container is permitted. Not only would we be swamped with containers, we would also have to double the size of our fuel receiving facility at a cost of better than two million dollars.

The investment in shipping containers for a 900 ton plant would likewise be doubled. If we assume 50 trips per year per container, 18 containers would be required at two units each while 36 containers would be required if we are restricted to one unit per container. At \$350,000 per container, which is not an unreasonable figure, this would increase the capital required from \$6,300,000 to \$12,600,000. These additional capital requirements are of concern to us and to others in the reprocessing business since these costs must be passed on to the customer and ultimately to the power consumer.

It is also important to us to be able to receive truck shipments around the clock. If receipts are limited to daylight hours only, there will be severe problems in scheduling and handling shipments, as well as increased demurrage charges. A restriction preventing night deliveries could easily adversely influence the design and staffing of the receiving facility with a further increase in capital and labor costs.

Since NFS and others are presently designing new or expanded fuel handling facilities, as well as planning for future transportation requirements, it is most important that we know now what design criteria will be applicable to truck containers. This information is required so that we may be able to size properly the

handling facilities and determine the type and number of shipment containers which will surely be required in the next few years.

Slide 1

Slide 2

Slide 3

Slide 4

Slide 5

Slide 6

Slide 7

SHIPPING CONTAINER DESIGN AND TRANSPORTATION

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The speakers you have just heard have described the nuclear fuel cycle and the complex spent fuel loading and unloading procedures that are involved. Now let's look at shipping container design and transportation. Several companies are quite active in this area of the fuel cycle and offer containers for sale or lease. A few of these companies offer complete service which includes transportation arrangements in addition to furnishing licensed containers. The following list [in order of entry into the business] acquaints you with most of the companies that are active in container design, licensing, manufacture, testing, or operation.

National Lead
Battelle Memorial Institute
Stearns-Roger
Atcor
Whitehead & Kales
Nuclear Materials Services
KPA Nuclear

National Lead, Atcor, and Nuclear Materials Services offer complete service. Also, the nuclear fuel suppliers [General Electric, Westinghouse, Babcock & Wilcox, Combustion Engineering, Gulf General Atomics] and the fuel reprocessors [Nuclear Fuel Services, General Electric, Allied Chemical, Atlantic-Richfield] offer complete service utilizing companies listed above as sub-contractors where necessary to augment their own capabilities. Rail and truck container transport is provided by contract and/or common carriers. The relatively large number of companies active in some aspect of this highly specialized business provides healthy competition and will assure the industry of optimum container designs, safe and efficient transport, and adequate container availability. At the present time, a few containers are available and in operation serving research and test reactors and first generation commercial nuclear power plants. However, containers to serve power plants brought on-line in 1969 and later are now in the design stage. These second generation plants will begin to discharge spent fuel units early in 1971.

Container design requirements are developed from the characteristics of the fuel units, the requirements of the utilities and the reprocessing plant operators, the carriers, and the federal regulations governing transport of radioactive materials. The fuel units in the second generation plants vary from 160 to 177 inches long and 5 1/2 to 8 1/2 inches square and cannot be further disassembled. This establishes the minimum length of the container and also dictates shipment in horizontal position. The specific power generation in the fuel and the time it is in the reactor determines the radiation shield thickness required in the container. These two parameters, container length and shield thickness, along with the number of fuel units to be carried per container, are the controlling factors with respect to container weight. In first generation plants, fuel units were shorter and power generated in the fuel was lower. This made it possible to design containers with 2 to 4 fuel unit capacity weighing less than 60,000 pounds. For example, a 4-unit container used at the Dresden Nuclear Power Plant weighed 45,000 pounds and was transported by truck without need for overweight permits. The container used at the Indian Point Nuclear Power Plant carried 2 units, weighed 56,000 pounds and was transported by truck with a special permit for gross vehicle weight of 90,000 pounds. In most cases in the past, lead radiation shielding was used for protection against gamma radiation.

With fuel units in the second generation plants of today nearly 15 feet long, extended residence time in the reactor and higher power generation in each fuel unit, container weight has markedly increased. This is primarily due to the longer container and the need for neutron shielding in addition to the increased gamma radiation shielding. Containers with capacity for 1 to 4 units of these second generation fuels will weigh 60 to 80,000 pounds. To minimize weight some container manufacturers have changed from commonly used lead gamma radiation shielding which costs 15¢ per pound to uranium shielding which costs from \$3 to \$5 per pound.

The nuclear power plant and reprocessing plant operators must have containers that are compatible with their loading and unloading facilities. These activities place considerable emphasis on minimizing the number of shipment that must be made and the loading and unloading time for each shipment. Their desire is to minimize the facilities and manpower required to perform the operations on the shipping container. Also, fuel cycle economic requirements dictate that the total time to transport an annual fuel discharge batch to the reprocessing plant for recovery of valuable materials must be minimized.

The carrier expects the designer to provide a container and tie-down arrangement that is compatible with his vehicle and the transportation environment. In particular, the mode of transport selected dictates size and weight limitations on the overall transportation system. The container and tie-down design must provide for rapid handling and attachment to the vehicle and also must be adequate with respect to the shock and vibration associated with vehicle movement. In the case of truck transport, the container location and method of attachment to the trailer must provide proper axle loading and a stable, smooth riding system.

Probably the most complex set of requirements which the container designer must meet come from Federal Regulations governing container design and transport. These regulations have been published to protect the public during container transport under normal

conditions and hypothetical accident conditions. The hypothetical conditions are believed to be reasonably representative of the maximum credible accident a shipment could encounter. Since public safety is most important in the container designers' efforts, I will cover this area in more detail. Basically, the container design must provide adequate reactivity control, containment, heat dissipation, and radiation shielding, under these conditions. From these basic requirements evolve the need for ingenious means for attenuating and absorbing neutrons and gamma radiation, unusually high structural integrity, and efficient reliable heat dissipation systems. The materials and systems must be functional and effective under accident as well as normal conditions of transport.

The Federal Regulations consider normal conditions of transport to be those associated with rough handling, shock and vibration incident to transport, temperature extremes from -40°F. to 130°F. , and adverse combinations of wind, sun, and rain or snow. The accident conditions are defined by a hypothetical sequence of events as follows:

1. A 30-foot free fall on an unyielding surface with the container at such an attitude as to cause maximum damage to the container.
2. A 40-inch free fall on a 6-inch diameter steel pin such as to cause maximum damage.
3. An exposure to a thermal environment at 1475°F. for 1/2 hour.
4. Complete immersion in water.

During and after exposure to these conditions, reactivity control must be maintained and radioactive material containment and radiation shielding systems must remain sufficiently effective to limit radiation levels to acceptable levels. Both government and industry have worked diligently toward development of these safety standards including numerous test programs to demonstrate the adequacy of the standards. For example, Figure 1 shows a prototype uranium shielded container and the results of a 40-inch free fall on a 6-inch diameter pin. Figure 2 shows the same container after the 30-foot free fall and subsequent actual exposure to fire. Evaluation of the results of these tests show that it is possible to provide the reactivity control, containment and radiation shielding systems necessary for safety under such severe conditions.

The nuclear industry has called upon the container designers to achieve compatibility between these numerous complex requirements and develop designs that provide for transport of the fuel units economically without compromising on safety and reliability. To further complicate the container designer's task, he must consider the fact that more than 50% of the nuclear power plants have no rail service and some do not even have crane capacity to handle the container that the designer might specify. Container designers have been faced with many of these problems for more than ten years, but it is just recently that the total requirements involving safety, reliability and economy have been sharply brought into focus and maximum demand has been placed on the designer's ingenuity. This attention is primarily a result of the rapid increase in utilization of nuclear power in the last few years.

Results of efforts to date on container development indicate that three basic solutions to the transport problem are feasible. The first is transport by rail in containers weighing from 80 to 100 tons. These containers will have higher capacity to offset the relatively slow transport by rail. Figure 3 is an example of this type of transport arrangement. To serve those plants without rail service, special handling and transport equipment will be required to move the containers from the power plant to the nearest rail head and shift the container to a rail car for transport to the reprocessing plant. This short haul requirement will result in gross vehicle weights up to 300,000 pounds.

The second solution is transport by rail in containers weighing 40 to 70 tons. Figure 4 depicts the arrangement for this transport method. These containers will have lower capacity but will also cost less than the larger containers and will be easier to utilize at power plants without rail service. Gross vehicle weight for the short haul from power plant to nearest rail head will be less than 240,000 pounds. Equipment and services for the short haul and transfer to a rail car will cost less, somewhat offsetting reduced container capacity.

The third solution is transport by truck directly from the power plant to the reprocessing plant in 30 to 40 ton containers. Figure 5 shows a typical arrangement for this type of transport except that the container shown is of earlier design and weighed less than 30 tons. The low capacity associated with these containers is acceptable because of the fast transport service available by truck assuming around-the-clock movement over the highways. Also higher container utilization is foreseen with these containers because they will not be dependent on rail service and will be compatible with plants with low crane capacity. However, most critical in meeting power plant and reprocessing plant requirements is the achievement of a container capacity that results in an acceptable number of shipments per annual discharge batch of fuel units. It is firmly believed that it will be impractical, if not physically impossible, for reactor plants and reprocessing plants to receive, load, and unload the number of shipments required if container capacities are limited to 1 to 2 fuel units because of gross vehicle weight limitations. Also basic freight costs will be more than doubled and container use charges will increase even more. All these factors will increase the cost of electricity to consumers.

With regard to the need for resolving these problems, these solutions require the development, design, manufacturing, testing, and licensing of containers which takes about three years from selection of the correct design concepts. Also power plant and reprocessing plant designers must have container handling, loading, and unloading information 5 to 7 years in advance of plant start-up. Use of these containers will begin in mid 1971 with major shipping programs starting in 1972. Based on these dates you can see why it is important for us to establish the basis for limitations on transport now since we are already late in reaching these decisions. The lateness is presently costing the nuclear industry considerable money. This is why at this time we seek consideration and advice on the problems we foresee related to movement of these heavy loads over the highways.

I will now cover in more detail those problems associated with transport by truck in casks weighing up to 40 tons and then Mr. Smith will do the same for the transport by rail

including the particular problems related to the short haul from the power plant to the nearest rail head for those plants without rail service in casks weighing from 40 to 100 tons.

The most critical design requirement for transport by truck is the gross vehicle weight limitation. A gross vehicle weight must be established that is acceptable based on special permits to travel over designated routes for 4 to 6 weeks each year from each of the power plants involved. Our attempt to establish gross vehicle weights to date have included discussions with highway officials, bridge and highway structural experts, as well as close cooperation between container designer, trailer designer, and the motor carriers that are interested in hauling this commodity. We have also examined the existing special permit maximum gross vehicle weights and axle load limits for many states. Results of these efforts indicate that a gross vehicle weight of 110 to 120,000 pounds with maximum axle loads not exceeding 18,000 pounds is reasonable and may be acceptable. Recent data development by coordinated efforts of carriers and trailer manufacturers indicates that special seven-axle tractor-trailer combinations will weigh approximately 30 to 35,000 pounds including container tie-down structures. Based on maximum axle load limit of 18,000 pounds for three trailer axles and three axles on the rear of the tractor and 10,000 pounds limit on the steering axle, the maximum gross vehicle weight would be 118,000 pounds. This leaves 83,000 to 88,000 pounds allowable container weight. This weight limits the capacity of container designs utilizing presently available shielding materials and systems to 2 to 4 fuel units. Container designers are now making and will continue to make every effort to develop more efficient shielding systems.

Figure 6 shows a longitudinal cutaway view of a typical container for transport of the second generation fuel by truck. Note that uranium shielding is used because equivalent lead shielding would result in considerably higher container weight. Figure 7 is a cross sectional view of the container for shipment of PWR fuel units. Note that consideration of container capacities greater than 2 fuel units is not covered because the gross vehicle weight involved would not be acceptable for routine movement under special permits. Figure 8 shows the container cross-section for BWR fuel units. Note that due to the smaller cross-section of this type of fuel, it is possible to achieve capacity for 4 units within what is considered a reasonable gross vehicle weight. Note in both Figures 7 and 8 that the water neutron shield displaces the uranium gamma shield outward which increases container weight. This neutron shield is required to adequately shield the high performance fuels from the second generation power plants now beginning to go on-the-line. The larger of these two types of containers will have a loaded weight of approximately 80,000 pounds which results in a gross vehicle weight of about 115,000 pounds.

Since this is the heaviest of loads we expect, it will be the basis for our special permit requests. Figure 9 shows the tractor-trailer container arrangement for transport of these containers by truck under special permits over designated routes. The container will be located so that the loading will be approximately 52,500 pounds on each of the two groups of three axles and 10,000 pounds on the steering axle. Gross vehicle weight will not exceed 115,000 pounds nor will the load on any one axle exceed 18,000 pounds. Axle loads in the three groups will be equalized by special load distribution structure between trailer and axles.

We believe that this tractor-trailer-container arrangement is a reasonable compromise between the power plant and reprocessing plant operators needs and the considerations related to acceptable bridge and highway load limits. Shipping more than one fuel unit per container increases gross vehicle weight but does not increase axle loads. Therefore, the total number of shipments per year for any particular power plant is at least cut in half which considerably reduces wear and tear on the highways. Note that even though the shipment is overweight, it is not oversize and will not create safety hazards usually associated with oversize loads of this gross weight.

The tractors to be used will be powered to move along with other vehicles, thereby avoiding undesirable obstruction of traffic. Tractors will be equipped with sleeping facilities, air conditioning, and other features to minimize driver fatigue. With this equipment, shipments are planned for around-the-clock operation subject to special permit restrictions, if any. To avoid extended parking of the tractor-trailer combinations along the routes, stops will be made for food and fuel only and then the shipment will be attended by one of the two specially trained drivers. All these provisions are directed toward achieving maximum safety.

Now Mr. Smith of General Electric Company, Reactor Fuel and Reprocessing Department will describe in more detail, containers for transport by rail and the problems of the short haul from power plants with no rail service.

FIG. 1

CASK TEST RESULTS

PUNCTURE TEST

Rechts Df 30

FIG. 3 WESTINGHOUSE 75 TON MULTI-ELEMENT
SPENT FUEL SHIPPING GASK AND RAIL CAR
(Courtesy Westinghouse Electric Corp.)

FIG. 4
GENERAL ELECTRIC
IF 300 SPENT FUEL SHIPPING CASK

SHOWN IN NORMAL RAIL
TRANSPORT CONFIGURATION

* REMOVED DURING TRANSIT

TYPICAL TRUCK SHIPPING CONTAINER
FIG. 6

FUEL CAPACITY	CONT'R WTS.	GVW	FUEL UNIT TO GVW RATIO
1 UNIT	58,000 LBS	80,000 LBS	1 $\frac{2}{3}$ %
2 UNITS	80,000 LBS	100,000 LBS	2 $\frac{1}{2}$ %

TYPICAL CONTAINER CROSS SECTION
FIG. 7

FUEL CAPACITY	CONT'R WTS.	GVW	FUEL UNIT TO GVW RATIO
2 UNITS	68,000 LBS	100,000 LBS	1 ½%
4 UNITS	77,000 LBS	112,000 LBS	2 ½%

TYPICAL CONTAINER CROSS SECTION
FIG. 8

MAX GROSS VEHICLE WEIGHT - 115,000 LBS

TYPICAL TRUCK-CONTAINER ARRANGEMENT
FIG. 9

**DESIGN AND TRANSPORTATION OF SHIPPING
CONTAINERS WEIGHING GREATER THAN 40 TONS**

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MANAGER, LICENSING & TRANSPORTATION
REACTOR FUELS & REPROCESSING DEPARTMENT
GENERAL ELECTRIC COMPANY
SAN JOSE, CALIFORNIA**

INTRODUCTION

In the previous paper, Mr. Peterson discussed regulatory and design requirements for irradiated nuclear fuel shipping containers. He also discussed the need for transporting containers which will weigh up to about 40 tons, which would result in a gross vehicle weight up to about 115,000 pounds.

I would like to discuss the design and transportation of casks which will weigh greater than 40 tons. I would emphasize that these containers would be shipped primarily by rail. However, for use in serving many of those reactors which do not have direct rail access, these containers would be shipped by truck for the distance between the reactor and the nearest rail-head. This approach to the irradiated fuel transportation requires only a minimum of highway travel, although higher gross vehicle weights and heavier axle loadings would be required. These factors may make it impractical to use this approach at all of the nonrail reactor sites.

CONTAINER DESIGN

I would like to emphasize that containers, regardless of weight, must be designed within the same restraints that govern the design of the smaller casks. Let me review very briefly the factors, as shown on Figure 1, which must be considered in the design of such containers.

First, the containers must be designed to ship satisfactorily the fuels which will be discharged from the commercial nuclear power generating stations. This means that we must take into account the increased dimensions and operating parameters of these fuels.

Second, these containers must be designed to the same licensing and regulatory requirements which were described previously.

Third, the designer must consider transportation methods which are available and which can be utilized for transporting the containers to and from the reactors.

Fourth, the designer must evaluate container handling facilities available both at the reactor and the reprocessing plants, and must consider any limitations imposed by these facilities on the weights and dimensions of containers.

Finally, the designer must balance all of the foregoing factors and restraints to arrive at an equipment design which will provide sufficient equipment utilization and practical transportation of the irradiated fuels.

While many of the factors are mutually exclusive they, nevertheless, must be balanced in arriving at a transportation scheme which will provide practical, long-term, efficient transportation of the irradiated fuels.

Next, I would like to review some factors which make larger casks desirable for transporting irradiated fuel. Figure 2 shows the relationship between the irradiated fuel capacity of the shipping container in metric tons of

FIGURE 1. CONTAINER DESIGN FACTORS

- FUEL DIMENSIONS AND CHARACTERISTICS
- LICENSING AND REGULATORY REQUIREMENTS
- TRANSPORTATION METHODS AVAILABLE
- CONTAINER HANDLING FACILITIES
- EFFICIENT EQUIPMENT UTILIZATION

FIGURE 2. CASK CAPACITY URANIUM CASKS

uranium as a function of weight of that shipping container. As you can see, a container weighing about 40 tons would have a capacity of slightly less than one metric ton, whereas a container weighing about 60 to 65 tons would have a weight capacity of almost two metric tons, and a container weighing on the order of 100 tons would have a capacity as high as four and one-half to five metric tons uranium. Thus, increasing the weight of the containers by two and one-half times will increase the amount of fuel that can be shipped by a factor of five.

