See Pocket II for encl ✓

Handouts fm 5-31-84 Salt meeting w/ DOE/NRC/States (To File fm NStill)

AGENDA

SIXTH BIMONTHLY MEETING WITH SALT STATES REPRESENTATIVES AND NRC

MAY 31, 1984

CAPITOL HOLIDAY INN
550 C STREET SW
WASHINGTON, D.C.

Thursday, May 31

8:30 a.m.	Introduction	
9:00 a.m.	Land Acquisition	A. Handwerker*
10:30 a.m.	Transportation	R. Peterson T. McSweeney J. Allen
12:30 p.m.	Lunch	
1:30 p.m.	Environmental Assessments	~~R. Sharma~~ Bob Wunderlich
2:30 p.m.	NRC	
3:30 p.m.	States Caucus	
4:30 p.m.	State Comments	

* ~~Dave Gray,~~ COE; D. Trost, HQ; H. Ramirez, CH; S. Daneman, BPMD

WM Record File 106.1

WM Project 16
Docket No.
PDR ✓
LPDR ✓

Distribution:

(Return to WM, 623-SS) A.W.

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PDR WASTE
WM-16 PDR

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Encl. to Agenda
5/31/84

SIXTH BIMONTHLY MEETING
WITH SALT STATES REPRESENTATIVES AND NRC

May 31, 1984

CAPITOL HOLIDAY INN
550 C STREET SW
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TRANSPORTATION AGENDA

A. Introductory Remarks	R. W. Peterson
1. Agenda Overview	
2. DOE Transportation Programs	
3. ONWI Transportation Program	
4. Transportation Scenarios	
5. Types and Quantities of Waste Shipments	
6. Transportation Modes	
7. Overview of Transportation Work to Date	
B. Transportation Regulations	
1. NRC - Packaging	R. W. Peterson
2. DOT - Transportation	J. C. Allen
C. Routing	T. I. McSweeney
1. Regional	
2. State	
3. Site-Specific	
D. Logistics/Economics/Risk Analyses	T. I. McSweeney
1. Models/Computer Codes	
2. National/Regional	
3. Site-Specific	
E. Accidents	R. W. Peterson
1. Types and Probabilities	
2. Natural Events	
3. Sabbotage	
4. Simulation Testing	
5. Record to Date	
F. Emergency Response	J. C. Allen
1. Federal - DOT, NRC, FEMA, DOE	
2. State/Local	

SALT ENVIRONMENTAL ASSESSMENTS

R.C. WUNDERLICH
MAY 31, 1984

EA STATUS

- Late March and Early May Salt Site EAs provided to the States and NRC
- Comparative Evaluation Methodology and supporting Data Sheets provided to the States and NRC in April
- Seven Draft EAs to be provided to DOE-HQ on June 11
- Documents are approximately 70-85% complete
- Planning effort underway to complete EAs prior to release for public comment

FUTURE ACTIVITIES

- CONTINUE TO DEVELOP AND REFINE THE EAS
  - EXPECTED ENVIRONMENTAL IMPACTS
  - ACCESS ROUTES
  - WATER REQUIREMENTS
  - SALT PILE MANAGEMENT
  - AIR QUALITY AND NOISE IMPACTS ANALYSES
  - CONSISTENCY
- MODIFY EAS TO REFLECT CHANGES IN THE PROGRAM BASELINE
  - CHANGES IN THE SITING GUIDELINES
  - CHANGES IN THE MISSION PLAN

RADIOLOGICAL EMERGENCY RESPONSE FOR TRANSPORTATION

I. Federal Level

A. Federal Response to Emergencies

Coordination - Federal Radiological Emergency Response Plan (FRERP)

Monitoring and Assessment - Federal Radiological Monitoring and Assessment Plan (FRMAP)

B. Federal Planning Assistance

State/Local Guidance - Guidance for Developing State and Local Radiological Emergency Response Plans and Preparedness for Transportation Accidents (FEMA-REP-5)