As a result of the larger payload, use of larger containers means fewer shipments are required and, thus, fewer movements over the highways. Also, from the standpoint of the reactor and reprocessing plant operators, fewer container loadings and unloadings are required. The larger containers also provide increased ratio of payload to container weight as shown in Figure 3. This results as the capacity of these containers increases much more rapidly than the weight. Thus, it can be seen that the payload per pound of container weight increases by about a factor of three by increasing the weight of the container from 40 tons to approximately 100 tons. This is important in the overall economics of shipment, as the freight charges for the movement of this fuel are paid on the total weight of the container moving both directions, and not just the amount of the uranium as irradiated fuel that is being shipped. The economic advantages are not in direct relationship to increased payload, however, as container costs are a significant part of the total transportation costs.

I would emphasize that increasing the size of the container from 40 tons to 100 tons does not add a dimensional clearance problem. As shown in Figure 4, the lengths for 40 ton, 65 ton, and 100 ton containers are the same, since they are designed to ship the same type fuel units. Also, the diameter of such containers increases from about 50 inches for the 40 ton container to 75 inches for the 100 ton container, an increase of only 50%. As shown, the dimensions of the 100 ton cask are well within width restrictions required for normal highway movements. Figure 4 also shows the approximate number of fuel units of the pressurized water reactor type that could be shipped in the respective containers, showing that the capacity increases about a factor of five.

Thus, the movement of larger containers will not result in any additional considerations regarding widths and heights but will involve only the ability to move the higher weights involved for the short distance between a reactor and the nearest railhead. Most reactors are located within 10 to 20 miles of such a railhead.

CONTAINER DESCRIPTION

Figure 5 shows the General Electric IF 300 Cask. The design of this container has recently been completed and an application filed with the Atomic Energy Commission for approval and licensing.

The container was designed to ship fuel units from both boiling water and pressurized water reactors by exchange of the inner fuel support basket, thus adding improved utilization of this equipment. The basic container

FIGURE 3. CASK PAYLOAD URANIUM CASKS

FIGURE 4. CASK DIMENSIONS

FIGURE 5

GENERAL ELECTRIC
IF 300 SPENT FUEL SHIPPING CASK

itself is very similar to that described by Mr. Peterson. Fins on the exterior of the container are used for absorbing the impact energy required to meet the drop test and to dissipate the decay heat generated by the irradiated fuel units.

The container has thick stainless steel inner and outer shells with uranium metal shielding material in between. The container is filled with water during transport to transfer the decay heat from the irradiated fuel units to the walls of the containers and also to provide the required shielding of the fast neutrons associated with high exposure power fuels available in the early 1970's. The container itself will transport either ten boiling water reactor fuel units or four pressurized water fuel units, and will weigh from 125,000 pounds for PWR shipments to 135,000 pounds for BWR shipments.

Figure 6 shows this container as mounted on a railcar for shipment between the reactors and the reprocessing plant. The container is shipped in the horizontal position so that there are no problems with height restrictions. The container includes the supplementary heat transfer system for dissipating the additional decay heat associated with the larger load of irradiated fuel units. This heat transfer system is designed to be operational under all normal transport requirements and is a redundant system to assure availability at all times.

As you will note, the container is mounted on a skid which is then positioned on the railcar. This is an important feature of this container, as this skid becomes the trailer deck of the transport vehicle when the container is shipped the short distance between a reactor and the nearest available railhead.

Figure 7 shows the sequence that prepares the container for shipment over the highways to the reactor when the empty cask arrives at the railhead nearest the reactor site. As shown, the railcar is positioned at a suitable end-loading ramp and a trailer with a rear axle assembly is brought into position at the other end of the railcar. The rear axle assembly, which has a self-contained hydraulic lifting unit is then attached to the other end of the skid. Both of these units are commercially available items which are used extensively for transporting heavy construction equipment.

The hydraulic power units are then activated and the skid is lifted into the position shown for over the road transport. General Electric feels that this concept is important for transporting loads of this type, since the container would have to be skid mounted anyway to provide the dual utilization. By making the skid become the trailer bed for over the road transportation, the gross vehicle weight of the unit which must be moved over the highways is greatly reduced.

CONTAINER TRANSPORTATION

The proposed vehicle configurations have been evaluated by people experienced with over-weight vehicle restrictions to arrive at configurations deemed adequate for moving such a load over the highways for the short distance between reactor and the nearest available railhead.

FIGURE 6

GENERAL ELECTRIC
IF 300 SPENT FUEL SHIPPING CASK

**SHOWN IN NORMAL RAIL
TRANSPORT CONFIGURATION**

* REMOVED DURING TRANSIT

Figure 8 shows such a configuration based on a seven-axle truck. As shown, the overall vehicle length would be about 77 feet, but at no point would be more than 8 feet wide. With this configuration, the load on the steering axle would be about 18,000 pounds, the load on the driving axles would be about 30,000 pounds each, and on the rear trailer axles would be about 42,000 pounds each. All these loadings are considerably greater than those proposed for the long distance movements of the smaller containers. However, it is felt they would be acceptable for many of the short distance, limited highway movements between reactors and the nearest railhead.

Figure 9 shows a similar configuration based on a nine-axle truck which would result in slightly lower axle loadings for the over the highway movements. In such a configuration, the vehicle length would be about 88 feet, but again would be less than 8 feet wide at all points. With this configuration, the load on the steering axle would be about 14,000 pounds, the load on the driving axles would be less than 25,000 pounds, and the load on the rear trailer axles would be less than 32,000 pounds each. Again, these loads are in excess of those proposed for long distance movements. However, the highways subjected to such loading would only be those between reactor and railhead.

SUMMARY

In summary, the shipment of large-size shipping containers for a short distance over the highways between the reactor and the nearest available railhead appears to be a practical and a necessary alternative which should be available to the utility for providing an efficient and effective method of transporting the irradiated fuel.

Figure 10 summarizes the advantages of the large-size containers. First, it reduces the number of shipments which must be made over the highways and, consequently, reduces the number of containers which must be loaded and unloaded at the reactor and reprocessing plant sites. Second, these containers will require a minimum of highway travel over public roads. This is particularly important since all potential traffic control requirements could be easily dealt with for the limited number of shipments and the limited areas which would be involved in supervising such shipments. Third, the movement of the large casks would be mostly in areas of low traffic and low population densities, again minimizing any potential for interference with the free flow of traffic in areas affected. Fourth, in many cases, the roads which would be used for the transportation of these containers have previously been used for the transportation of much heavier loads during the plant construction operations, therefore, there should be minimum problems encountered in transportation of containers of the size proposed between the reactors and the railheads. Finally, even the largest containers proposed can be moved within the current legal limits of width and height.

We appreciate the opportunity to appear before you here today, to describe situations with which we are faced in providing transportation of the irradiated nuclear fuel units from the power generation stations currently under construction in the southeastern United States. We trust that as we have made these presentations, it has become apparent that the transportation

FIGURE 7. CASK OFF LOADING SEQUENCE

FIGURE 8. 1F300 SEVEN AXLE TRUCK SHIPMENT

FIGURE 9. 1F300 NINE AXLE TRUCK SHIPMENT

FIGURE 10. LARGE CASK ADVANTAGES

- **REDUCED NUMBER OF SHIPMENTS**
- **MINIMUM HIGHWAY TRAVEL REQUIRED**
- **MOVEMENT IN AREAS OF LOW TRAFFIC AND POPULATION DENSITIES**
- **SAME ROADS USED FOR HEAVIER CONSTRUCTION LOADS**
- **LEGAL WIDTHS AND HEIGHTS**

of irradiated nuclear fuel is a complex undertaking, and is not directly analogous to the transportation of most other commodities. We would like to emphasize the requirements which are placed upon us for advance planning and firm commitment to a specific transportation method several years in advance of the date when such transportation will be required. From the standpoint of the utility in locating and operating their nuclear power station, this commitment is made five to seven years in advance of shipment, and from the standpoint of the shipper in the design and procurement of the necessary equipment, the commitment must be made about three years in advance of shipment.

We feel that the container designs and the transportation methods which have been described meet the requirements for providing practical, efficient transportation of the irradiated fuel from these reactors, and can be handled in the proposed methods without resulting in undue potential for damage to the public highways.

TOTAL SHIPPING REQUIREMENTS

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The preceding gentlemen have discussed 3 major categories of technical interest; first, the unusual commodity to be shipped, secondly the complex techniques for loading the commodity into shipping containers and thirdly, the heavy-well engineered-expensive shipping containers.

We will now develop the shipping requirements for the SINB region and obtain a feel for the potential number of truck shipments that could occur in future years.

Of the four modes of transportation (water, highway, combined rail-highway and rail) only the latter three appear feasible for the majority of the SINB region sites. As Mr. Gifford pointed out earlier, 27 sites have already been announced for this area. My presentation will be based on the initial 25 nuclear powered plants as listed in the first slide (Figure 1). This listing places the 25 initial plants into two categories. The 12 plants listed in the left hand column have both rail and highway services while the remaining 13 nuclear powered plants listed in the right hand column may be reached by highway only.

It is interesting to observe that in several cases, there are as many as three nuclear powered plants located at a single site (the 3 Oconee units in South Carolina and 3 Browns Ferry units in Alabama). Still the long term economics did not dictate that a rail siding be constructed even when substantial credit was granted in the study for savings in the rail transportation of the plant construction materials and the large components required for the erection of the nuclear powered plants. This fact emphasizes the better economics available through highway transport, particularly for shorter hauling distances. We should point out here that as more fuel reprocessing plants are constructed throughout the United States, the average transport distance will decline thus favoring an even higher percentage of highway transport.

Even today, as the list indicates, over one-half of the first 25 power plants announced in the SINB region have elected to ship over the highways. Of course many of these plants have the choice to ship either by through truck or by truck-rail combination but not all of these plants can utilize the latter truck-rail combination due to limited capacity of the nuclear power plant overhead crane, terrain restrictions, etc.

I would like to concentrate now on the type of equipment that several firms have proposed to supply for transporting the spent fuel units from the 13 nuclear power plants listed in this right hand column and the plants to be constructed in the future with access only by highway.

The next three slides illustrate equipment designed to ship one, two, and four PWR fuel units by truck or truck-rail car combination. The first of these (Figure 2) would transport a 58,000 lb. container designed to carry one PWR fuel unit which will result in a combined gross weight of about 90,000 lbs. This six axle rig will work out to about 16,000 lbs. max. on each of the multiple wheel axles and 10,000 lbs. on the steering axle. The BWR version of this configuration would gross out at 100,000 lbs. but carry 2 BWR fuel units. The axle loadings would increase correspondingly to about 18,000 lbs.

The second tractor-trailer combination (Figure 3) would carry an 80,000 lb. container designed to carry two PWR fuel units which will result in a combined gross weight of about 115,000 lbs. This seven axle rig utilizes a jeep or jo-dog and a three axle trailer. The max axle loading here is about the same as the earlier design or approximately 17,500 lbs. The BWR version configuration would gross out at 112,000 lbs. and transport 4 BWR fuel units. The axle loading would decrease correspondingly to about 17,100 lbs.

Since the axle loadings of each rig are about the same and none of the units are over dimensioned, the significant difference is in the gross weight. In addition, all of the rigs are overweight and will require routing restrictions with possibly a more limited routing for the heavier combinations.

The third basic configuration is illustrated by this slide (Figure 4). You will recognize it as the truck-rail car combination for transporting larger capacity containers. This nine axle configuration will handle 4 PWR fuel units or 10 BWR fuel units in a 156,000 lb. container at a gross weight of approximately 245,000 lbs. The multiple wheel axles will carry 24,900 lbs. to 31,500 lbs. with about 14,500 lbs. on the steering axle. This rig is designed, of course, to operate over short distances from the nuclear power plant to the nearest suitable railhead. A seven axle rig has also been designed to carry the same container thus resulting in a higher axle loading and a lower gross weight of about 235,000 lbs.

Now that we have reviewed the number of fuel units that may be shipped per highway vehicle, we will now project the number of vehicle trips that may be required in the SINB region. First, we must make some assumptions as to the type of transport mix, that is, the breakdown of plants that will ship by rail, by truck, and by the rail-truck combination. A good starting place is to consider the 12 announced SINB

region nuclear power plants having a rail siding. If one neglects highway transport restrictions for the moment, a cost analysis will clearly show it will be more economical to ship by truck than by rail for at least one-half of these 12 plants, particularly the 7 plants having a rail siding but within 10 hours truck transport time to the proposed South Carolina reprocessing plant. Of these 6 or 7 nuclear power plants that will shift to truck travel, it is obvious that none of these will shift from the rail mode to the truck-rail combination mode hence these six or seven plants would be placed in the through-truck category, leaving the balance for the rail-only mode. With respect to the second category of nuclear powered plants having no rail sidings, it is equally obvious that none of these will shift to the rail-only mode, however, a number of them could elect, for economic reasons, to ship their spent fuel units by the truck-rail mode. I believe it would be reasonable for one to assume that about one half of the plants having no rail siding could fall in the truck-rail combination mode and the remaining half in the through-truck mode. In summary, therefore, the through-truck mode could readily be selected for half of the plants with rail sidings and half of the plants with no rail siding or approximately one half of the total transport requirements in the SINB region. In addition, some shipments could be made by trucks from nuclear powered plants located outside the SINB region to the proposed South Carolina reprocessing plant. This would result in a net increase of travel over the highways for even if spent fuel were shipped out of the SINB area to a northern reprocessing plant, some of the movements would still take place over the SINB region highways.

For purposes of calculation, therefore, it would appear reasonable that through-truck transport could be the economic choice of the equivalent half or more of the SINB region plants. For calculation simplicity, we will select the SINB nuclear powered plants having no rail siding since this represents some 54% of the initial 25 announced plants. Our next slide (Figure 5), therefore, lists only the announced nuclear powered plants in the SINB region having no rail sidings and tabulates the number of fuel units to be shipped each year for the period of 1973 through 1980. You will note only 160 fuel units will be shipped in 1973 and only three years later, this number has increased 7 fold to 1,120 fuel units each year. The number of fuel units on this slide remains at 1,120 per year only because future plants that have not been contracted are not included here.

The next slide (figure 6) transforms this same listing into the number of one way truck shipments by: a) assuming two PWR and four BWR fuel units per shipping container and b) multiplying the calculated number of one way trips (to allow for the return of the empty but heavy shipping container). By 1976 the number of one way truck shipments has reached 840 and again this number holds constant since plants not yet contracted are not included here. The next slide (Fig. 7) projects the total number of one way truck shipments by adding the effect of the nuclear powered plants to be contracted at a later date to meet the ever increasing electrical power load. By 1980, the projected number of truck shipments may reach 2000 each year.

If weight limitations are imposed, not only will the total number of shipments double to approximately 4000 per year by 1980, but the cost penalties passed on to the electrical power consumers will approach 7 million dollars per year by 1980 as shown in the next slide (Fig. 8). These cost penalties were calculated by using a 2 fuel unit PWR and a 4 fuel unit BWR container for the base case and developing the additional freight, container lease, and miscellaneous costs associated with the use of smaller containers suitable for only one PWR fuel unit or two BWR fuel units.

Another interesting analysis concerns the cost penalties associated with restricted travel during daylight hours only. This next slide (Fig. 9) shows the penalty to be even more severe than the gross weight related penalty as the range of charges reaches 17 to 23 million dollars per year by 1980.

To summarize, then, we can see that the number of potential truck shipments and the possible dollar penalties associated with gross weight and daylight only travel are significant. They are significant when we assume that approximately one half of the spent fuel units will be shipped by through truck. This assumption could easily be on the low side for two reasons. First, as more nuclear powered plants are constructed, the site problem will become more difficult and the resulting access problems could lead to fewer rail sidings. Secondly, as mentioned earlier, as more fuel reprocessing plants are constructed, the average transport distance will decline and the resulting economics will favor truck transport.

With the preceding thoughts in mind, I would now like to introduce our next speaker, Mr. James W. Lee, Transportation Consultant, who will present the Committee recommendations.

SINB REGION

ACCESS TO ANNOUNCED PLANTS

RAIL & HIGHWAY		HIGHWAY ONLY	
ROBINSON	(SO. CAROLINA)	TURKEY POINT III & IV	(FLORIDA)
BRUNSWICK I, II & III	(No. CAROLINA)	HUTCHINSON ISLAND	(FLORIDA)
SEQUOYAH I & II	(TENNESSEE)	BROWNS FERRY I, II & III	(ALABAMA)
NORTH ANNA I & II	(VIRGINIA)	OCONEE I, II & III	(SO. CAROLINA)
RUSSELLVILLE	(ARKANSAS)	SURRY I & II	(VIRGINIA)
CRYSTAL RIVER	(FLORIDA)	CALVERT CLIFFS I & II	(MARYLAND)
ALABAMA POWER CO.	(ALABAMA)		
E. I. HATCH	(GEORGIA)		
TOTAL - 12 PLANTS		TOTAL - 13 PLANTS	

FIGURE 1

TRANSPORT WEIGHT

SINGLE PWR FUEL UNIT

FIGURE 2

TRANSPORT WEIGHT

TWO PWR FUEL UNITS

FIGURE 3

TRANSPORT WEIGHT

FOUR PWR FUEL UNITS

FIGURE 4

FUEL UNIT SHIPMENT SCHEDULE

(ANNOUNCED SINB AREA PLANTS WITHOUT RAIL SERVICE)

	NUMBER OF FUEL UNITS PER YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
TURKEY POINT III & IV	50	100	100	100	100	100	100	100
HUTCHINSON ISLAND	--	--	50	50	50	50	50	50
BROWNS FERRY I, II & III	--	190	380	570	570	570	570	570
OCONEE I, II & III	60	120	180	180	180	180	180	180
SURRY I & II	50	100	100	100	100	100	100	100
CALVERT CLIFFS I & II	--	60	120	120	120	120	120	120
TOTAL/ YEAR	160	570	930	1120	1120	1120	1120	1120

FIGURE 5

NUMBER OF ONE-WAY TRUCK SHIPMENTS

(ANNOUNCED SINB AREA PLANTS WITHOUT RAIL SERVICE)

	<u>NUMBER OF ONE-WAY TRIPS PER YEAR</u>							
	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
TURKEY POINT III & IV	50	100	100	100	100	100	100	100
HUTCHINSON ISLAND	--	--	50	50	50	50	50	50
BROWNS FERRY I, II & III	--	100	190	290	290	290	290	290
OCONEE I, II & III	80	120	180	180	180	180	180	180
SURRY I & II	50	100	100	100	100	100	100	100
CALVERT CLIFFS I & II	--	80	120	120	120	120	120	120
TOTAL/YEAR	180	480	740	840	840	840	840	840

FIGURE 6

PROJECTED

NUMBER OF ONE-WAY TRUCK SHIPMENTS
(SINB AREA PLANTS WITHOUT RAIL SERVICE)

FIGURE 7

POTENTIAL ANNUAL SINO AREA SPENT FUEL SHIPPING
PENALTY CHARGES DUE TO WEIGHT LIMITATIONS

FIGURE 8

REVISED
1-12-70

POTENTIAL ANNUAL SINO AREA SPENT FUEL SHIPPING
PENALTY CHARGES DUE TO TIME OF TRAVEL LIMITATIONS

FIGURE 9

REVISED
1/12/70

COMMITTEE RECOMMENDATIONS

James W. Lee
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THE SINB COMMITTEE MEMBERS RECOGNIZE YOUR PROBLEMS

When the Position Paper and letter from the Southern Interstate Nuclear Board first was received by you Highway Department Officials, many of you may have thought to yourselves "Here is another group of motor carriers selfishly trying to obtain special privileges."

As a transportation consultant for the last thirteen years, and an industrial traffic manager for some 15 years previously, I probably would have thought the same, had I not been working with the nuclear industry for a number of years. No one would blame you for considering this idea, for I know, and the other members of the SINB Committee have learned, through the many meetings and contacts with members of your group preceeding this Conference; that Highway Officials are deluged with requests for special consideration.

We know that you are beset by many pressures to grant relief from your standard regulations, from a great number of industries who feel that each has a singular problem deserving of special consideration.

We know that your decisions to allow or disallow the movement of heavier loads are not governed by set regulations, but represent a delicate and proper blend of highway and bridge capabilities, economic necessities of your State, and an earnest and sincere desire on your part to assist the unrestrained flow of commerce whenever possible.

So, we have not come today demanding certain privileges.

We do not say that you should grant us these more flexible regulations simply because we ask for them, instead, we have tried to give sound reasons to grant the few exceptions we seek.

Why do we plea that an exception should be made for shipments of nuclear spent fuel? Why should the nuclear industry request special treatment?

For over five years, the nuclear industry toiled to design a spent fuel container not exceeding the legal weight limits. Mr. Peterson told you that despite the use of costly materials, and the finest engineering design efforts, the unique nature of spent fuel finally compelled the industry to recognize the impossibility of making a container which could comply with any currently legal weight maximum.

Can you think of any other trucking situation which is so unique? Spent fuel highway shipments will consist of a 3000 pound payload, in a container and trucking equipment package which weighs 112,000 pounds, and carries the additional burden that it must move one way empty; when loaded, it will move at a gross vehicle weight of 115,000 pounds. The spent fuel is only about 2½% of the total weight moved.

What about a competitive product in the generation of electrical power. Fuel oil? A tank truck can carry 50,000 pounds of fuel oil, using 23,000 pounds of container and trucking equipment for a gross vehicle weight of 73,000 pounds, which also must return empty. The fuel oil is 67% of the weight moved.

Look at general commodity shipments. 25,000 pounds of trucking equipment moves 47,000 pounds of general commodities. So 65% of the 72,000 pounds moved over the highway actually is cargo.

Two and one half percent of cargo (as in the case of spent fuel) is an unusual transportation situation, in fact. Therefore, we seek your cooperation because our commodity is so unique.

UNUSUAL NATURE OF MOTOR CARRIER PARTICIPATION IN THIS MEETING

It is the normal practice for road departments to deal with motor carriers more often than with industrial groups, and as you must have observed from the proceedings today, motor carriers actually play a very small part in this request for more liberal regulations governing overweight shipments of nuclear spent fuel.

This plea comes; not from the trucking industry alone, but from the nuclear fuel cycle industry. It is not the motor carrier industry alone which is saying "Please permit us to haul heavier loads of nuclear spent fuel". It is the nuclear power industry as a whole asking for relief because it has exhausted all other practical possibilities.

The motor carrier industry is not saying "Please let us haul bigger loads of nuclear spent fuel so that we can make more money."

On the contrary, strict adherence to current interpretations of the overweight permit requirements specifying the lowest divisible load would provide a maximum number of loads and profit for the motor carrier industry.

So obviously, the motor carrier industry is not here seeking any special privilege or benefit for truckers.

Nor is the motor carrier industry seeking an undue advantage over competing modes of transportation such as the railroads. Mr. Gifford and Mr. McDaniels explained that over 50% of the nuclear power plants in the Southeast do not have, or will not have rail-

road sidings, and, therefore, are compelled to depend upon truck shipments for the movement of spent fuel. And Mr. Smith told you about the intermodal General Electric container, but he also described the impracticability of using this rail-truck container to serve all of the non-rail utility sites.

Why then is the motor carrier industry asking for relief? And why have so many members of the nuclear industry participated in this Conference? Today, you heard from nuclear power plant manufacturers, fuel unit fabricators, container designers and manufacturers, shipping services, electrical utilities, and fuel reprocessors.

They explained that the nuclear fuel cycle companies, like motor carriers, are a service industry. That our combined efforts have one common goal, and that is, the furnishing of equipment and services needed by the electrical utility companies so that in turn they can provide low cost electrical power for consumers in the Southeast.

This is a desirable objective indeed, for you heard Dr. Schultze tell about the many benefits which low cost electrical power from nuclear power plants will bring to your States.

Electrical utility companies tell us a seven year lead time is required for the planning of nuclear power plant facilities! consequently, today, container manufacturers and suppliers of spent fuel shipping services are being asked by utilities to advise them of the capacity of crane facilities, and fuel unit storage pools, which should be designed into nuclear power plants, now on the drawing board. Suppliers of shipping services are presently being asked to provide firm quotations for the movement of spent fuel three years from now, with the duration of some of these shipments extending to 1978 and representing millions of dollars invested in equipment on which construction must be started this year.

As these requests for information filtered down through the nuclear fuel cycle the motor carrier industry was asked for firm information about the weight of containers it will be able to haul in the future, and firm quotations were requested. As the Position Paper explained, the regulations governing overweight shipments vary so greatly within the 17 Southeastern States that it was impossible to answer these questions with accuracy and assurance.

Thus, the nuclear industry has come to this Conference with these serious problems, and is asking for your help because your cooperation will benefit the people and industries of your States.

THE PRESENT REGULATIONS

I think it will simplify your consideration of our requests if we tell you first about those portions of the present regulations which will not cause a problem and which we do not seek to change.

PERMIT COST

We do not seek to change Permit Costs.

SPEED LIMITS

Present speed limits are not unduly restrictive.

ESCORTS

Existing escort regulations do not cause a problem.

DESIGNATED ROUTES OF MOVEMENT

Some of you gained the impression from our Position Paper, that we were seeking to move over any highway we chose to use. We are sorry that we conveyed that incorrect impression.

As a representative of the motor carrier industry, no one knows better than I do, that carriers must rely on State Highway Departments to select the proper route of movement for an overweight load, because no one has a more intimate knowledge of your States' highways and bridges, and their capabilities, than the Highway Officials, who are responsible for their maintenance and upkeep.

You have seen that nuclear spent fuel loads follow a predetermined pattern. First, a series of shipments between a specific nuclear power plant and reprocessor plant for a one to three month interval; then another series of shipments of the same nature between another nuclear power plant and the reprocessing plant. Shipments from several power plants may move simultaneously. The pattern of these movements; the ample time available to develop the most practical and safest route of movement, and the willingness of the nuclear industry, and the motor carrier industry to cooperate closely with individual highway departments in the selection of safe routes; will enable you to specify the routes we may use, well in advance of shipment.

DIMENSIONAL LOADS

You have seen the pictures and heard the description of nuclear containers for the proposed long-haul over-the-highway shipments. They are never over-dimensional. It is not anticipated that they will ever exceed the normal dimensions of a standard highway trailer, and we are not asking for any changes in dimensional restrictions.

TIME OF TRAVEL RESTRICTIONS--HOLIDAYS AND HOLIDAY WEEK-ENDS

The nuclear industry will schedule shipments of nuclear spent fuel to avoid the necessity of travelling during peak traffic periods caused by holidays and three day holiday week-ends.

WEIGHT TOLERANCES

No change is sought in present weight tolerances.

REGULATORY CHANGES NEEDED

The Committee has tried to show the compelling need of the nuclear fuel cycle industry for longterm assurance that it will be able to obtain permits for repetitive shipments of overweight containers capable of transporting shipments of spent fuel on an economic basis.

To permit the nuclear industry to ship spent fuel on an economical basis requires only three changes in present overweight permit regulations. These are:

1. Allow spent fuel shipments to move 24 hours a day, seven days a week, except during holidays and holiday week-ends.
2. Assurance of permits for repetitive shipments.
3. Permission to move 115,000 pound gross vehicle weights over designated routes.

UNIFORMITY

We hope that you will agree to make the proposed changes on a uniform basis for all States, because every overweight shipment of spent fuel must pass through from two to four or more States.

From earlier communications with various members of your group, we believe you are as much in favor of uniformity where practicable, as we are. Mr. A. E. Johnson, Executive Director of the American Association of State Highway Officials, told us of his desire to avoid approaching this matter on a basis which might result in different rules and regulations in various regions. He said "I believe that this is a matter that should be approached from a high degree of uniformity." Mr. R. G. Kendall, Jr. former Highway Director of the Alabama Highway Department, told us that he agreed that uniformity should be reached, if possible.

A uniform response to the request for changes, by all of the Southeastern States could pave the way to achieve nationwide uniformity through "AASHO" efforts.

Let us take a look at limitations on time of travel.

TIME-OF-TRAVEL-DAYLIGHT HOURS ONLY

All Southeastern States automatically limit any permit loads to daylight travel only. We are told by members of your group that

night time travel is limited because well over 90% of permit loads are over-dimensional, as well as overweight. In other words, this limitation is simply a traffic safety measure for over-dimensional loads.

But, as you have seen, a nuclear spent fuel load is not over-dimensional; it is the same size as any other tractor and semi-trailer, moving routinely down the highway. Even though it is overweight, it moves on highway equipment, which permits it to move with the traffic, limited by speed regulations, of course.

The needs of the general commodity trucking business to operate over-the-road equipment at night are recognized by highway regulations because most of the shipments are picked up and delivered during the daylight working hours of shippers and receivers, are recognized by highway regulations.

We suggest that the needs of the nuclear spent fuel cycle industry be recognized as well, by permitting a load of nuclear spent fuel, which is no bigger than any other truck on the highway, which is capable of moving with the traffic, and thus affords no greater hazard to highway traffic and other trucks on the highway, be granted permission to move at night in the same manner as regular truck traffic.

TIME-OF-TRAVEL RESTRICTIONS - NON HOLIDAY WEEKEND

We ask that the same philosophy be applied to the movement of nuclear spent fuel loads during normal week-ends although we agree with the regulations that keep trucks off the highways on holidays and holiday week-ends. We fully recognize that there are serious traffic safety problems at these times.

On normal week-ends, when other truck traffic moves freely and without restraint, we ask you to permit nuclear spent fuel loads to do so also.

If spent fuel cannot be moved at night, and on normal week-ends, penalty charges to the nuclear industry, and in turn, the power users of the Southeast, could reach \$23,307,000 per year by 1980.

The nuclear industry is here today asking relief to permit nuclear spent fuel loads to move without time-of-travel restraints during non-holiday week-ends.

ASSURANCE OF PERMITS FOR REPETITIVE SHIPMENTS

Mr. McDaniels told about our need to transport repetitive shipments of 115,000 pounds gross vehicle weight. The need exists because the industry's projection of the amount of spent fuel moving into the reprocessing plant, from non-rail power plants, is

1800 one way trips per year in the 17 Southeastern States, by 1980.

Without assurance that we can move repetitive shipments, we must tell over half of the nuclear power plants in the SINB region that we have no absolute certain method of transporting their spent fuel.

Mr. Peterson described the complex design, engineering, and construction problems waiting to be solved, and Mr. Gifford pointed out the near-term deadline facing all of us.

Without assurance that overweight loads of spent fuel will be permitted to move on a repetitive basis, nothing can be done toward solving these immediate and serious problems.

Please remember, we do not ask for a change in the permit procedures or fees; nor are we requesting reciprocity between States or "Blanket Permits".

SHIPPING METHODS

Hours and hours of discussion within this Committee were devoted toward establishing the probable mix of spent fuel shipments. The Committee, representing the nuclear and trucking industries foresees the use of three methods of shipping spent fuel commencing about 1973. These are rail shipment, inter-modal, and truck shipments.

RAIL SHIPMENT

Comprehensive studies point to an optimum container weight of about 100 tons for rail shipments. Obviously, such heavy containers will move on rail cars, and it is these large 100 ton containers that will service the spent fuel transportation requirements of most of the nuclear power plants which have rail sidings.

Clearly, it would be difficult to consider using such heavy containers for shipping spent fuel from the non-rail nuclear power plant locations. Our Committee believes that it is impractical to consider using a 100 ton container, even for the short haul movements of 2 to 35 miles from a rail head to a non-rail utility location. In such an event, it would be necessary to move at least a 300,000 gross vehicle weight load over the public highways, so we believe the use of the optimum rail containers will necessarily be restricted to those power plants possessing railroad sidings, or who can move the highway portion of the distance over private roads.

RAIL-TRUCK, INTERMODAL SHIPMENT

You heard Mr. Smith describe the intermediate weight container which will be used by General Electric for shipping spent fuel from non-rail power plant sites, and you saw sketches of the container.

Under this inter-modal concept, the 135,000 pound container would move by rail to the nearest railhead, and then, with a gross vehicle weight of about 235,000 pounds, the container would be transported over the 2 to 35 mile highway distance from the railhead to the power plant and back.

Of course, these over-the-highway movements will require overweight permits, but Mr. Smith explained that he does not plan to use this container for long distance over-the-road movements. His application to you for overweight permits will be on an individual State basis. The heavy containers will move over relatively short distances between points in one State.

On the basis of interviews with a number of utility companies who are operating nuclear power plants, it appears to be impractical to use the rail-truck container for all of the non-rail locations. In some cases, the distance is too great for the movement of such a heavy load, in others, the terrain and the bridges are not adequate for 235,000 pounds gross vehicle weight. In addition, some utilities do not have adequate crane capacity to handle a 135,000 pound container for the loading and unloading procedures, so the inter-modal container solves a part of the problem, but not all of it.

HIGHWAY TRUCK CONTAINER GROSS VEHICLE WEIGHT, 115,000 POUNDS

The only realistic solution to the spent fuel transportation requirements of the remaining nuclear power plants, which do not have rail service lies in the 115,000 pound gross vehicle weight load; thus permitting the transport of an 80,000 pound container. You heard container manufacturers tell you how their detailed studies revealed why it is completely impractical and economically impossible to use a smaller container for this purpose. Careful cost estimates disclosed added charges of approximately \$6,731,000.00 dollars per year by 1980, if the nuclear industry must use a one unit container. These millions of dollars of additional costs will be paid by the businesses and citizens of the Southeastern States.

If transporters can use an 80,000 pound container, it can move at a gross vehicle weight of 115,000 pounds, which is the same as, or less than, the gross vehicle weight currently granted on a non-repetitive basis by 53% of the 17 Southeastern States.

It can move at a gross vehicle weight which is below the maximum of 120,000 pounds now permitted by the 17 Southeastern States.

It can move at a gross vehicle weight which is below the average gross vehicle weight authorized for any single shipment by all of your States.

SUMMARY AND RECOMMENDATIONS

This Committee was formed in April of 1969. Since then, it has held ten meetings and many thousands of dollars of time and effort have been contributed by the nuclear fuel cycle companies who have worked diligently to try to solve the problem of economical transportation of spent fuel.

You have seen and heard the results of the Committee's lengthy, careful and considered studies. These studies reveal that benefits from a few changes in overweight permit standards would accrue to the residents and industries of the 17 States in the SINB region in the form of lower cost electric power.

The studies disclose that all three modes of transportation must be used to do the job. Rail service alone can be used by less than half of the nuclear power plants in the SINB region. The rail-truck container concept cannot serve all of the non-rail locations. Economic and engineering considerations and the inherent nature of the commodity, spent fuel, compel the use of a 115,000 pound gross vehicle weight unit for highway shipments.

In summary, let me say that the nuclear power industry will be utilizing all available modes of transportation. But it can do so efficiently only if:

1. Spent fuel truck shipments can travel 24 hours per day, seven days per week, except during holidays and holiday week-ends.
2. Permits for repetitive shipments can be assured.
3. 115,000 pound gross vehicle weight unit can be moved over designated routes.

These proposed changes are fundamental to the prompt resolution of problems currently facing the nuclear fuel cycle industry. An immediate solution is urgently needed.

Therefore, this Committee recommends to you the adoption of these three changes in overweight regulations for shipments of spent fuel on a uniform basis throughout the Southeast.

No other changes in the regulations or procedures are sought.