II. State Level

A. Mississippi

Mississippi Natural Disaster Plan

Mississippi Radiological Emergency Response Plan

B. Louisiana

Louisiana Disaster Preparedness Plan

Peacetime Radiological Response Plan

C. Texas

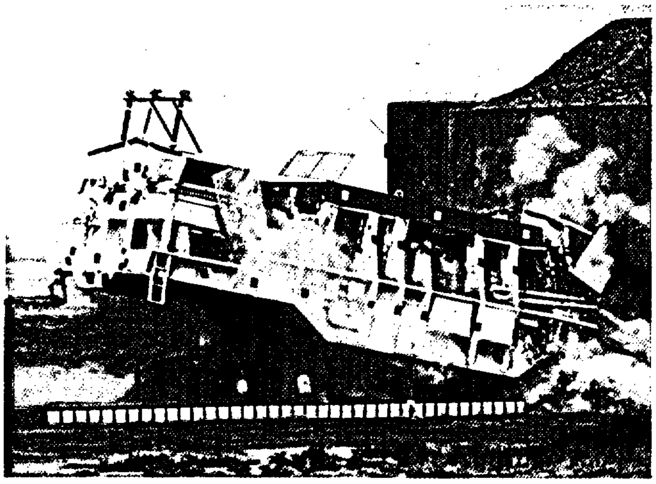
Texas Emergency Management Plan
(Annex L to Part 1 - Peacetime Radiological Incidents)

D. Utah

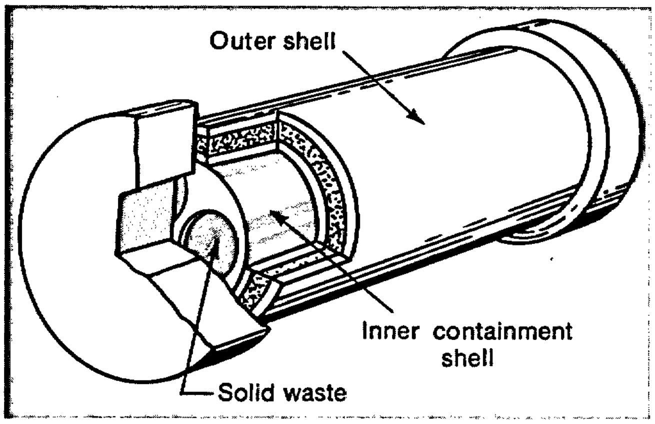
Utah Natural Disaster Plan

Utah Radiological Emergency Response Plan

Can nuclear wastes be transported safely?



Nuclear waste shipping casks have undergone rigorous crash and fire tests.



High-level nuclear waste will be shipped in heavily shielded casks via truck or railcar in accordance with applicable federal regulations.

Studies to ensure the safe transportation of nuclear waste to the repository are being conducted. These include consideration of the risks of exposure to people from waste being transported past their homes and from accidents involving vehicles carrying nuclear waste casks.

Studies show that any radiation exposure to the general population from vehicles carrying shielded casks of high-level or transuranic waste would be insignificant. The dose to persons near (100 feet to 2,500 feet) the route of a vehicle containing spent fuel (or high-level waste) would be from 0.0006 to 0.000001 millirem* per shipment. If 1,000 casks carrying nuclear waste went by the same house every year, the increase in radiation exposure to the inhabitants would be less than one percent of the dose due to natural background radiation.

There is no risk of a self-sustaining nuclear reaction in a shipping cask. The spacing of the nuclear waste within each cask would make it impossible to bring enough radioactive material together to initiate a chain reaction.

During almost 30 years of nuclear waste shipments, there has not been a death or injury attributable to the radioactive nature of nuclear materials shipments. There are 2.5 million nuclear materials shipments per year, representing less than 3 percent of the estimated 100 million hazardous materials shipments. About 95 percent of nuclear materials shipments involve small amounts of radioisotopes for

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*The average U.S. natural background radiation is 110 millirem per year. A millirem is a measurement of the effects on human tissue from a dose of radiation.

Transportation of Nuclear Waste to a Repository

Federal Regulations

- The U.S. Nuclear Regulatory Commission (NRC) provides minimum standards covering the design, construction, and testing of packaging used for transporting hazardous radioactive material. The NRC also issues certificates of compliance with its standards (10 CFR 71).
- The U.S. Department of Transportation (DOT) regulates transportation safety and sets standards for shippers and carriers (49 CFR 171-178).

Containers or Casks

- Casks are designed and constructed to withstand severe accidents without release of radioactive material.
- Truck casks weigh approximately 25 tons.
- Rail casks weigh up to 100 tons.
- Casks are made of several layers of stainless steel and a layer of radiation shielding material such as lead. Some casks will also have neutron shielding.
- Casks must be certified according to NRC standards prior to use.
- Casks are inspected and tested during manufacture and prior to being placed in service.
- Casks must be recertified periodically for continued use.

Routing

- DOT regulations require highway carriers to use the interstate highway system.
- State governments, in consultation with local governments, can also designate preferred highway routes as provided for in 49 CFR 177.825.
- There are no specific railroad routing regulations for nuclear waste.

Types and Numbers of Shipments

- All shipments will be in dry solid form—no liquids will be associated with the radioactive material.
- A typical nuclear power plant, which produces enough electricity for about 600,000 households, normally discharges about 30 tons of spent fuel a year.
- At the turn of the century, it is estimated that there will be an average of 1 to 2 rail shipments per day and 2 to 3 truck shipments per day to the first repository.

Accidents

- In shipping over 5,500 spent fuel elements during the past 20 years, there has never been an injury or death to carrier personnel or to the public that can be attributed to the radioactive nature of the cargo. There have been only two transportation accidents of any kind.

- The federal government has the capability and resources nationwide to assist state and local authorities in coping with a radiological hazard if it should occur.

Overall Risk From Transportation

- A person living next to the final route into the repository will receive less than 1 percent of natural background radiation from all shipments.

- No radiological injuries or deaths are predicted to result directly from transportation accidents.

This publication was prepared by Battelle's Office of Nuclear Waste Isolation, Columbus, Ohio, under contract with the U.S. Department of Energy.

4/84

LAND ACQUISITION

ALAN HANDWERKER, COUNSEL
SALT REPOSITORY PROJECT OFFICE
DEPARTMENT OF ENERGY

MAY 31, 1984

10 C.F.R. 60.121 ESTABLISHES THE NRC LICENSING REQUIREMENT FOR OWNERSHIP AND CONTROL OF INTERESTS IN LAND FOR THE REPOSITORY.

SECTION (A) REQUIRES THE GEOLOGIC REPOSITORY OPERATIONS AREA (HLW FACILITY, INCLUDING SURFACE AND SUBSURFACE AREAS WHERE WASTE HANDLING ACTIVITIES ARE CONDUCTED) AND THE CONTROLLED AREA (A SURFACE LOCATION EXTENDING HORIZONTALLY NO MORE THAN 10 KILOMETERS FROM THE OUTER BOUNDARY OF THE UNDERGROUND FACILITY AND THE UNDERLYING SUBSURFACE FROM WHICH INCOMPATIBLE ACTIVITIES WOULD BE RESTRICTED FOLLOWING PERMANENT CLOSURE) BE ON LAND UNDER THE JURISDICTION AND CONTROL OF DOE, OR LANDS PERMANENTLY WITHDRAWN AND RESERVED FOR ITS USE.

THE REPOSITORY SITE MUST BE HELD FREE AND CLEAR OF SIGNIFICANT ENCUMBRANCES, SUCH AS:

1. RIGHTS ARISING UNDER THE GENERAL MINING LAWS;
2. EASEMENTS FOR RIGHT-OF-WAY;
3. ALL OTHER RIGHTS ARISING UNDER LEASE, RIGHTS OF ENTRY, DEED, PATENT, MORTGAGE, APPROPRIATION, PRESCRIPTION OR OTHERWISE.

10 C.F.R. 60.121 (b) REQUIRES DOE TO EXERCISE ANY JURISDICTION AND CONTROL OVER SURFACE AND SUBSURFACE ESTATES OUTSIDE THE CONTROLLED AREA NECESSARY TO PREVENT ADVERSE HUMAN ACTIONS THAT COULD SIGNIFICANTLY REDUCE THE REPOSITORY'S ABILITY TO ACHIEVE ISOLATION. THE RIGHTS OF DOE MAY TAKE THE FORM OF APPROPRIATE POSSESSORY INTERESTS, SERVITUDES, OR WITHDRAWALS FROM LOCATION UNDER THE GENERAL MINING LAWS. REQUIRED WATER RIGHTS WOULD ALSO BE ACQUIRED.

LAND OWNERSHIP AND CONTROL REQUIREMENTS ARE ALSO CONSIDERED IN TWO SITING GUIDELINES:

1. <u>960.4-2-8-2 - POSTCLOSURE QUALIFYING CONDITION</u>. THE SITE SHALL BE LOCATED ON LAND FOR WHICH DOE CAN OBTAIN, IN ACCORDANCE WITH THE REQUIREMENTS OF 10 C.F.R. 60, OWNERSHIP, SURFACE AND SUBSURFACE RIGHTS AND CONTROL OF ACCESS THAT ARE REQUIRED IN ORDER THAT POTENTIAL SURFACE AND SUBSURFACE ACTIVITIES WILL NOT BE LIKELY TO LEAD TO RADIONUCLIDE RELEASES GREATER THAN THOSE ALLOWABLE UNDER THE REQUIREMENTS SPECIFIED IN SECTION 960.4-1 (10 C.F.R 60, 191).