**COMPARISON OF PAYLOAD FOR VARIOUS
TYPES OF COMMODITIES**

RATIO OF CARGO WEIGHT TO GROSS VEHICLE WEIGHT

OIL 0.670

**GENERAL COMMODITIES
0.650**

**NUCLEAR SPENT FUEL
(TWO FUEL UNITS)
0.025**

REVISED 1/12/70

SINB REGION

ACCESS TO ANNOUNCED PLANTS

RAIL & HIGHWAY		HIGHWAY ONLY	
ROBINSON	(SO. CAROLINA)	TURKEY POINT III & IV	(FLORIDA)
BRUNSWICK I, II & III	(NO. CAROLINA)	HUTCHINSON ISLAND	(FLORIDA)
SEQUOYAH I & II	(TENNESSEE)	BROWNS FERRY I, II & III	(ALABAMA)
NORTH ANNA I & II	(VIRGINIA)	OCONEE I, II & III	(SO. CAROLINA)
RUSSELLVILLE	(ARKANSAS)	SURRY I & II	(VIRGINIA)
CRYSTAL RIVER	(FLORIDA)	CALVERT CLIFFS I & II	(MARYLAND)
ALABAMA POWER CO.	(ALABAMA)		
E. J. HATCH	(GEORGIA)		
TOTAL - 12 PLANTS		TOTAL - 13 PLANTS	

NUCLEAR SPENT FUEL HIGHWAY SHIPMENTS

REGULATION CHANGES NEEDED

<u>REGULATION</u>	<u>NO CHANGE</u>	<u>CHANGE</u>
1. PERMIT COST	X	
2. PERMIT PROCEDURES	X	
3. SPEED LIMITS	X	
4. ESCORTS	X	
5. DESIGNATED ROUTES OF MOVEMENT	X	
6. DIMENSIONAL LIMITATIONS	X	
7. TIME OF TRAVEL RESTRICTIONS, HOLIDAYS & HOLIDAY WEEK-ENDS	X	
8. WEIGHT TOLERANCE ALLOWANCE	X	
9. TIME-OF-TRAVEL RESTRICTIONS, NIGHTS & NON HOLIDAY WEEK-ENDS		X
10. ASSURANCE OF PERMITS FOR REPETITIVE SHIPMENTS		X
11. GROSS VEHICLE WEIGHT MAXIMUM		X

POTENTIAL ANNUAL SING AREA SPENT FUEL SHIPPING
PENALTY CHARGES DUE TO TIME OF TRAVEL LIMITATIONS

PROJECTED
NUMBER OF ONE-WAY TRUCK SHIPMENTS
(SING AREA PLANTS WITHOUT RAIL SERVICE)

INTER-MODAL CONTAINER
Weight 135,000 Pounds
Gross Vehicle Weight - 235,000 Pounds

94

CASK & DECK REMOVAL OR LOADING-USING HYDRAULIC GOOSENECKS & TRUCK

POTENTIAL ANNUAL SINB AREA SPENT FUEL SHIPPING
PENALTY CHARGES DUE TO WEIGHT LIMITATIONS

PWR WORK SHEET

SPENT FUEL TRANSPORT CHARGES STUDY FOR SINB SPENT FUEL SHIPPING POSITION PAPER

UTILITY: ARKANSAS POWER & LIGHT
 NAME OF UNIT: ARKANSAS NUCLEAR ONE
 LOCATION: RUSSELLVILLE, ARKANSAS
 SCHEDULE: INITIAL COMM. OPER. DEC. 1972 YR. OF INITIAL SHIPMENT 1974
 SHIPPING DISTANCE ONE WAY, SITE TO COLUMBIA, S.C.: 822 Miles

FUEL UNITS PER CONTAINER

A. BASIC DATA

	ONE	TWO
	Uranium	Uranium
1. Container Shield Material	90,000	115,000
2. Gross Vehicle Weight, Lbs.	58,000	80,000
3. Container Transport Weight, Lbs.	320,000	420,000
4. Container Price, \$	118	59
5. Shipping Span in Days, Non Restrict.	496	248
6. Shipping Span in Days, Restrictive		

B. \$/FUEL UNIT - NON RESTRICTIVE SHIPPING

1. Freight Charges	1,646	1,136
2. Permit Charges	510	255
3. Container Rental & Administration	5,687	3,606
4. Insurance	87	59
5. Telegrams	40	20
6. Fuel Inventory Interest	1,145	572
7. Total \$/Fuel Unit Non Restrict. Shipment	9,115	5,648

C. \$/FUEL UNIT - RESTRICTIVE SHIPMENT ADDERS

1. Tractor Delay Charges	1,118	559
2. Container Delay Charges	18,217	11,551
3. Fuel Inventory Delay Charges	3,667	1,833
4. Total \$/Fuel Unit Adders for Delay	23,002	13,943

D. TOTAL \$/FUEL UNIT RESTRICTIVE SHIPMENT

32,117 19,591

E. ANNUAL TRANSPORT CHG., 59 FUEL UNITS

1. Annual Non Restrictive Shipment Charges	537,785	333,232
2. Annual Restrict. Penalty Charges	1,357,118	822,637
3. Annual Total Restrict. Shipment Charges	1,894,903	1,155,869

Revised 1-12-70

BWR WORK SHEET

SPENT FUEL TRANSPORT CHARGES STUDY FOR SIMB SPENT FUEL SHIPPING POSITION PAPER

UTILITY: TENNESSEE VALLEY AUTHORITY
 NAME OF UNIT: BROWN'S FERRY #1
 LOCATION: BROWN'S FERRY, ALABAMA
 SCHEDULE: INITIAL COM. OPER. OCT. 1970 YR. OF INITIAL SHIPMENT 1972
 SHIPPING DISTANCE ONE WAY, SITE TO COLUMBIA, S.C.: 462 Miles

FUEL UNITS PER CONTAIN'R

	TWO	FOUR
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A. BASIC DATA

	Uranium	Uranium
1. Container Shield Material		
2. Gross Vehicle Weight, Lbs.	100,000	112,000
3. Container Transport Weight, Lbs.	68,000	77,000
4. Container Price, \$	375,000	416,000
5. Shipping Span in Days, Non Restrict.	189	189
6. Shipping Span in Days, Restrictive	440	220

B. \$/FUEL UNIT - NON RESTRICTIVE SHIPPING

1. Freight Charges	561	318
2. Permit Charges	8	4
3. Container Rental & Administration	3,264	1,788
4. Insurance	49	28
5. Telegrams	15	8
6. Fuel Inventory Interest	208	105
7. Total \$/Fuel Unit Non Restrict. Shipment	<u>4,105</u>	<u>2,251</u>

C. \$/FUEL UNIT - RESTRICTIVE SHIPMENT. ADDERS

1. Tractor Delay Charges	211	106
2. Container Delay Charges	4,335	2,365
3. Fuel Inventory Delay Charges	276	138
4. Total \$/Fuel Unit Adders for Delay	<u>4,822</u>	<u>2,609</u>

D. TOTAL \$/FUEL UNIT RESTRICTIVE SHIPMENT

8,927	4,860
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E. ANNUAL TRANSPORT CHG., 189 FUEL UNITS

1. Annual Non Restrictive Shipment Charges	775,845	425,439
2. Annual Restrict. Penalty Charges	911,358	493,101
3. Annual Total Restrict. Shipment Charges	<u>1,687,203</u>	<u>918,540</u>

FIG. 3. WESTINGHOUSE 75 TON MULTI-ELEMENT
SPENT FUEL SHIPPING CASK AND RAIL CAR
(Courtesy Westinghouse Electric Corp.)

MAX GROSS VEHICLE WEIGHT - 115,000 LBS

TYPICAL TRUCK-CONTAINER ARRANGEMENT
FIG. 9

PANEL DISCUSSION

Moderator: Sterling W. Cole
Panelists: Sanford P. Hellman
Carl A. Larson
James W. Lee
Edward D. North
Reuben W. Peterson
Henry C. Schulize
C. Wesley Smith
Harold E. Walchli

STERLING W. COLE: Good morning, gentlemen and our two lovely girls.

I have been associated with the atomic energy problem and program since it began twenty-five years ago. That association initially was at the national level through the participation of the Joint Committee. I am more proud of the fact that in all of my twenty-five years of association with that subject, I was chairman of the Joint Committee when the present law was enacted which made it possible to open up the box of secrecy of the atom to the full exploitation of its uses for the good and benefit of mankind.

There have been other reasons that I have had to be proud of my association with the atom but I think I am the most proud of that. I have served not only at the national level but at the international level through my work in Austria as the head of the International Atomic Energy Agency and now for the past six months, as Federal Representative, I have been associated with the atom at the local level which I find most stimulating and interesting because it is at that level where the end use of atomic energy makes itself seen and felt and the benefit enjoyed.

As I sat and listened to the discussions yesterday in the presentation of one of the many problems of nuclear energy at the local level but a problem which is the most acute, I tried to put myself in the place of a highway engineer, highway superintendent, an official responsible for maintenance of the highways and the bridges, to determine what my reaction would be. I think I should say that I have been greatly impressed with the presentation by the panelists. Initially, through the inspiration of the staff of the Southern Interstate Nuclear Board, Bob Gifford and Colonel Peyton and his assistants, they have worked up a very instructive and enlightening presentation and yesterday they told you everything. There are some phases of the problem which they might have eliminated but they wouldn't have been honest with themselves or

with you if they had omitted the unfavorable aspects.

I was interested in checking down through the list of persons who are attending this conference and find that out of the one hundred twenty-five who were here yesterday, roughly twenty-five to twenty-eight are from the highway departments of the states. It shows that there is a ratio of about roughly five to one of what we will call industry, atomic energy industry, vis-a-vis those who have the responsibility of dealing with this immediate problem of transport of spent fuel. It has been gratifying to me to learn that all of the member states of the SINB are at this gathering with the exception of two, and those two happen to be the ones located at the extremity, the geographic extremity, of the region. It is understandable why Texas would not be represented here because I fancy that it will be many, many years before Texas will feel required to use nuclear energy to generate its electricity, having such an abundance of gas and oil in its own border.

The story presented yesterday was very complete but I must confess that for a time I was a bit dismayed when it was shown that it is not absolutely essential for the industry to use the highways exclusively. It is possible by using short haul from the plant to a railroad spur not to exceed twenty or thirty miles away, we were told, it is possible to use the railroads but in so doing we were also shown that it would add considerably to the cost.

I have heard it said here that this group, the atomic energy industry, is a special-interest group. I don't think anybody can deny that but is it any more of a special-interest group than the American Automobile Association or the American Truckers Association or any association which uses the highways, those pathways to progress? I don't believe that it is. It is an industry that has a special responsibility of getting to the people that life-blood which the people require, electric energy, in order to maintain their present comforts of life, their refrigerators and all those other consequences of electric energy.

Then in trying to rationalize the situation, I think if I were a highway superintendent, I would ask myself: Are these requests which this industry makes, are they reasonable or are they unreasonable? Well, there were three requests as you recall, one having to do with making it possible for them to drive during the nighttime and on non-holiday weekends. That to me would seem to be the most reasonable and most acceptable in view of the safety record in the transport of the spent fuel, there having been no accident whatever causing any damage to persons. In the light of such a perfect record, it seems perfectly reasonable and justifiable to open up that avenue of opportunity for the transport of the spent fuel.

The next one is having to do with repetitive permits. Well, I would think that if a permit once was given and the route followed as delineated by the highway people and there was no evidence of harm or damage to the highway or to the bridges, it would not be unreasonable to accept a policy of granting repetitious licenses or permits.

The most troublesome one is with respect to the weight, but when we learn that this weight request of 115,000 pounds is approximately the same

amount that is permitted by half of the southern states and that this 115,000 pounds is the average weight that has been allowed, an average mean weight allowed in all of the member states, then it would seem that that, too, approaches the realm of reason.

I do think that when you and the highway departments think this over and go back and talk with your superiors and with your associates, you can well come to the conclusion that these requests are not out of reason especially having in mind that the relief which is sought is not for the good just of the nuclear industry or for the truckers, but it is good for the people, it is for the good of the people in the areas which you represent by giving new industries, employment and the benefits of electric energy.

Now, we will get to the questions which I hope will be numerous. I think it would be useful if each person who has a question would identify himself, speak loudly so that the reporter can hear the name and can hear what you have to say. I have been asked by Colonel Peyton to tell you that there will be a coffee break at 10:30. Now, we are open and ready for questions. Yes, sir.

V. W. GUY: V. W. Guy from Mississippi. I have had your one hundred fifteen thousand pound load checked and we could put that weight on the interstate on that rig but we couldn't put it on our other bridges. There are very few bridges off the interstate system that are built to the same standard.

Now, it seems to me that one of the main ways to start solving this thing is for the availability of highway transportation to be taken into consideration when a plant is located. That should be a factor, it seems to me. I think the highway department should be consulted in that matter. If you just go put a plant down out in the country somewhere where we have bridges, and we have some of them that won't hold up your hat, we can't accommodate that load over that type of highway.

This load you are talking about moving from the plant to the rail siding, I have given some of them and it is with a different rig than you have got. It has more actual spread over the bridges and it's moved very slowly. It's moved under controlled conditions and there is a difference there in that assumption and there is one other item. It was assumed that when we hauled some heavy equipment in to build a plant that we can automatically use the rig that you had over that road to haul this pent fuel which may or may not be true. It is not true in any case where I have had a plant. We have always had special things that we did like shoring up bridges and shortening the spans or we have built bypasses. Both the shoring and the bypass had to be removed after the hauling was over, and under the circumstances it wouldn't be available to this. You wouldn't want to repeat that, I don't think, every time you moved one of these heavier rigs to the railroad.

We have used four, seven, eight, as many as ten axles strung out over sixty feet moving some real heavy things. One of our conventional plants was built not long ago and I suddenly had a man from Kansas City sitting in front of me and he said, "We are building a power plant at Moselle. I have got a 300,000 pound stator to move in there. How am I going to

move it?"

I think that highway availability ought to be taken into consideration when you start locating these plants. Thank you.

STERLING W. COLE: You have answered one of the questions that came to my mind yesterday. I considered about the necessity of using the roads to build the plant, getting the heavy machinery and all into the plant. Why they can't use those same roads, getting the spent material out of the plant to a rail siding. You have given the answer because in many instances there were special arrangements made to shore up the roads and the bridges and so forth. Since it was Mr. Lee who yesterday used the argument that the average or the majority of the states permitted 115,000 pounds, I would ask him to respond to that question.

JAMES W. LEE: I think that Mr. Guy has made several very good points and the best answer I can give to the problem of the bridges and the roads is to repeat again that we know we have to rely upon the state highway departments to tell us which roads and which bridges are capable of handling the 115,000 pound gross vehicle weight loads, if they are to be moved.

It may be necessary in some cases to shore up bridges as Mr. Guy has suggested. This would not be an undue burden on the industry because, as Mr. Hellman pointed out, the pattern of these loads is of a repetitive basis over a period of perhaps two or three months where you have a series of twenty-five or thirty loads moving between a nuclear power plant and the reprocessing plant, so that if certain reinforcing had to be done, it wouldn't be a case of doing it only for one movement.

I want to say also that I agree very strongly with his suggestion that the road availability -- the conditions of the road -- be considered when a new site is selected for a nuclear power plant.

I think that the utilities are giving much more consideration to this problem now. One of the utility representatives yesterday told me that they tried to select their site locations at least ten years ahead of construction and ten years ago the technology of the container industry, the nuclear container industry and the trucking business too, as far as that goes, was not at a point where the problems we are facing today could be visualized as well.

So today we are trying to live with a condition which in the future can be eliminated in many cases by preplanning.

STERLING W. COLE: Dr. Schultze has had considerable experience in nuclear plant siting. He may want to respond to that.

HENRY C. SCHULTZE: I think it is a valid point. I don't think I have anything more to contribute at this time, Sterling. I wish that we did have someone here from the utility industry such as Bill Lee of Duke Power who might respond to this.

Selecting a site for a nuclear power plant poses many problems. I think those of us who live in South Carolina can well recall the difficulties faced in selecting a site in Oconee County, South Carolina, and securing the land and proceeding in the manner to gather this property in without impairing the progress or their activities. There are many problems here. I think it is a question more for a utility man than for me, sir.

STERLING W. COLE: Well, with that suggestion, we will turn to a utility man and ask him what he thinks of it. Mr. Larson.

CARL A. LARSON: When a utility begins thinking about a new unit, generating unit, and the siting of that unit, one of the important factors is the size of the equipment to be moved into the plant, especially during the construction phase. The two large pieces, the generator stator and the reactor vessel, I believe are the two largest in the plant. Beyond that, we could look to the road surrounding the site to move that equipment and any equipment that may be required to move into the plant in the future.

I think one of the problems that we have is that we are siting a plant, let's say, in New York, and in trying to plan for reprocessing, we see a reprocessing plant in upstate New York and we see potential plants in South Carolina. We see another plant out in Illinois. Now, in the future, there will probably be additional reprocessing plants. Therefore, to cover all of the contingencies would require a study of a number of miles of roads to be sure that we could move that equipment or the containers.

So it is not an easy problem and one that is not easily solved to take that into account in planning the siting of the plant other than in its immediate area.

I think the reprocessing plant siting would have the same problem in considering all of the areas of nuclear plants that would be surrounding the plants.

STERLING W. COLE: Thank you. Yes, Mr. Hellman.

SANFORD P. HELLMAN: I would like to add a few other comments on this subject. When a utility chooses a site for locating a power plant, access to highways or railroads for moving the spent fuel to the reprocessing plant is certainly an important consideration but there are many other factors which influence the overall decision on location of the plant.

One of these factors is water supply. A nuclear plant needs a water supply for cooling. Another factor is the distribution of the population in the area. A third factor is transmission lines. Transmission lines are expensive to build and thus an effort is made to locate the plant where the amount and distance of transmission lines would be minimized. Finally, there are the environmental problems which have been given wide publicity in the news media recently.

Thus the choice of a site for locating a nuclear power plant is dependent upon a compromise of these many different factors, of which access to highways or railroads is only one of the considerations.

STERLING W. COLE: Is there any other panel member who would like to give additional thought to the question that was raised by Mr. Guy?

RUBLE A. THOMAS: Mr. Cole, I am Ruble Thomas, Southern Services. I am a utility man. I do work in site selection for our system. I think that the two panel members did an excellent job. There are many factors. However, one of the big ones, other than just distance of transmission, is reliability of the system. There are certain locations where you can put in power generation with more power system stability than you can others; but the thought I would like to point out is that you have another dimension if highways could be used for spent fuel transportation. If you just follow the railroad and the rivers, this constrains you to those locations. So if we can, like Mr. Guy mentioned, take into account roads, we have a whole new dimension for sites including where the railroads are not located to work in with the other factors. I think that is the important thing to us, the importance of the ability to consider highways for spent fuel transportation in our selection of sites.

STERLING W. COLE: I am happy to see that there was a response from a representative of a utility in the audience. In that connection, apropos of the allegation that this is a special-interest group, meaning, I think, particularly the utilities, I cast down through the list of persons in attendance and find that out of the one hundred twenty-five odd persons, there are five utilities present or represented. I am sure the absence of other utilities does not indicate a lack of interest in solving this problem. I prefer to feel that they stayed away purposely because they didn't want to feel that by overwhelming this meeting by a large attendance, the utility representatives would be charged with undue pressure on the highway officials. There are seventeen states in the southeastern interstate nuclear region, there must be an average of at least three utility companies for each state. That means roughly fifty to sixty utilities scattered throughout this region are or will be vitally affected by the resolution of this problem. When only four or five of them attend, it has some significance and because they are the ones who have to settle this problem at once, since they have plants in operation or under construction.

Mr. Mickler, yes.

ROLFE MICKLER: I am Rolfe Mickler with the Florida Department of Transportation. Since the whole conversation apparently revolves around getting the nuclear spent material from the plant, I must assume that there is no problem in getting it to the plant, that it is either harmless or goes in smaller sticks or something.

STERLING W. COLE: I would say that Mr. Peterson would be able to respond to that. There is no weight problem getting the fuel into the plant; how come there is such a problem getting it out?

REUBEN W. PETERSON: The big difference is that the fuel going into the plant is really not radioactive to such an extent that there is any shielding required and the containers are very light. I think Mr. Walchli showed you some pictures yesterday of three containers loaded with fresh fuel on a truck and that the whole load there was just about all fuel. Those

containers are probably only five to ten thousand pounds, something like that. Maybe, Hal, you would want to add something to that.

HAROLD E. WALCHLI: As Mr. Peterson said, new nuclear fuel exhibits no radioactivity that would necessitate a heavy shield of any kind. They are packaged in the case of PWR assemblies, in steel or iron containers primarily to give protection to the product rather than to provide shielding or restricted access to the fuel.

As I mentioned yesterday, one of these containers that we currently use holds two assemblies and the total weight including the container is about 6,000 pounds, so you can put six of them on a truck, in some states as many as eight on a truck. This means we can ship sixteen fuel assemblies and still get them over the highways with no difficulty whatsoever.

So, as far as the delivery of the nuclear fuel to the site, there is no problem using conventional trucks. You can always make the loads in any quantity you wish. The problem of moving spent fuel from the plant is due to the requirement that the container itself must be heavy. There is no way of getting away from this requirement.

In order to stop radiation, you must have a heavy material to absorb it. If you were to use a light material, such as water which provides shielding in the reactor, you would end up with a mighty large truck full of water which would weigh about the same as we are talking here. In addition, it would be physically much larger and we would have oversize, over-dimension problems too. We think we have taken the most practical approach to this in trying to get our containers just as small and light as we can; but no matter how much smaller we make them, we really can't make them much lighter because it takes the weight of material to absorb this radiation in order to provide the protection that is required to meet existing regulatory shipments.

STERLING W. COLE: Mr. Smith

C. WESLEY SMITH: I would just like to add one very quick comment to that. In the shipment of the fresh fuel, basically the weight of the container is essentially equal to the weight of the commodity shipped. In shipping PWR or BWR fuels, the fuel would weigh about 3,000 pounds, and the container would weigh another 3,000 pounds for a total of about 6,000 pounds per unit. In the case of the irradiated fuel shipments, the container will weigh anywhere from twenty to one hundred times of the weight of the fuel that is being shipped in it and the only way that you can get down to the twenty to one ratio is when you get up into the containers that weigh on the order of one hundred tons. In other words, the one unit, PWR container that Mr. Peterson described to you yesterday is the containers with one hundred to one ratio of container weight to product weight. This is the basic difference in getting the fresh fuel to the plant as opposed to getting the irradiated fuel away from it.

STERLING W. COLE: I think this is a good point to again refer to the charge of special interest, to point out that circumstances require this special request by the industry because it is a unique industry, completely

different from any other petitioner you may have for special permits to use your highways. No other industry, trucking, has a payload of only two per cent of the total gross weight. It is only for that reason, because of the minute ratio of the payload to overall weight, that they are asking for your consideration.

Yes, question back there.

JOHN W. LONG: My name is John W. Long and it is more difficult for you to listen to me than it is for me to talk. In a job the size of our Oconee nuclear station, it takes a lot of work by everyone, not just the traffic department, so Bill Lee has done a lot of work with the highway people. I haven't had the pleasure yet to meet the South Carolina representative here yesterday and today, so I don't know exactly what work has been done, but I know the road was upgraded substantially between our railhead down by the Newry Mill about a mile off the Southern main track, and I understand at Duke's expense. Now, whether that is still a state road or not, I do not know, but we have already received the two steam generators for the first unit. They came from Barberton, Ohio by special train to the railhead, and they weighed 570 tons each. They are moved from the railhead up to the plant site by this big Reliance Truck Company dolly which was built over in France. Duke did do a lot of planning before they selected this site, but the extent they worked with the highway department, I do not know, but I am sure they did considerable work. Henry might know. He was with the state development board and he might be familiar with what handling took place. That is about as much as I know about it at this time.

HENRY C. SCHULTZE: I was not with the State of South Carolina when the initial activities were begun. I think Mr. Long is correct. Duke did work very diligently and very hard with the state highway department. Mr. Moseley would you like to comment on that, please, sir, or Mr. Pearman?

S. N. PEARMAN: Well, I will just say Duke Power Company certainly did work --

STERLING W. COLE: A bit louder, please, Mr. Pearman.

S. N. PEARMAN: I can't talk as loud as you can.

STERLING W. COLE: Why don't you come over closer and then we can all hear you.

S. N. PEARMAN: I don't have one of these congressional voices. I am sorry.

STERLING W. COLE: I am not happy with the advantage I have with a microphone to give me that congress voice.

S. N. PEARMAN: As I said, Duke Power Company did work very cooperatively with the South Carolina Highway Department and in every respect and I want to say to that, there are three of us from our state down here, Mr. Cole, which does indicate our interest. We came down here to

try to learn more about your problems and hoping that we could assist you in our state.

Now, as far as this road that I believe Mr. Long mentioned to move these unusually heavy loads over, we would certainly anticipate no problem in moving this 245,000 pound load from a plant to a railhead and certainly would have no problem in doing that. This road, by the way, is a state highway road and is maintained by the state highway department. Now, we have studied these loads on our bridges and I don't want to go into detail because I have our technicians here who would know more about that than I do, but they tell me that when we put over 92,000 pounds on just the average roads that these loads would be hauled over, that we are endangering many of our bridges which were not built to support heavier loads.

I noticed yesterday someone here on the panel said that it might be a possibility of reducing that 115,000 pounds by as much as up to ten thousand pounds less and I would certainly hope that you would explore every possibility of doing that because if it could be done, it may be that we could assist in granting permission to haul loads up to between ninety to possibly one hundred thousand pounds on some of our roads.

As far as letting you haul these loads at night, if they can be limited to the poundage that I have just mentioned, I think that we could go along with that too, so I just want to say that I don't think it would be any particular problem in getting from any of the plants in our state or reprocessing plants that propose to be constructed in our state to railheads, but I do think that there would be some problems in hauling one hundred fifteen thousand pounds over many of our highways in the states. Thank you.

STERLING W. COLE: Thank you very much, Mr. Pearman, as I am sure do those on the panel and the committee who have been grappling with this problem. I appreciate the comment which you have made and am sure the responsible people will exercise additional effort to reduce the weight to one hundred ten thousand pounds.

Yes, sir.

CHESTER S. EHRMAN: My name is Chester Ehrman. I am with Allied Chemical and our interest is in operating a reprocessing plant in South Carolina as was mentioned yesterday by Dr. North. I would like to comment that we have been in touch with Mr. Pearman and his group and have received considerable information from him regarding routes and weight limits. We appreciate that and are looking forward to continuing working with him on this problem.

I would like to point out that a reprocessing plant is a focal point of spent fuel shipments from many utility plants. Each utility plant discharges fuel once a year, resulting in a certain number of shipments over local roads near that plant. The number of shipments over local roads near the reprocessing plant is considerably greater. The Allied Chemical plant will be five times bigger than NFS, which is the one discussed yesterday by Dr. North. The capacity will be five tons of fuel per day. In

terms of the number of shipments and on the basis of getting two PWR elements into a cask, there would be about five trucks per day coming in and five going back out, or ten trucks a day in the immediate area around our plant. If we had to receive one PWR element in a cask, the number of PWR truck shipments in our area would double. The increased number of shipments affects not only local road damage, but the design of our plant as well.

STERLING W. COLE: In connection with the remarks that were made by Mr. Pearman as Chief Commissioner of the Highway Department of South Carolina, I think I should say that it is not the intention of those of us, those people who have made the presentation and are working with the problem, of seeking a commitment from any of you representing the highway departments who are here today. On the other hand, if any of you do have an impulse to give expression to your thinking, such as Mr. Pearman has just given, it would be most helpful in guiding the industry towards seeking a solution which will be more readily acceptable to the highway people. Yes, sir.

A. J. METLER: My name is A. J. Metler. Are we concerned with the expressways and the local roads or just the local roads?

STERLING W. COLE: I am told that Wesley Smith is the best qualified to answer the question.

C. WESLEY SMITH: Jack, I think in that regard that depending on the type of shipment that you are looking at, you are concerned with both expressways and local roads. In the situation that I described yesterday, using the intermodal transport, we would be primarily concerned with the ability to move over local roads between the reactor and the railhead. In the case of the 115,000 pound gross vehicle weight shipments that Reuben Peterson described, there I think you would be interested in moving both over the local roads to an expressway system and then from there to the vicinity of the reprocessing plant on expressways. I am not sure in all cases what the situation is there regarding local roads.

In our case, we are about five miles off of Interstate 55 in Illinois and would not have much problem at that end. I don't know what the situation is at the Allied Plant. I think we are really concerned with both. In other words, I think we would move in the case of long distance shipments to the main highway system and then go through on that to near the destination and then perhaps off of that on local roads into the reprocessing plant.

STERLING W. COLE: I wonder if Dr. North may have some point to raise in connection with the question?

EDWARD D. NORTH: I think it is quite important to make a distinction, when you are speaking of expressways, between federally owned interstate highways and privately owned highways such as the New York State Thruway. These privately owned thruways do not in many cases permit the shipment of radioactive materials. They have the same fears that some of the northeastern railroads do, and at the present time in our

facility in New York we are restricted against travel on the New York State Thruway. Thank you.

REUBEN W. PETERSON: I think it is important to point out that this restriction is not due to the weight limits; but it is due to policy decision and insurance problems and the like and not due to the weight restrictions.

I think there is another thing that we are trying to do here. As you have been told, it takes anywhere from seven to ten years to go through the process of selecting a utility site and getting it designed, put together and ready to operate. In 1970, we are talking about ten years from now and I think we all recognize that there are many highways, many bridges that are in existence today that will not do this job, but the important thing is that we plan ahead so that in the future we can do it. It may necessitate a little different thinking on this because I am sure there are other industries that are coming along that are putting additional requirements on the highways in terms of weight. I don't know if I mentioned yesterday what the next generation of power reactor fuel is going to look like, but if we take our existing fuel which requires a container something on the order of sixteen feet and we extrapolate that to the next generation, we would say that the next container size is going to be about twenty feet long. Now, if we go to twenty feet long, we are going to go up approximately four out of sixteen, so we are talking about twenty-five per cent increase in weight which will mean that we probably will have to come down to one fuel unit per shipment. If we restrict our thinking now to shipping only one of our current generation of fuels, we have a new problem all over again in a few years and we have not applied the advanced thinking that we should have as people interested in looking at the over-all industry and the economics of the whole country. I think that there are certain states which have not had the need and their roads have been constructed with lesser capabilities than in some of the other states. As you look around, you see the population growth and it is quite evident where the population is increasing, the roads are getting bigger, heavier, and the bridges are doing likewise to support the activity. That is why we point out we think it is necessary for you highway officials to tell us which highways we can use and which ones we cannot use and to say what must be done in order to use them. Where there are cases where they can't be used, the industry will have to look at how we solve this particular problem; whether industry itself comes in and has to bolster up some of the bridges or assist in some of the highway programs.

It certainly is less expensive in some cases to modify and strengthen a bridge than it is to pay twice the shipping cost over the next forty years, and the average lifetime of a utility plant is at least forty years. So when you start looking at total dollars out, it may still be less expensive to help out on some of these things.

I don't know whether there are any of you utility people here that would like to comment on their feelings on that or not. I think the utilities recognize that they have a public responsibility to produce power and this is just one of the problems that is coming along now in meeting that responsibility.

C. WESLEY SMITH: I would like to add one comment in regard to the effect of the length of these fuel assemblies. One of these containers will weigh about 400 pounds to the inch of the type we are talking about. So when you add an extra two feet to the fuel length, you can see that it adds a considerable amount to the weight of these containers. If the wall doesn't get any thinner, it will be the same container. The forty ton container which Mr. Peterson described will weigh about four hundred pounds to the inch.

STERLING W. COLE: I must confess that I am rather shocked with the news that has been given us by Dr. North about the New York Thruway, inasmuch as my legal residence is New York State. For twenty-five years, I represented a section of that state in the Congress. I have always regarded New York as being in the forefront in the nuclear energy industry. Really, I feel that I must bow my head in a bit of shame when I am told that the New York State Thruway Authority does not permit shipment of spent fuel over that turnpike because of the radiation hazard. I hope this feeble voice may reach Albany so that they can correct it.

Yes, sir.

CLEMENT B. TOMLINS: Mr. Cole, my name is Tomlins and I represent a transportation firm which specializes in the utilities, both fossil and nuclear. Mr. Cole, you may be more surprised to know that the New York State Thruway does not allow the lowest amount of radioactive material in any form on its highway. Go down into the low MR class, if it is classified, if it does meet the definition of radioactive material, ionization of matter does not allow New York State through it.

I personally have fought this battle to a point that I have lost interest in it.

C. WESLEY SMITH: Congressman Cole -- go ahead.

CLEMENT B. TOMLINS: I had something else, but go ahead, please.

C. WESLEY SMITH: I might mention this is not a problem that is unique with New York. The policy of the toll road tunnel and toll bridge authorities in most states is that they will not permit radioactive material to move over their facilities and it is not only radioactive material but in many instances extends to other commodities which bear labeling required by the Department of Transportation regulations as hazardous commodities. Their feeling is that an accident on their system with this could interfere with the free flow of traffic. Since they are privately financed facilities, they count it as an unacceptable risk.

STERLING W. COLE: With that information from Mr. Smith, then I may raise my head again from a position of shame.

CLEMENT B. TOMLINS: Mr. Cole, while I am on my feet, may I use your office as the sounding board to echo back to this group?

STERLING W. COLE: Of course you may. Why don't you come to the microphone so that everybody can hear you?

CLEMENT B. TOMLINS: Let me speak loud. My firm is a citizen of the State of New York. It is also a citizen of the other twenty states, twenty-seven states, from which we hold rights. By this remark, I am expanding the purpose of this meeting. I, as a manager of a transportation firm, am continually frustrated by the twenty-seven highway departments, by the twenty-seven public service commissions, by the twenty-seven gas and fuel taxes, by the ad valorem tax, by the Indiana State Income Tax. Why cannot a group such as this get together and make a uniform set of standards, say for the size and weight, why can't a group like this get together and make a uniform set of size and standard weights, minimum, perhaps; why cannot a group representing states get together and make a uniform system of licensing? This has been attempted with these "D" cards and there are still some states including the State of New York which has not even honored the system. Why can't we walk out of here, lock the doors, leave these twenty-eight people that are representing these fifteen states, let them come up with a mutual answer. When they say that they have the mutual answer, we will unlock the doors and let them out.

STERLING W. COLE: Mr. Guy has his hand up.

V. W. GUY: I don't want to do a lot of talking, I really don't, but I want to inform you that the Commercial Vehicle Sizes and Weights Committee of the Southeastern States here in Atlanta last December adopted a set of uniform regulations about which you have been speaking and these were referred to the administrative committee of the association. What is going to come of it, I don't know, but you might write them a letter.

STERLING W. COLE: The gentleman from Missouri.

L. V. McLAUGHLIN: Congressman Cole, I am Lyle McLaughlin, State Highway Department for the State of Missouri. I am not sure that I know exactly how the rest of these state highway departments feel, but of the three things that this board has requested, in my opinion the most critical one is this repetitive movement of the 115,000 pound load. We are definitely sure in our state that many of the bridges on our 32,000 mile system of state highways will not readily handle this 115,000 pound load without seriously over-stressing many of them and possibly doing considerable damage. Now, you are asking for permits here on a repetitive basis for this 115,000 pound move while hauling multiple containers. We don't issue permits to anyone else to haul over the state highway system with a load that is reducible. Certainly, we would not do it to the coal haulers within the state and we feel that while you are in the process of designing your equipment and if you intend to haul multiple units, it should be designed so that you can operate within the legal limits and you can operate at will, of course, on the system, that is, down to 73,200 pounds, or thereabouts.

This weight is definitely going to be a problem to the bridges. Now, there is no question about it. Many of the bridges on our system were built at the time of the Centennial Road Law forty, fifty years ago and they are still being used in a sizeable number -- we will put it that way -- because there have not been public funds made available to reconstruct all of those bridges, not that they don't need it because many of them do.

Now, I will be the first to admit that maybe these loads do not seriously overstress bridges on the interstate system but to move this heavy load on heavily traveled weekends and you are saying any weekend except holiday weekends or at night, is a safety hazard. There is just no question about that. I think if you will examine the accidents by the trucking industry, you will find that out. Considerable emphasis has been made on the eighteen thousand pound axle. Now, that is all right when considering single axles but if you are going to consider multiple axles, then some other weight should be taken into consideration because we would be opposed to the fifty-two thousand five hundred pound load for a multiple of three axles which would be less than your eighteen thousand pounds each.

On a tandem group in our state, the legal weight limit is 32,000 pounds and under certain conditions we can issue a permit up to 48,000 pounds for a triple axle if the axle is fully equalized. I understand you intend to design your equipment so that the axle will be fully equalized. It is not that we wouldn't like to cooperate in every way possible because I assure you that the State of Missouri does want to cooperate in every way possible.

We are concerned with the repetitive movement of this 115,000 pound load and perhaps the use of rail or water as a vehicle for moving these loads is going to be the most suitable. Of course, that is not for us to decide; it is for you people to decide.

STERLING W. COLE: Mr. McLaughlin, I thank you very much, you and Mr. Guy, for your expressions. I am sure all of us would welcome further expressions from the highway people to give expression to their thoughts with this problem.

Emory Parrish, the Assistant Director of the Georgia Highway Department.

EMORY C. PARRISH: I don't know which is the most trouble to a highway department, the shortage of funds that all of us work under, our personnel problems or trying to keep special-interest groups from getting special privileges on hauling overweight loads. These are our three most serious problems. I am sorry I wasn't able to be here at 9:30 this morning but our legislature is in session right now considering such a move so I have been somewhat busy.

This question of bridges, we have a number in this state of H-fifteen bridges. The 115,000 pound repetitive load that we are talking about is a fifty per cent overload on that bridge and this load is, my people tell me, twenty per cent above the allowable stress that this bridge was designed under.

Lockheed has a nuclear plant up at Dawsonville. They asked us for a permit to haul spent fuels between their plant or their railhead and their plant, at Dawsonville, about thirty-five miles. We had the roadway analyzed to see what we would have to do to permit this repetitive load. We were only talking about four loads a day. It would cost us six million dollars to rebuild that road to handle that load when a railroad could have been built into the plant for four million dollars. This is a serious problem. We are quite

interested in the cost. I got the figure last night after hearing the papers yesterday of seven million dollars cost per year if you can only haul one unit. Which, as I recall, if the figures are right, this was a ninety thousand pound gross load. With seventeen states in this region, that seven million dollars a year using 3.8 persons per family and considering only residential power units, this cost then distributed among the seventeen states amounts to fifty cents per family per year, not counting industry.