2. <u>960.5-2-2 - PRECLOSURE QUALIFYING CONDITION</u>. THE SITE SHALL BE LOCATED ON LAND FOR WHICH DOE CAN OBTAIN, IN ACCORDANCE WITH THE REQUIREMENTS OF 10 C.F.R. 60.121, OWNERSHIP, SURFACE AND SUBSURFACE RIGHTS, AND CONTROL OF ACCESS THAT ARE REQUIRED IN ORDER THAT SURFACE AND SUBSURFACE ACTIVITIES DURING REPOSITORY OPERATION AND CLOSURE WILL NOT BE LIKELY TO LEAD TO RADIONUCLIDE RELEASES TO AN UNRESTRICTED AREA GREATER THAN THOSE ALLOWABLE UNDER THE REQUIREMENTS SPECIFIED IN SECTION 960.5-1(a)(1) (10 C.F.R. 20; 10 C.F.R. 60; 40 C.F.R. 191).

METHODS OF ACQUISITION - SITE CHARACTERIZATION

PUBLIC LAND. SECTION 302(B) OF THE FEDERAL LAND POLICY AND MANAGEMENT ACT OF 1976 PROVIDES THAT THE SECRETARY OF INTERIOR MAY PERMIT FEDERAL DEPARTMENTS TO USE, OCCUPY AND DEVELOP PUBLIC LANDS ONLY THROUGH RIGHTS-OF-WAY, WITHDRAWALS, AND WHERE THE PROPOSED USE AND DEVELOPMENT ARE SIMILAR OR CLOSELY RELATED TO THE PROGRAMS OF THE SECRETARY FOR THE PUBLIC LANDS INVOLVED, A COOPERATIVE AGREEMENT.

PUBLIC LAND FOR THE EXPLORATORY SHAFT FACILITY AND RELATED SITE CHARACTERIZATION ACTIVITIES WILL BE OBTAINED BY WAY OF A COOPERATIVE AGREEMENT.

PUBLIC LAND REQUIRED TO PROTECT THE POTENTIAL REPOSITORY SITE WILL BE OBTAINED BY WAY OF AN ADMINISTRATIVE WITHDRAWAL OF LESS THAN 5,000 ACRES. TITLE TO THIS LAND WILL REMAIN IN BLM.

PRIVATE LAND. DOE WILL UTILIZE THE CORPS OF ENGINEERS TO PURCHASE SURFACE AND SUBSURFACE RIGHTS REQUIRED TO CONSTRUCT THE EXPLORATORY SHAFT FACILITY.

PURCHASE PRICE WILL BE BASED ON GOVERNMENT APPROVED APPRAISAL.

CONDEMNATION PROCEEDING WILL BE UTILIZED AS A LAST RESORT IF THE GOVERNMENT IS UNABLE TO NEGOTIATE THE PURCHASE OF THE REQUIRED LAND.

LAND TO PROTECT THE POTENTIAL REPOSITORY SITE WILL BE OBTAINED BY EITHER A FEE SIMPLE PURCHASE OR A LEASE. LEASES, IF USED, WOULD BE FOR A FIVE-YEAR TERM, WITH OPTION TO RENEW.

SHOULD DOE BE UNABLE TO NEGOTIATE PURCHASE OR LEASE AGREEMENTS TO PROTECT THE POTENTIAL REPOSITORY SITE, CONDEMNATION WILL BE UTILIZED.

METHODS OF ACQUISITION - REPOSITORY

PUBLIC LAND. A PERMANENT WITHDRAWAL OF THE GEOLOGIC REPOSITORY OPERATIONS AREA AND THE CONTROLLED AREA WILL BE MADE PURSUANT TO AN ACT OF CONGRESS.

PRIVATE LAND. DOE WILL COMPLETE FEE SIMPLE PURCHASE OF THE GEOLOGIC REPOSITORY OPERATION AREA AND THE CONTROLLED AREA. DOE WILL ATTEMPT TO PURCHASE THE REQUIRED AREAS THROUGH NEGOTIATION BASED ON A GOVERNMENT APPROVED APPRAISAL. CONDEMNATION WILL BE UTILIZED AS A LAST RESORT.