We go a little further, and I forget the other figure, it was about twenty-seven million dollars. We were talking about a dollar and a half per family. From our standpoint, we in Georgia under the law cannot issue a permit for two units to move. We can issue a permit under stringent conditions to get the reactor in, six hundred tons or 600,000 pound load, but we cannot, whether it is PWR or BWR, it doesn't make any difference to us to permit you to haul more than one fuel unit. The law states that if the load can be readily dismantled, then you cannot issue a permit for it. We in Georgia feel that while you are now in the stage of design, if you will design your vessel so that you can carry one unit, then we won't have any problem. I don't know how the other departments feel. I know what those that I talked with yesterday afternoon say. We are in favor of uniform procedures as far as the SASHO Committee is concerned. We did a lot of work on it ourselves. We would request this committee, this board, to design their vessels to haul one unit and then we can work with you on the permit.

STERLING W. COLE: Thank you very much, Mr. Parrish. Now, I think that we have reached a --

L. V. McLAUGHLIN: I had one more short statement that I wanted to make and I might go ahead and agree with this last speaker and to the effect that he talked about the fifty per cent overstress on an H-15 bridge and I suspect he is talking about a new structure, not some of these bridges that are forty, fifty years of age which we don't know exactly what the overstress would be on those.

What I intended to say further was that I kind of doubt whether in the State of Missouri we could do what you are asking for, this repetitive moving of this load of 115,000 pounds, because if we did it for this group, obviously we would have to do it for all similar groups that might make such a request and then, in essence, we are legalizing the movement of loads that are above those established by state statute, so we questioned whether or not the state highway department has authority to grant permits under such conditions.

STERLING W. COLE: Thank you, Mr. McLaughlin. Now, we have reached that point where the coffee break is to take place out in the outer hall.

(Short recess.)

STERLING W. COLE: Gentlemen, would you please take your seats so that we may renew this discussion?

When we broke up for the coffee, I am told that some confusion had developed by reason of the comments of the last two speakers when they

referred to multiple units, the problem of dealing with multiple units because of the restrictions and the respective laws of their states.

I have asked Mr. Larson to try to clarify this problem of multiple units so far as the transport of spent fuel is concerned.

CARL A. LARSON: I would just like to make clear that the issue before us, and I am speaking as a user of these shipping services and these containers, the issue before us is not the number of assemblies, whether it is one or two assemblies, that will be acceptable. Actually, I would like to ship three, four or more assemblies in containers. I think we have to focus on the weight and not on the number of assemblies. If we focus on the weight, 115,000 pounds, 92,000 pounds or 73,000 pounds, whatever it is, I am going to rely on the container designer to get as many assemblies as he can into that container. From that point on, it is his problem and from what we heard yesterday and today, we recognized that is a serious problem.

STERLING W. COLE: Thank you, Mr. Larson. Yes, sir.

EMORY C. PARRISH: Let me respond to this. We understand that the industry would like to haul one, two, three, four or one hundred units. We are talking about individual fuel units. Our laws permit movements down to the least divisible load. We cannot go above that.

Now, these laws were passed for a particular reason and this was to keep the states from issuing permits for overweight loads above the 73,280, so with us it is not a concern of 115,000 pounds versus 90,000 or 130,000 but it is the load you haul -- the fuel unit, model over the table. This is our concern and as long as the industry will design these casks to carry one unit, we can permit and in Georgia we will permit their movement. But with more than one unit, be it PWR or BWR, we will not nor can we issue a permit to move a load of any kind above 73,280.

STERLING W. COLE: Thank you, Mr. Parrish. I am sure that Mr. McLaughlin will reply to that.

L. V. McLAUGHLIN: I was only going to reiterate what he says. The Missouri statute limitation for load is 73,280 pounds and to haul anything greater than that, the load must definitely not be reducible in character and that is only for short moves or one-trip moves.

STERLING W. COLE: The purpose of this gathering is to present to you as representatives of the highway departments the problems which the nuclear industry has in this aspect and we are here to hear from you and your department what your problems may be with respect to meeting these problems. It has been a very useful discussion and I would hope that more people from the highway departments would feel free to express themselves in this regard. Yes, sir.

HENRY GRAY: I am Henry Gray, Assistant Director, Arkansas Highway Department. We have the same statutes and we have the same type of bridges. Our H-15 bridges will not take the overstress which actually comes up to fifty per cent and which really is getting pretty close to maximum. We have

the same problem as far as repetitious permits, also holidays. This is the way our statutes are.

STERLING W. COLE: Thank you, Mr. Gray. Yes, sir.

FRANK J. TAYLOR: I am Frank Taylor, Louisiana Department of Highways. I am going to digress a moment from the weight problem and get into this other problem which is dealing with the possibility of movement during the 24 hour period, continuous movement.

As Mr. Guy stated and as these gentlemen here made the remark about the states getting together to get some degree of uniformity, the Southeastern Association of State Highway Officials, the committee on commercial vehicle sizes of weights, worked at some length to come up with some degree of uniformity in the matter of permits.

As stated in the papers which were presented, the one thing which is now uniform among the seventeen states under consideration is no night hauling, no weekend hauling. This is uniform, gentlemen, and this is one of the things they are asking the highway departments to waive. Frankly, I cannot see any possibility of the seventeen states now reversing their decision. You may have several of them which would but I just cannot see all seventeen of them completely reversing their stand.

Now, this is said to be a unique situation in that the weight of the commodity being hauled is only some two per cent of the total load. I know in Louisiana we have a lot of oil industry as some of the other states do and there are many of these self-contained draw works units which are constructed on a trailer. They are not able to be removed from it. They are part of it. So, therefore, their payload is nothing, absolutely nothing. They don't haul anything on it. This is on it to start with. Yet, they are overloaded and they don't receive any special consideration any more than the man would who was hauling draw works unit, which could be placed on a trailer and taken off at a well site.

Also, we have many compressors, pumps, transformers, etc., which are only overweight and they are limited to this requirement of daylight hours only and I can foresee that if any dispensation were made in this case, then you would be faced with the same thing with these people. Thank you.

STERLING W. COLE: Thank you, Mr. Taylor.

REUBEN W. PETERSON: Mr. Moderator, from the standpoint of the people trying to decide what kind of containers to build and when to build them, the response we are getting this morning, although not very encouraging, is certainly very helpful in this decision-making purpose.

We know that by this summer we must start building something to meet the needs of the utilities. We didn't say much about it yesterday but these containers, regardless of which size and weight we talk about, are going to cost maybe four or five hundred thousand dollars each. About the time we put that kind of money into a fleet of these containers and the vehicle that goes with them, we must be assured that somewhere down the road, as far as future

planning goes, utilization isn't going to be stopped by policy decisions or regulation changes or strict enforcement of existing regulations. This is where we are trying to find out just where we stand, and as Mr. Larson said, it is not a question of one, two or three assemblies in these containers. We don't want you to look at it that way. We want you to look at what is a gross vehicle weight that you can consider reasonable.

Now, we told you yesterday how we arrived at this weight and it sounds like we have overlooked a few things that aren't our specialty. That is why we are here, to get this direct response from you. That 115,000 pounds is no magic number. It is our best estimate right now and very frankly, it is a little on the high side because we have some real problems with the container designs, particularly with the neutron shielding problem. I know some of you pointed out to me that there has been a radical change in weight from a position paper we gave you last year compared to what we are telling you now. This is not covering anything up; this is the facts of the matter. We have learned quite a few things in the last six to eight months about the neutron problem.

I don't want you to feel that we don't know what we are doing. It is a very difficult problem. In fact, when you come right down to it, what containers we build and what neutron shielding we put on them this year is still an uncertainty because we may not know what the magnitude of the problem really is until we get some of this fuel out of the reactors and actually measure the neutron emission.

So, you see, we have got a rather difficult situation but we will build some containers this year and those decisions will be based heavily on what we are hearing here and hopefully what we will hear in the near future from you on acceptable gross vehicle weights. Now, we know this much: We are not going to get down to 73,000 and if that is strictly applied, it will pretty clearly say that those utilities without rail service at their reactors are in trouble. I doubt very much if we will get below 100,000 pounds even if we went to one fuel unit, but one fuel unit is of no practical interest to us or to the whole industry. Take for example one of these BWR reactors that was mentioned yesterday discharging some 160 fuel units every year and ship one of those at a time. We know that it is impractical, if not physically impossible, to handle that many containers and go through that many loading and unloading operations. I think it may be impossible.

I know we as container designers and manufacturers and service people will not run the risk of investing our money in a container where there is that much doubt of its ultimate utilization from the utility and a reprocessing plant standpoint. What we would like to do is have you people consider further all the factors we have presented to you in arriving at our proposed gross vehicle weight. We still believe we have a special case because of the low payload related to most other commodities.

We have looked at the coal and the oil industries, the steel industry and others and they all have quite a different situation than we have. That is our viewpoint. We think that we can haul these heavy loads without unacceptable wear and tear on the highways. We think we can get into the range where it will be acceptable on your bridges. I know there are bridges

that can't handle these loads and we will find routes around them, circuitous routes between two points to meet your requirements over highways you think will handle the traffic. There has been quite a bit of experience in other parts of the country already. Take, for example, the Consolidated Edison experience moving from Indian Point to West Valley, with a 95,000 pound gross vehicle weight. There was a fleet of three casks and three trailers and one tractor; the job was done very efficiently and with no major problems. The same thing applies to the power plant in Illinois moving to West Valley. This has been handled by both railroad and truck. By the same concept of truck casks moving on specially designed trailers, we were able to stay under 100,000 pounds, but those shipments went under special permits. I am sure that they had the same ground rules, the same regulations as those that are being mentioned here this morning. This minimum divisible load rule is not news to us. We know that is the sensitive issue. However, we also know that once the container design is set and containers are built, then this minimum divisible load rule is met because we are not trying to ship two containers; it is one container and has one weight. Regardless of what is in it, the weight changes very little. We only have about 3,000 pounds difference between the loaded and the empty container.

So with that background, with the facts that we have tried to convey here, the considerations we are faced with, we would like you highway people to consider all the factors we have presented, try to give us your best judgment on what you think is a reasonable gross vehicle weight and then dump the problem right back in our lap and we will take it from there. We have a real difficult time problem in that we need to build some containers this year. If we can't get the answer or if the answer is to apply the minimum divisible load rule which means one fuel unit per container, the answer will be pretty clear, we just won't go by the highways. Then, we will have future efforts, I am sure, by the people that really are hurt by this to try to find other solutions, but we should do all we can now to deal with the problem. If we get anywhere around this 100 to 110,000 pound area, we do have some flexibility in design, with respect to the number of axles we can put under the load if that would help. The overall length of the vehicle is also flexible because we are thinking of very specialized trailers.

If special or added features in the axle load compensating devices would help, we can consider that also. We think we have systems now that will equalize the loads on individual axles to avoid load concentration. Those things we do have some control over but we really don't have any control over setting acceptable gross vehicle weights. That is the help we need from you.

As far as nighttime travel, I realize this is a restriction nearly everywhere now, but our look at that had indicated it is really related to over-dimensional shipments and, as was said yesterday, we thought it reasonable to ask waiver because we are not overdimensional. Furthermore, we have experience that shows we can move pretty well with the traffic so we are not obstructing, we are not reducing peoples' vision and we thought from a safety standpoint not really creating additional hazards.

Certainly, in spite of what you hear and read in the news media, these shipments, in my opinion after many years in the container design, are far less hazardous than many, many things moving over the highways every day

around the clock seven days a week. It is hard to conceive of an accident that could come close to what we called yesterday the hypothetical accident condition and even under this hypothetical accident condition, we are designing these containers so that no unacceptable hazard will be created. Those are the viewpoints of the people trying to get the casks under construction and meet the needs of the utilities and the reprocessors. We really don't want to let the problem drag out. We can't let it drag out. We are really behind schedule now so whatever the answer is, that is what we need.

STERLING W. COLE: Mr. Parrish had his hand up.

EMORY C. PARRISH: Mr. Cole, I don't mean to be taking up all the time and I am glad to see highway people sitting in the other part of the audience instead of right over here in this little group. We are not going to have this problem in Georgia for our plant. We found that the Georgia Power Company is far-thinking, they are well organized. They will have rail shipments to their centers. Law is a technicality and you know these technicalities keep gross loads down on the highway. It is sort of like, "There is no such thing as a young lady being a little bit pregnant. She either is or she isn't. There is no point in between." Now, it all comes back, we can haul the casket if you don't want to put any fuel units in it. It can weigh 200,000 pounds and we can issue a permit to haul that casket. But the first time you put two units in, under Georgia law we cannot issue you the permit. That is about as straight as I know how to make it. We understand the problem. We have been working with Georgia Power for, I don't know, five years, I guess, on this problem. We have got 17,000 miles of highways in Georgia on our state system. We have a three billion dollar investment in those highways but it has taken us since 1916 to get that three billion dollar investment. So we are talking about money, and three billion dollars is a lot of money, but fifty-four years is a long time too.

Now, all of the southeastern states have roads that are fifty years old. These roads have not been reconstructed. We are talking about primary state highways, these roads with six inch compacted bases on them. Some of them may be less than six inches but I don't know of any in Georgia. Now, this would be in Georgia with a 90,000 pound unit, a special permit. The question: Can the permit be continuous? We don't know. We know this: No state has a history of maintenance cost for this type of repetitive load. It may be necessary five years after you spend this money for containers, that if these roads won't stand it, the highway departments, whether they want to or not, may have to stop issuing the permits. This is a more serious question and one that I think the board should consider because the highway department will have to consider it. Maintenance cost is going up year after year. Our Governor vetoed a gas increase last year. We are sitting with three million dollars to do twenty-one million dollars worth of resurfacing on our state highways. I guess we are pointing at all the industries. It is a serious problem. If we go into this design and expect to haul 90,000 pounds or 115,000 pounds repetitive loads for a period of six weeks, I believe they said yesterday, each year then we could have serious maintenance problems. Of course, it looks like anything in Florida is going to be coming through Georgia anyway -- our problem is mainly going to be from that area. We ought to take another look to see if there is any way possible to get it below the 73,280 pounds. If there is not, then we are taking a big chance.

STERLING W. COLE: Mr. Ehrman.

CHESTER S. EHRMAN: I would like to comment on shipping only one unit per cask versus damage to the roads. I would hope that as a part of the evaluation of the overall situation, one would consider the example of shipping 160 BWR elements each year in single element casks with a GVW of ninety thousand pounds versus four element casks with a GVW of 115,000 pounds. Use of the larger casks would cut the number of BWR shipments, by a factor of four, or forty shipments a year from a reactor as against one hundred sixty shipments a year. I think there is an extremely fundamental evaluation that must be made regarding the number of shipments at 90,000 pounds GVW versus the significantly fewer shipments at 115,000 pounds GVW and the effect that this has on road damage. Thank you.

STERLING W. COLE: Thank you. Mr. Smith from the Tennessee Highway Department.

JERRY W. SMITH: Mr. Cole, I would like to confirm one thing. Tennessee is faced with the same problems that the State of Arkansas, the State of Georgia and the State of Missouri is, and when you get over 73,280 pounds as far as the multiple choice units, you have got a problem and I would just like to affirm that Tennessee is faced with the same thing.

V. W. GUY: I want to fill out my information a little bit here. Mr. Peterson, how do you get an empty cask down to your plant to load it up?

REUBEN W. PETERSON: The operation, how do we go about this?

V. W. GUY: You have to get a cask down here to where you are going to take the spent fuel out.

REUBEN W. PETERSON: The cask will probably be headquartered in a particular location, most likely at or near the reprocessing plant. An empty cask will go to the power plant over the same route over which it will come back loaded.

V. W. GUY: How much is it going to weigh?

REUBEN W. PETERSON: The gross vehicle weight of the empty shipment will be about 110,000 pounds and when it gets loaded, it will increase about 3,000 pounds.

V. W. GUY: Thank you.

STERLING W. COLE: Yes, sir.

J. W. SPURRIER: John Spurrier, Kentucky Department of Highways. We are in the same position that our sister states are in many ways. Even on resurfacing, we have two, three million dollars allotted for resurfacing. We have twenty-two million dollars worth of needs. There is one point that I am missing, really. Maybe I didn't get correct information yesterday but it seemed like that these fuel units at one time were short. You could haul them in these casks in legal loads. Now, you are saying that these units

are fourteen or sixteen feet long and you need permits for 115,000 pounds. There was an indication yesterday -- I took it this way -- that maybe these units are going to get up to twenty feet long. Where is the stopping point going to be? If you go to twenty foot units, you are going to have to have longer casks; you are going to have to have more weight. According to our law, we can issue in single units, whether or not it is divisible. Where is the stopping point going to come on the design of the units?

REUBEN W. PETERSON: I will attempt to answer that. Right now the stopping point is at about 177 inches. The containers that will be built this year -- that is all they will handle. We know that there is a possibility of still longer fuel units coming and that will be a separate problem but there is enough demand right now for shipment of fuel units 177 inches or less that we can see enough utilization for casks built now to handle those.

STERLING W. COLE: This gentleman.

ELMER C. LUSK: Elmer Lusk. I would like a clarification on the possible uses of the interstate system. For example, the fuel from Florida, can it be transferred through Georgia on an interstate system so that no complications would arise?

STERLING W. COLE: I will ask Mr. Walchli to respond.

HAROLD E. WALCHLI: I think he is really asking the question from the state people.

EMORY C. PARRISH: I can answer that one real quick. The law in Georgia says you cannot. You have to have the least divisible load. Section 127, Title 23 of the U. S. Code says that no funds shall be appropriated to any state which permits loads to be moved on the interstate system that could not legally be transported on July 1st, 1956. Georgia could not legally let a load be transported on any highway in 1956 if it had more than one fuel unit and, therefore, we could not let it move on the interstate system.

We have had this pointed out to us very strongly in Georgia. It seems that the Atlanta Transit System was operating 102 inch buses on the interstate. I personally had to write a report to be sent to Washington as to why these 102 inch buses were operating on the interstate system since we could not legally authorize them July 1st, 1956. The Atlanta Transit System had to reroute all of their routes to get the 102 inch buses off the interstate. So any load that could be moved in Georgia on July the 1st, 1956, can be moved now. Other than that, it cannot.

HAROLD E. WALCHLI: Can I ask you a question, sir? Independent of the statutory limits that you are talking about, is there any technical limit from a capability standpoint of being able to do this?