CURRENT DOE LAND ACQUISITION ACTIVITY

DOE IS IN THE PROCESS OF NEGOTIATING AN INTERAGENCY AGREEMENT WITH THE U.S. ARMY CORP OF ENGINEERS. THE PROPOSED AGREEMENT IS STRUCTURED IN TWO PHASES:

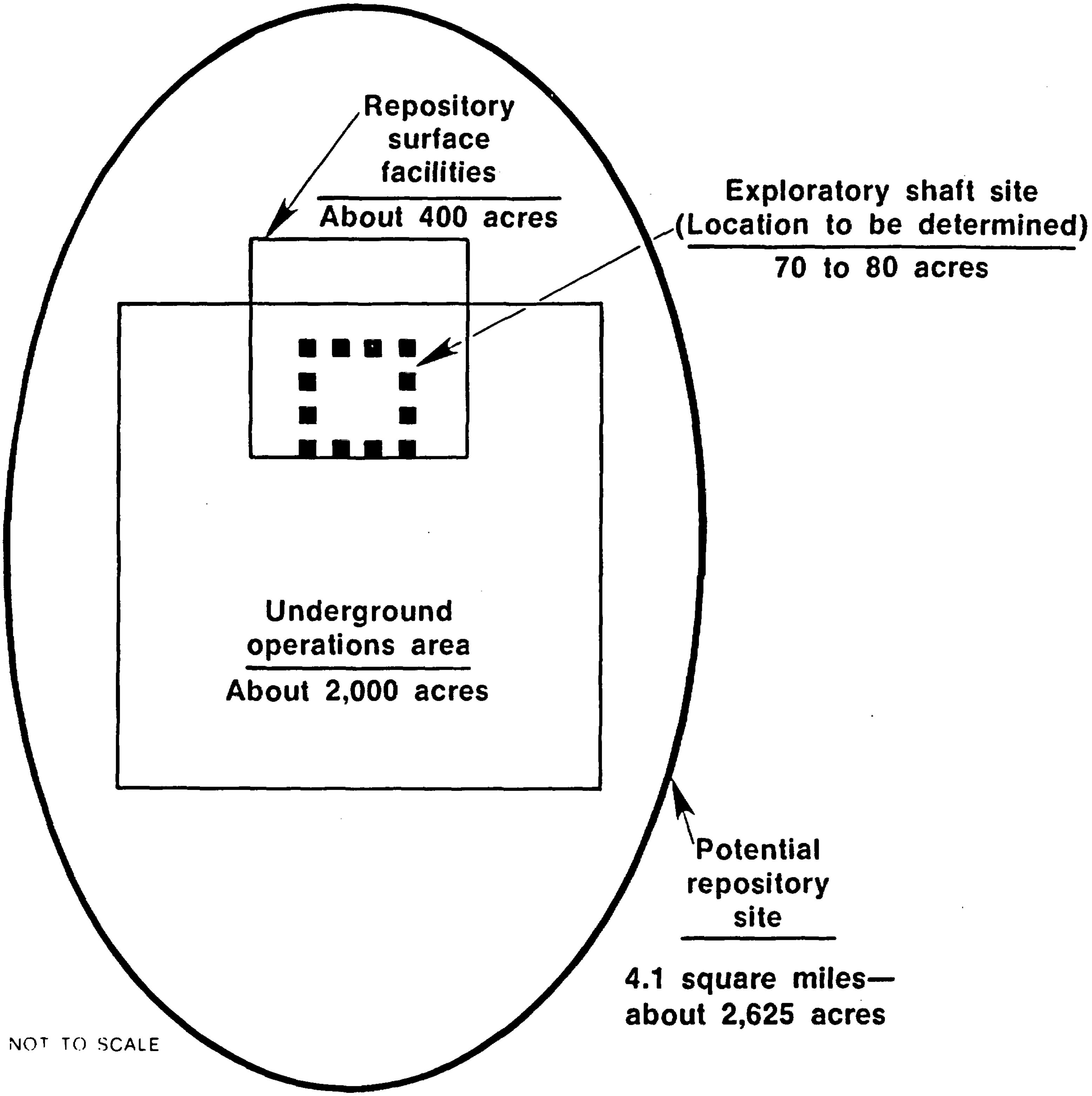
PHASE I. PREPARATION OF SEVEN REAL ESTATE PLANNING REPORTS AND CORPS ATTENDANCE AT DOE MEETINGS.