EMORY C. PARRISH: All bridges on the interstate system are H-20 bridges to handle at least H-20 loads. This 115,000 load will cause some overstress. Now, sooner or later, if you continue to overstress the bridge would fail. If we could be sure that when that bridge fails it would have one of these movements on it, then the utilities could pay for the cost of rebuilding

that bridge. That may be something else. No matter what you do with this load, you are going to get an overstress on that bridge.

STERLING W. COLE: Thank you, Mr. Parrish.

REUBEN W. PETERSON: May I ask a question back?

STERLING W. COLE: Of course, Mr. Peterson.

REUBEN W. PETERSON: We have heard a lot about the statutory limit. It is no news to us, really. We have known that for some time. Yet, the thing that is confusing to me and maybe one of you from the highway department would venture to answer the question for my own information. What sort of rationale are these highway people going through in the states where they are allowing us to go ahead and move in this 95 to 100,000 or 110,000 gross vehicle weight range? It is happening regularly every year. The frequency hasn't been great but we have said to ourselves that we see shipments moving under the same rules which apply in nearly all the states. What are they thinking? How are they interpreting the statutes and what sort of process are they going through in allowing us to move when it seems so clear here that there is just no way around it?

EMORY C. PARRISH: Again let me answer. Georgia has no responsibility for what goes on in Alabama or any other state. We are responsible for roads in this state. It is very much a legal question. As an example, this year in our legislature, that is now in session, we sponsored a bill to permit 102 inch buses on state highways in our urban areas for these buses who are licensed under the Public Service Commission for a 50 mile route. We have had to withdraw that bill because of the special-interest groups within the legislature uniting to say, "Well, let's allow 78,000 for pulpwood; let's allow 102 inches for concrete pipe, cotton and plywood" to the extent that we have had to withdraw the very bill that we wanted. I don't know what New York does. I am sure their statute is very similar to ours. Maybe they don't have the attorney general we have.

STERLING W. COLE: Mr. Guy.

V. W. GUY: I believe the answer to the gentleman's question could be seen in a difference in Georgia's law on permits than Mississippi. Now, Emory says that they cannot issue one above the least divisible load. Now, that is not mentioned in Mississippi law. It is discretionary. It can be issued at the discretion of the highway commission. We are not bound by dividing them down to the lowest weight but now what we use as our guidepost is the American Association of State Highway Officials Recommended Maximum Overstresses for Occasional Loads which run about thirty-seven and a half or thirty-nine per cent on the interstate and that was the basis on which I said that we could move that weight in Mississippi. I am not telling you we will move it because there are other people in this thing, but that weight would come within the overstress on the rig you have. Now, I am not bound by Emory's law about not having two containers.

STERLING W. COLE: Yes, sir.

DAVID H. FISHER: Dave Fisher from Maryland. I think it has been mentioned here that the interstate act set up certain weight limitations which were related to those in effect at the time of the enactment of the act. States do, however, have authority by special permit, of course, to move loads which are in excess of that. I think the intent of the act was primarily to say what the legal loads could be to move uncontrolled over the highway.

Now, I think most of the states issue these special permits for overweight, overdimensional, and so forth, and these are under controlled conditions. Under the special permit, you can determine that there is only going to be one of these vehicles on a structure at any one time and you can take certain precautions or you can reinforce the structure if the loading seems to require it.

Now, with a blanket type of permit, which is really what you all are asking for, you lose all that degree of control. There is no way of anybody knowing how many of these overweight vehicles are going to be on a structure at any one time. You also have instances as we have of drivers because of the adverse travel that might be involved in using a specified routing deciding they are going to take a short cut. They are without police escort or without controls and we really have no way of controlling their activities. Many of the states like Maryland, I am sure, do not control the complete highway system of the state. We control about one-fifth of it, so you do have then also the problem of not only the highway department's becoming involved but you also, I think, are going to have to look to a lot of the local, county, city and the municipal departments who may be affected by this request.

STERLING W. COLE: Thank you, Mr. Fisher. I wonder if Mr. Parrish would care to respond to that observation which, as I get it, permits states to grant special permits by way of exemption from that federal limitation?

EMORY C. PARRISH: This is somewhat surprising, Congressman Cole, because it hasn't worked this way before. Our attorney general told us that with these loads that can be divided, we are not permitted to issue any permit. I know of no exemption in Georgia.

STERLING W. COLE: On the question of controlling the movement of the trucks, I think I would ask Mr. Lee to respond to that, not for the purpose of arguing, but simply to clarify.

JAMES W. LEE: That is right, Congressman Cole. I want to emphasize that I certainly don't want to get into any argument or any kind of rebuttal to what has been said here today. We came to this program with the hope that the highway administrators would speak with us openly and frankly and we certainly are appreciative of the fact that they are, "telling it to us like it is," as my teenagers say.

I don't know of any load that moves over the highway that moves under more controlled conditions than spent fuel. By the time a carrier has the U. S. Atomic Energy Commission and the Department of Transportation, and in many cases the state health department, looking over his shoulder, he doesn't dare move one inch off of the designated route, so I don't think that the possible danger of a truck moving over a road which he is not supposed

to travel, or two trucks arriving on a bridge at the same time, is a real threat. Under the conditions which govern the movement of spent fuel, these factors can very easily be controlled.

If I may, Mr. Moderator, I would like to suggest that, well, first of all, a great many things have come out of this discussion this morning. We have learned a lot. We have learned about some problems which we were aware of, but now know more detail, and we have learned about some of your problems and some of the regulations which bind you, that we were not aware of. Certainly many of these things are not the type of matter that can be resolved, or that we can gain enough information about, in one session such as this.

Our committee would like very much to establish a mechanism whereby we could meet with designated members of your group, possibly through one of your existing organizations such as the Southeastern Association of State Highway Officials. In fact, I believe someone mentioned a committee in that group, the Size and Weight Committee, which probably would be a very appropriate vehicle for such meetings and I would like to know what the highway people think of designating a group of that kind to meet with us at a reasonable time in the future, when we could explore some of these problems together in more detail.

STERLING W. COLE: You sort of beat me to the mike on that one, Mr. Lee. I am joking with my friend. He stole my final plea but I am glad that he did because it comes from him and he is very knowledgeable.

V. W. GUY: I just want to say that we would be willing to cooperate in any way we can in helping any way we can. I know I am speaking for Mississippi and I might say that I don't know whether the chairman of the Size and Weights Committee is here or not, but something like this is generally handled in a little higher level than the committee members. It might be that you should get a designation from the administrative heads of each state on who would attend.

STERLING W. COLE: We had one question back in the rear.

WYATT M. ROGERS, JR.: Wyatt Rogers. Just for my own edification, not being part of the nuclear industry or the highway sector, what is the basic difference between what you might call blanket permits and repetitive permits? I assume that there is some distinction between the two. Blanket permits to my mind would connote an open ended type of thing with no or little state control, whereas a repetitive permit would have to go, I assume, through a basic application and include route designations. Am I interpreting this right?

STERLING W. COLE: I have my own notion of what it means but for fear of being wrong, which I probably am, I will ask Mr. Lee, who is an authority on the subject, to answer.

JAMES W. LEE: I have heard so many definitions of an authority that I always cringe when someone puts this tag on me. There are many, many more people in this room who know more about permits than I do. I think the

difference between a repetitive permit and blanket permit, in the minds of many of the highway people here, does not exist. I have found in some of these discussions that various definitions have been placed on these words. In my mind, a blanket permit is, as one of the other gentlemen said just a few minutes ago, a license just to go out and go without control, but a repetitive permit, as we are using the term, means a highly controlled movement over a designated route, but a movement that will have to repeat itself a series of times.

STERLING W. COLE: Thank you. It is approaching the time when we should break up for lunch which is to take place at 12:00, but before doing that I wonder if I might have the authority to propose in the light of what Mr. Lee has just suggested, to propose a follow-up to this discussion. Obviously, we cannot let the matter drop here. It may be that there is no solution and I must confess the discussion has pointed in that direction unless there is some substantial change in the laws of some of the states. But to the end of pursuing the subject, I wonder if it might not be in order to suggest that the committee of the Southern Interstate Nuclear Board, through Mr. Gifford, communicate with the appropriate officials of the Southeast Highway Commissioners Association, I am not sure that I got the correct name, to explore this further and perhaps have a meeting between the group to discuss it with the experts who are knowledgeable.

I saw a hand back in the far corner to the right. Oh yes, Mr. Parrish.

EMORY C. PARRISH: It is me again. If I might suggest, Congressman, this is a problem that is going to be national. It is not going to direct itself only to SASHO or the southeastern area. I can quote from the letter from Alf Johnson, the Executive Director of the American Association of State Highway Officials, in which he recommends, and Georgia certainly concurs with his recommendation, that this will be national in scope and suggests that the nuclear industry work through AASHO.

Now, here in the SASHO region, Georgia would certainly be willing to sit down and talk as we have with Mr. Peyton and the people on the board before, but I think the beginning point would be with AASHO and then we would adopt AASHO's suggestions.

STERLING W. COLE: I appreciate your suggestion, Mr. Parrish, even though I have some reservations regarding its wisdom. Now, I would like to hear from Mr. Fisher.

DAVID H. FISHER: Maryland, of course, is not in SASHO although it is in the Southern Interstate Region, so there is a problem which would be resolved by the suggestion that AASHO be the agency to work through.

STERLING W. COLE: I knew you would be very helpful, Mr. Fisher, because you have given me an additional reason for having reservations.

L. V. McLAUGHLIN: The State of Missouri is not in the SASHO region either. It is in the Mississippi Valley Association of State Highway Officials and I think Mr. Parrish offered a very good suggestion in that this be taken up with the American Association of State Highway Officials because all through

the years that association has been instrumental in establishing the policies for overdimension and overweight loads. I think that this is a fine place for it to originate.

STERLING W. COLE: Yes sir, Mr. Taylor.

FRANK J. TAYLOR: Frank Taylor. I don't want to throw a monkey wrench in anybody's business. We have pretty much the same law in Louisiana as these other gentlemen have in their states regarding the divisibility of a load. The point just strikes me though that when you have a cask, you have a certain commodity, the moment you put something in it, that is controllable, whether it be one, two, three, four, five capsules. In other words, the empty cask itself is a load. The moment you put the first capsule in it, this is something that has been added to it and where do you draw the fine point of what is controlled? That could be a very moot question, I mean, as far as actually being controlled is concerned. This may cause some different thinking.

STERLING W. COLE: That is one of the subjects which will be discussed by this interchange between the southeast group or the national group that is envisioned here. Mr. Smith, just for one last comment.

C. WESLEY SMITH: One very quick comment. I would like to add my endorsement to Jim Lee's suggestion and Mr. Parrish's suggestion both of working on this problem on a regionwide or if we can a nationwide basis. Our fuel recovery plant will be starting up next year, in 1971. The NFS plant is in operation. Other plants will come on line in 1973. We will well be attempting to use these containers to serve reactors and utilities in all parts of the U. S. We won't be designing special containers for one state and another. I think it is important and I would lend my endorsement to working on this on a regionwide and ultimately a nationwide basis.

STERLING W. COLE: Thank you. I feel I should comment to indicate my reservation of Mr. Parrish's suggestion of making this a nationwide effort for two reasons. Initially, this symposium was convened at the request of the governors of these southern states and for that reason it would seem logical that pursuing their mandate it would be to engage in exchange with the highway authorities in their regions.

Furthermore, I would think from experience that it is much more difficult to obtain a nationwide solution than it is a regional solution, and further I would like to anticipate that the Southern Interstate Nuclear Board could set the pattern, could lead the way, could provide a standard which the other states or regions or perhaps the whole country could eventually follow. At least my experience with them has indicated that the Southern Interstate Nuclear Board has the capacity to exercise that degree of leadership.

However, to accommodate both suggestions, I think it might be appropriate to engage initially and concentrate primarily on the Southeast Highway Association but at the same time to engage in discussions with the National Association.

I will now turn the matter back to Colonel Peyton.

LUNCHEON SESSION

Allen T. Peyton, Jr.
Deputy Director
Southern Interstate Nuclear Board
Atlanta, Georgia

Master of Ceremonies

We are quite honored to have as our luncheon speaker today Mr. Ernest Tremmel who is the Director, Division of Industrial Participation of the Atomic Energy Commission. As you know, we are a statutory, non-federal agency but we do work quite closely with the Commission and the majority of our contacts are through Mr. Tremmel and his people. Ernie has been a great help to us and we are quite honored that he would come to Atlanta to be on this program. As a matter of fact, he flew down this morning just to appear before this group and he is flying back this afternoon.

Ernest has been in this business since about 1943 and is one of the most knowledgeable people that I have ever met. He is also a very fine public speaker so I am sure that you will enjoy his presentation.

NUCLEAR ENERGY AND TRANSPORTATION

Ernest B. Tremmel, Director
Division of Industrial Participation
U. S. Atomic Energy Commission
Washington, D. C.

NOTE: (Representations of slides used by Mr. Tremmel appear at the end of his talk.)

Ladies and gentlemen and members of the SINB staff, I am delighted to be here today. I consider myself kind of honored, you know, because I really don't know a lot about the highway business and I guess the one area of the nuclear industry that my group needs to study a little more and get on top of is the shipping part of it and the problems involved. When Mr. Peyton said I was a good speaker it reminded me of the story which I am sure some of you heard about the preacher who came to this new church in this growing city, and after he had been there two years he was looking through the records and he noticed that all the previous preachers had only lasted about a month or two and had been kicked out. When he saw the superior, he said, "Gee," "I must be a darn good minister because I lasted two years and nobody else lasted very long." His superior said, "Listen, don't get too cocky. This town never wanted a church and they never wanted a minister and you are the closest thing to nothing they have ever had." I am not sure but maybe that is why I am here. They told me to keep this talk to ten or fifteen minutes and that is what made me suspicious.

I did want to say that I started out my career after I graduated from the University of Wisconsin in engineering working for the city engineer. So I did work a couple of years with our highway department many, many years ago but I certainly can understand the problems that the states are facing today in trying to improve some of the transportation that occurs with these nuclear power plants. I know that you are looking at many of the questions that need to be answered and the problems that need to be solved.

I don't want to belittle the problems because I was reading in the paper coming on the plane where hearings have been going on in the State of Maryland and the Governor's proposed some new laws in regard to nuclear power. I want to say that certainly as an employee of the AEC, I don't want to belittle the problems we have and I think we are going to need the coopera-

tion of the state and the local people in order to make nuclear power acceptable and useable in our society.

I thought today what I would do is just run through the total picture. I'll give you a quick picture of the nuclear industry, mainly nuclear power and some of the environment problems and not try and give you any message or get into your transportation problems. I read the papers that Mr. Peyton was kind enough to send me and I am sure you have gotten a lot of good information at this meeting, at least I did. So without any further comments, I will go ahead with the slides now.

They have got sort a new gadget now that makes some of these slides move so we are trying it on the audience here today. Now, I always point out to everybody that the Atomic Energy Commission is kind of unique in that when the act was passed and the work was transferred from the military to civilian, the words were added, "And strengthen free competition in private enterprise," and that is sort of what my job and my group have had the responsibility for in the last ten years in the AEC.

Now, as you know, the AEC consists of five commissioners appointed by the President. Dr. Glenn Seaborg is the Chairman and the AEC is divided into two parts. The General Manager is responsible for the part of the AEC that runs all our operational projects such as development of weapons, and all of our facilities. We established a Director of Regulations whose job is to regulate the private industry that is coming into being. For example, licensing of all nuclear power plants fall under the Director of Regulations and our authority under the Congress is that we are to license these plants from a health and safety point only. There has been some confusion in the public of about why we don't look at these plants from their effect on the environment and how attractive they look. It isn't that we are not interested in these aspects, but we don't have that responsibility at the present time. There is legislation being introduced that might give us additional responsibility but at the present time our authority is limited to health and safety.

Moving on, I wanted to show you what the budget of the AEC has looked like since its inception and you can see it starts in 1955 -- we hit a peak in '62 or '63 and this year there will be a slight decrease. Our budget has been leveling off each year although we have done fairly well considering the cutbacks in the federal program.

It is interesting to note how the peaceful uses have been gradually increasing through the years. In fact, we are at a point now where about fifty per cent of the taxpayers dollars the AEC is spending are being spent towards peaceful goals and the rest is still being spent on military.

We will take a quick look at the areas of peaceful uses of nuclear energy. We really can divide them into four areas: reactors and of course nuclear power falls under this area; biology, medicine, and physical research; radiation uses; and peaceful nuclear explosives. You have all heard about the big accelerators being built under our research program and, of course, more recently about peaceful nuclear explosives.

Now, a quick look at the peaceful budget. In 1969, the specific items for peaceful uses were about eight hundred and five million out of about 2.1 billion and you can see that reactor development gets the lion's share of this budget and our military programs have been decreasing. We have managed to get additional funds into physical research and biology and medicine as military programs have decreased with some increase in radiation uses and peaceful explosives.

Moving on and taking a look at the reactor budget. I would like to make a point in regard to nuclear power because the coal people like to tell us that we are spending about 2.1 billion dollars for research on nuclear power. The specific item for civilian power in the AEC's budget amounts to one hundred seventy million dollars and you can see that we spent almost as much on space reactors. Admiral Rickover's program costs about one hundred fifteen million dollars, and then we have a category covering materials, safety, waste management, etc. where we are spending money on safety, thermal pollution, waste management, and the kind of things that you people have been discussing for the last two days, such as transportation.

Now, of course, I always like to show a picture of a nuclear power plant. When I was a boy, I was raised in Wisconsin, the little town of Lacrosse and I remember how pretty the snow fall would be and within an hour or two later, it was all black from the soot and smoke from the industrial plants and from coal burning locomotives. To me, nuclear power has finally offered man a chance to get energy in a way that does not affect the environment or has the least effect so I have been surprised in the last year to see all the opposition to nuclear power.

I wanted to show you quickly a sketch of a nuclear plant. Most of you are familiar with what a nuclear power plant is, but, essentially, the reactor replaces the coal burner or the oil or gas burner which heats the water. The water in turn is generated into steam and drives and causes electricity in the same way in either a nuclear or fossil plant.

Moving on, of course, one of the reasons as we all know why we need nuclear power is that our population has been increasing rapidly and our demand for energy per person is always increasing. This means that in our country we are having very large increasing demands for energy and a lot of this demand is coming in the form of electric generation. I believe that this is because of our private utility system and the competition between utility systems. Our utilities have done such a fine job in my opinion of keeping the cost of electricity down while inflation has increased other costs, so that electricity is finding more and more uses.

Of course, right now, you are all aware of the fact that utilities are facing a real crisis in their history because for the first time many of them are having to take a look at increasing rates because of inflation and other problems.

In the United States we have about six per cent of the world's population and we use about thirty-six per cent of the electricity generated, so you can see that when people ask why nuclear power, that we have got to find some way of providing this electricity that the people want. If one examines the

energy demand for the future, you can see that not only nuclear has to grow but in order to meet the demand for energy in our country, we have to call upon all of our energy sources. You can see that right through 1980 the use of coal is predicted to increase steadily. The same way with gas, hydropower, but we have to look to nuclear power to start carrying the main load of this new and increasing demand for electric energy.

Now, to give you a brief picture of what has been happening in nuclear power; back in 1965, what we call the surge to nuclear power began to occur and you can see how the utilities ordered nuclear power in comparison to the fossil plants. In 1969 these orders decreased and, of course, there are many reasons for this. One of the reasons why steam or fossil orders increased is that many of the utilities were not able to get their nuclear plants on schedule, as the result, they had to order fossil plants which can be built quicker to fill in until these nuclear plants come on line.

This is a map that many of you have seen which shows how nuclear plants are located around the country. As you would expect, they came first in New England and they have moved to other parts of the country. In fact, it has been interesting to see how in your southern states nuclear power has all of a sudden started moving and is being ordered by utilities in your states.

Now, looking ahead, a lot of people have said, "Well, nuclear orders have fallen off. People aren't going to buy any more nuclear plants." From all our studies and estimates, we still think that by 1980 there will be 150,000 megawatts of nuclear capacity installed which will be about twenty to twenty-five per cent of the total and we don't see any problem in reaching this total since we are already close to it. We have about 105 plants amounting to close to 80,000 megawatts, well over halfway towards 150,000 MW. We have about five more years in which to order the other seventy thousand and so far this year it looks like nuclear power is going to have a good year again.

If you are interested in the industry that builds these plants, as can be expected, General Electric and Westinghouse are the major suppliers with Combustion and Babcock and Wilcox also being suppliers of reactors. The oil industry has been moving into the nuclear business slowly and Gulf General Atomics is trying to market a high temperature gas cooled reactor which we in the Commission think looks very promising.

Just a couple of slides in regard to this problem of the environment. I am sure most of you realize that the release of radioactivity from a nuclear power plant comes from two sources, gases and liquids and, of course, as was pointed out, the nice aspect about a nuclear plant is that we can control the release of radioactivity. In other words, these gases can be collected and released to the atmosphere in a way that meets the requirements that the government or state sets and the same way with the amount of radioactivity in the liquids. We can collect these liquids and store them and, therefore, control the release to the environment. These radiation levels, of course, which I am sure you have been reading about in the paper, that is the amount of radioactivity a person is allowed to have is set closely by a number of committees who all advise the President and then the President sets what the radiation level should be for nuclear plants.

Of course, what I try and point out to people and the Commission is trying to point out too is that we all are exposed to radiation. Background radiation comes even from: internally, in our bodies; we are born with radiation in us. We get radiation from the kind of buildings we live in. If you live in one kind of a building, you get twice as much as another. Of course, we are exposed to radiation from the sun and from the atmosphere.

One of these charts shows how much the natural radiation levels vary depending upon where you live and these variations don't occur only because of the atmosphere, but occur because of the kind of material in the ground that reflects the radiation. As Mr. Roddis, President of Consolidated Edison pointed out in a speech, if you move to a higher story in an apartment building in New York, you could get much more radiation than you would living on the boundary site of a nuclear plant.

I am told by our specialists that the average chest x-ray would give you more radiation than if you lived on the border line of a nuclear plant every minute of your life for two years. The other day I went to the doctor because I hurt my knee playing tennis and the first thing he said was, "Well, it is just a ligament, I think. Nothing serious but we might as well x-ray it." I said, "By the way, did you know that one chest x-ray will give you more radiation than living on the boundary of a nuclear plant for two years every minute of your life?" He said, "What has that got to do with your case? I am not supposed to give x-rays anymore?" I said, "Well, if people are concerned about radiation from nuclear plants, you better start taking a look at why you are giving x-rays." I explained that I am not against x-rays but I just don't think we should give them for everything. He then explained that an x-ray would never show a strained ligament and that he really didn't need to give me an x-ray. Incidentally, my bill came and it was high enough that I think he charged the same amount as if he had given an x-ray.

It might also be pointed out that when you take twenty-five round trips to the west coast you are exposed to a level of radiation which could be more than we allow to the public from exposure from a nuclear plant.

Now, of course, the other area that people are concerned about is thermal pollution, that is heated water being discharged to our lakes and ponds. One of the things most people fail to realize, and this is very elementary, is that the cool water one takes out of a river or pond or ocean does not come in contact with the reactor; it is used to condense the steam and the water that goes in the reactor which is a closed system so that this water does not become exposed to radioactivity, so the biggest problem that people are worried about is how much heated water can be put into any given body. I know that you have been reading a lot of papers on radiation and transportation and realize that there are limits in the number of fuel elements one can place in a container. There is a limited number of nuclear plants or any kind of plants you could put on any given body of water but certainly at this point in time I believe the nuclear plants being built will not have any serious effects.

In the meantime, there are some interesting studies underway, one out in Eugene, Oregon, where people are taking the heated water and flowing it through seven farms. The farmers are using this water in the winter time to prevent a kill frost which happens every three years. The cost of the system

is about the price of one year's crop, so that if they can stop losing a crop every three years with this water, it will well pay for itself in three years. They are also using the water in the summer to spray on the trees so the peaches don't get sunburned. I am sure everybody here in Georgia knows about peaches getting sunburned since you are a peach state.

Now, going on to your shipping, I just wanted to show one slide. In regard to all the papers and talks that were presented, it seems to me that the real area of concern in shipping nuclear products from a nuclear plant is the radiated fuel that has to be reprocessed. In reading your reports, I can see that we have to call upon some ingenuity in design in order to get these containers so that they can be transported over the highways and meet the highway requirements and not, of course, disrupt traffic or hurt the roads. I thought you might be interested in where the reprocessing plants planned so far are to be located. One is in West Valley, New York and I notice that one of the papers at this conference states that they had already made something like one hundred and some shipments of radiated fuel. General Electric has a plant under construction in Illinois near the Commonwealth Edison Plant. Atlantic Richfield and Allied Chemical Company are each planning large plants in South Carolina. I noticed that in one of the speeches, somebody said these last two plants would represent well over fifty per cent of the capacity. I think they are both five-ton plants and NFS is going to become a three-ton and GE is a one-ton, so they really represent seventy-five per cent of the reprocessing. However, for the purposes of the highway officials there are the four locations you are talking about when shipping radiated fuel in the next five to ten years. We expect to see a reprocessing plant on the west coast eventually as soon as there is enough radiated fuel to justify some company investing in one. And again we made a survey. Our Nuclear Industry Report - 1969 summarizes the shipping market to be seventy casks through 1980 and we showed the annual value of the dollars that are involved in the costs of these casks. We don't show the other kind of containers because radiated fuel really in the area that I think we are the most concerned about and we wanted to see what the grand total of the market might be for industry to look at. By 1980, the market is estimated as 500,000 tons of shipments with an annual value of 11.3 million dollars. This is a pretty attractive market for companies to look at and should be challenging in trying to figure out how to design casks that meet with the highway departments' requirements.

Just a couple of other slides since I don't want to omit other uses of atomic energy. Most of you are aware what radioisotopes are used for and I have a couple of examples to show. One can detect leaks in a pipe by putting an isotope in a liquid, and wherever the leak is you get a concentration of radiation that can be measured. This is used quite frequently now in industry.

Another use of isotopes, of course, is gauging and here again the principle is using a radioactive source and a counter. Incidentally, this principle has found considerable use in the cigarette industry for paper they use to roll the cigarettes in.

I show one other area that is very promising and that is the artificial heart and, of course, I am thoroughly convinced that heart transplant is not the answer -- that we have to come up with an artificial heart eventually --

and this could be a rather fantastic market if it ever is proven feasible. There is quite a bit of progress being made in this area.

The last area which I wanted to mention is the use of peaceful explosives. Actually, the biggest use comes from an underground nuclear explosion where you create a crater and you can use it for a number of purposes; gas storage, waste disposal, gas stimulation, bleaching of ore, breaking of ore and water conservation.

We have been carrying out several projects in this area. You can see from one of my charts that to get a ten kiloton explosion, you need a forty-two inch diameter hole -- it would cost approximately \$350,000 to do this. With TNT, you would need a hole eighty-four feet in diameter and you would need to spend over five million dollars for that much TNT.

One of the purposes being studied for the use of nuclear devices is to dig another Panama Canal. One of the problems is trying to develop clean devices that would not give out much radiation and this may take a little more development before we can be ready to use these for that purpose.

Of course, one of the other areas that is fascinating to me is to try exploding one of these devices in a copper field. I understand our copper reserves are very low and that it is not economical to extract the copper under present known methods. The president of Kennicott Copper Company told our Commission that in the last fifty years they have seen nothing on the horizon that offered a technical solution to extracting some of our low-grade copper, but that peaceful nuclear explosion might be the answer. We are therefore working on a joint project with them leading to exploding one of these devices in a copper reserve field.

This ends my remarks for today. Thank you very much.

ATOMIC ENERGY ACT OF 1954

SECTION I. DECLARATION - . . . IT IS . . .
THE POLICY OF THE UNITED STATES THAT -

. . . . SUBJECT AT ALL TIMES TO THE PARAMOUNT
OBJECTIVE OF MAKING THE MAXIMUM CONTRIBUTION
TO THE COMMON DEFENSE AND SECURITY

THE DEVELOPMENT, USE, AND CONTROL OF ATOMIC
ENERGY SHALL BE DIRECTED SO AS TO PROMOTE
WORLD PEACE, IMPROVE THE GENERAL WELFARE,
INCREASE THE STANDARD OF LIVING, AND STRENGTHEN
FREE COMPETITION IN PRIVATE ENTERPRISE.

☆ UNITED STATES ☆ ATOMIC ENERGY COMMISSION

ATOMIC ENERGY COMMISSION PROGRAMS

BILLIONS OF DOLLARS

MILLIONS OF DOLLARS

COMPARISON BETWEEN FOSSIL FUEL AND NUCLEAR POWER PLANTS

POPULATION ESTIMATE for the UNITED STATES
(Each symbol represents 30 million)

**ELECTRIC
UTILITY
GENERATING
CAPABILITY
AND
NUCLEAR
POWER
GROWTH**

NUCLEAR POWER PLANTS IN THE UNITED STATES

The nuclear power plants included in this map are ones whose power is being transmitted or is scheduled to be transmitted over utility electric power grids and for which reactor suppliers have been selected

NUCLEAR PLANT CAPACITY

(KILOWATTS)

OPERABLE	5,095,700
BEING BUILT	39,288,200
PLANNED REACTORS ORDERED	33,974,000
REACTORS NOT ORDERED	6,800,000
TOTAL	85,157,900

ELECTRIC UTILITY CAPACITY BY CONVENTIONAL MEANS
AS OF JAN. 31, 1970: 329,318,247 KILOWATTS

LEGEND

OPERABLE	■ (17)
BEING BUILT	▲ (49)
*PLANNED (Reactors Ordered)	● (37)

*7 more plants have been announced for which reactors have not yet been ordered.

U.S. Atomic Energy Commission

CENTRAL STATION NUCLEAR POWER

N S S S O R D E R S

REACTOR SUPPLIERS	NO. OF UNITS	CAPACITY	
		MWE	%
BABCOCK & WILCOX	12	9,209	12
COMBUSTION ENGINEERING	10	8,475	11
GENERAL ELECTRIC	38	30,168	39
GULF GENERAL ATOMIC	2	370	(less than 1%)
WESTINGHOUSE	36	28,349	37
OTHER	4	923	1
TOTAL (1/30/70)	102	77,494	100

RELEASE OF RADIOACTIVITY BY NUCLEAR POWER PLANTS

VIRTUALLY UNMEASURABLE
ABOVE NATURAL RADIATION
AT SHORT DISTANCES FROM
PLANT SITE

NATURAL RADIATION

**ANNUAL TOTAL:
100 - 1,000
MILLIREMS**

NATURAL RADIATION LEVELS

ANNUAL DOSE (MILLIREMS)

COSMIC RADIATION

BWR POWER PLANT

SHIPPING CONTAINERS - IRRADIATED FUEL

	<u>Tonnage of Shipments</u>	<u>Number of Shipping Casks</u>	<u>Annual Value</u>
1970	70	70 Casks Through 1980	\$1 Million
1975	1,500	(75 ton each, \$35-45 Million	\$3 Million
1980	3,800	Cumulative Total)	\$6 Million

SHIPPING CONTAINERS - GRAND TOTAL

	<u>Tonnage of Shipments</u>	<u>Annual Value</u>
1970	100,000	\$ 5.0 million
1975	250,000	\$ 6.7 million
1980	500,000	\$11.3 million

RADIOISOTOPES

- IN MEDICINE
- FOR ELECTRIC POWER
- AS IRRADIATORS
- IN INDUSTRY
- IN AGRICULTURE

NUCLEAR POWERED HEART PACER

10,000 UNITS NEEDED EACH YEAR.

Pu-238 POWERED UNIT SHOULD OUTLAST
BATTERIES BY 2 TO 4 TIMES IN ITS
10 YEAR LIFE.

UNDER DEVELOPMENT BY

APPLICATIONS OF DEEPLY BURIED NUCLEAR EXPLOSIONS

- TERMINAL GAS STORAGE
- WASTE DISPOSAL
- RECOVERY OF GEOTHERMAL HEAT
- GAS RESERVOIR STIMULATION
- LEACHING OF MINERAL ORE
- BREAKAGE OF ORE FOR MINING
- WATER CONSERVATION

10 KT EXPLOSIVE

NUCLEAR

CONCLUDING REMARKS

Robert H. Gifford
Executive Director
Southern Interstate Nuclear Board
Atlanta, Georgia

Ladies and gentlemen, there will be no more speeches. I just wanted to say as we close this session that the Southern Interstate Nuclear Board deeply appreciates the outstanding contributions that have been made by all of you, both those presenting the papers and those who have responded to them. We are confronted with an opportunity to solve intelligently and with circumspect planning a problem which foretells some serious complications if we don't move now. Historically we have lost more leadership opportunities by inaction than by ineptitude and I am sure that the growing problem of nuclear materials transportation can be solved. I want to especially thank those who have been part of the project team in helping compile information, distill it and try to present it in a meaningful fashion. I hope all of you have been enriched somewhat by having participated in this conference.

We recognize with appreciation the exceptionally fine exhibits that were provided by Georgia Power Company, the Hatch Plant Exhibit; by Westinghouse and GE who provided the fuel elements; and Babcock and Wilcox for the reactor model.

With that, gentlemen, we thank you again and stand adjourned.

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"Transportation of Nuclear Spent Fuel"
February 5 and 6, 1970
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SEQUEL

May 15, 1970

Subsequent to the conference in February, program committee members met with Mr. A. E. Johnson, Executive Director, American Association of State Highway Officials (AASHO); Mr. W. J. Wilkes, Bureau of Public Roads, acting as Secretary of the AASHO Bridge Committee; and other members of the Federal Highway Administration to discuss the spent fuel transporter with a one-three-three axle configuration which was discussed at the conference. The two tri-tandem axle assemblies carrying 52,500 pounds each would overstress the basic H-15 bridge; therefore the vehicle design was not acceptable.

Messrs. Johnson and Wilkes made several suggestions, including using an articulated configuration. The suggestions were adopted and drawings were submitted to them. The vehicle design incorporated twin steering axles and three sets of tandems carrying 32,000 pounds each. The 32,000 pound tandem axles were within the legal limits of the states, but the distance between the two rear assemblies was too short. Accordingly, the committee was requested to increase the design length of the vehicle to 60 feet so that the distance between the rear tandems could be lengthened by two feet. In response to that request, the vehicle design shown in this section was submitted to AASHO for its consideration.

The AASHO Bridge Committee will have to make an analysis and curve of the percent of stress on H-15 bridges before recommendations can be made to the highway departments. Therefore, it is not known what AASHO's final determination and recommendations will be.

American Association of State Highway Officials personnel have been professional, cordial and cooperative. The committee appreciates their suggestions and assistance and looks forward to continued cooperation with them. AASHO has been assured that the nuclear and transportation industries will not relax their efforts to reduce the gross vehicle weight of the loaded nuclear fuel transporter.

Radius of Curve in feet	Maximum Offtracking in feet	Turning Track Width in feet
75	7.5	15.5
90	6.1	14.1
120	4.4	12.4
165	3.2	11.2
200	2.5	10.5
250	2.0	10.0

NUCLEAR SPENT FUEL TRANSPORTER
SOUTHERN INTERSTATE NUCLEAR BOARD

12,000 LBS.
6,000 LBS.
18,000 LBS.

8,000 LBS.
24,000 LBS.
32,000 LBS.

**VEHICLE
LOAD
GVW**

8,000 LBS.
24,000 LBS.
32,000 LBS.

8,000 LBS.
24,000 LBS.
32,000 LBS.

(A) Tandem Steering Axles

SPECIFICATIONS FOR SPENT FUEL TRANSPORTER

Human Factors Engineering: Tractor has sleeper cab which is equipped with air conditioning and dual heaters. It is fully insulated with spun glass which will reduce road and wind noise to a minimum. It is designed for operation in temperatures ranging from 120°F to 40° to 50° below 0°F without driver discomfort.

Power Train: Vehicle is powered by 370 h.p. diesel engine. Differential ratio is 4.63 to 1. Transmission has fifteen forward speeds equally split and it and the differentials are designed for 120,000 lb. loads. Fully loaded vehicles will accelerate and move with normal traffic, cruising at 50 miles per hour with a top speed of 54 mph.

Suspension: Transporter is equipped with air suspension which provides almost instantaneous equalization under changing road conditions. All axles are 25,000 lb. capacity.

Tires: 10:00 x 20

Brakes: Mountain type, 7" on tractor and 8 5/8" on trailer. Exhaust brakes will reduce temperature of primary braking system while making long descents.

Fifth Wheels: Three inch diameter, high tensile strength kingpins with positive locking devices. Anchoring of fifth wheels will equal capacity of kingpins.

Structural Integrity: Structural components and weldments will withstand forces of 10 G's forward, 5 G's lateral, and 2 G's vertical.

Width: Overall width does not exceed 96 inches.

5/1/70