<u>PHASE II</u>. ACQUISITION OF REQUIRED PRIVATE REAL ESTATE INTERESTS FOR SITE CHARACTERIZATION.

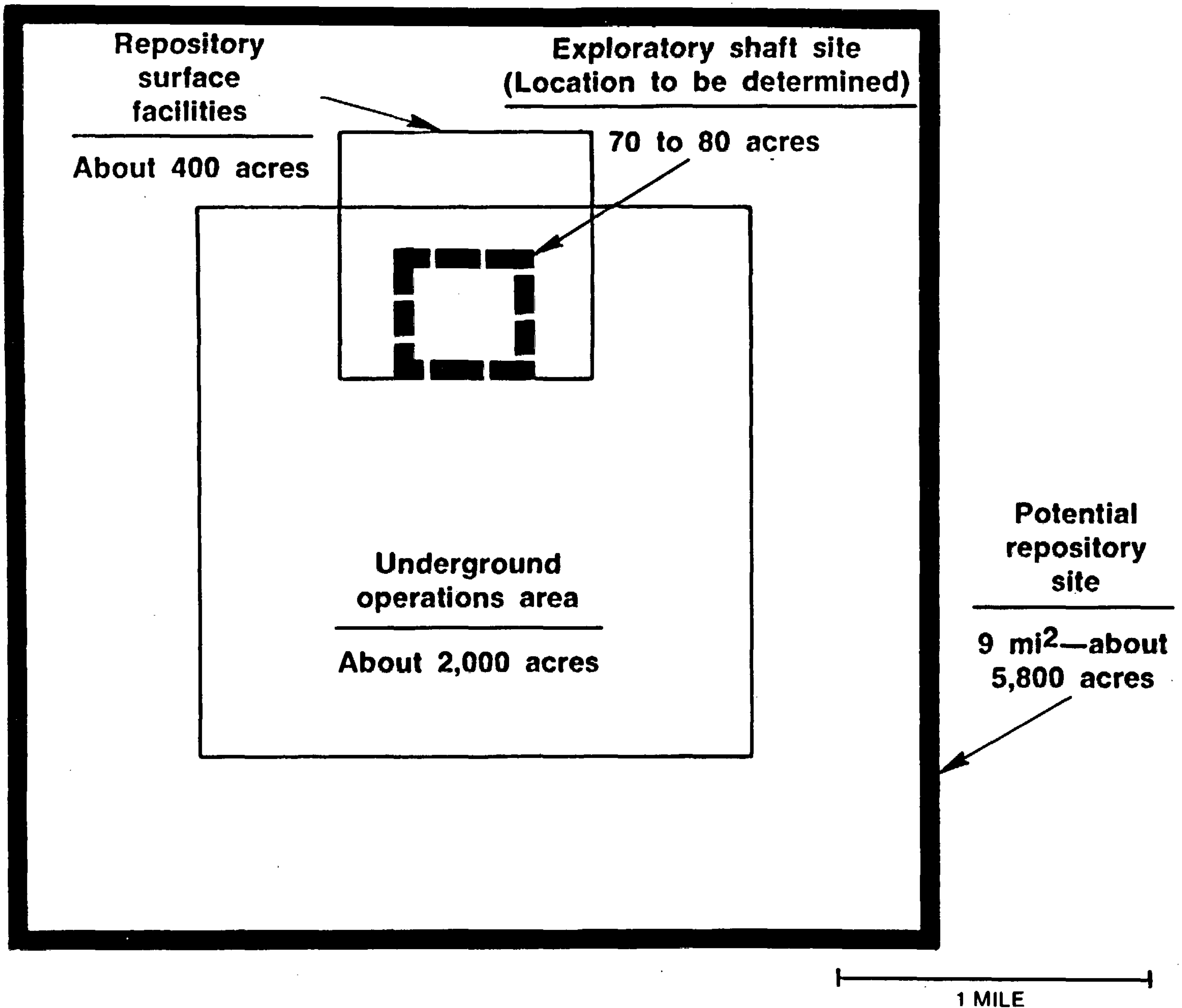
PUBLIC INTERACTION. THE INTERAGENCY AGREEMENT REQUIRES APPROVAL OF DOE PRIOR TO THE CORPS' CONTACTING MEMBERS OF THE PUBLIC OR LOCAL AND STATE GOVERNMENTS.

REAL ESTATE PLANNING REPORT

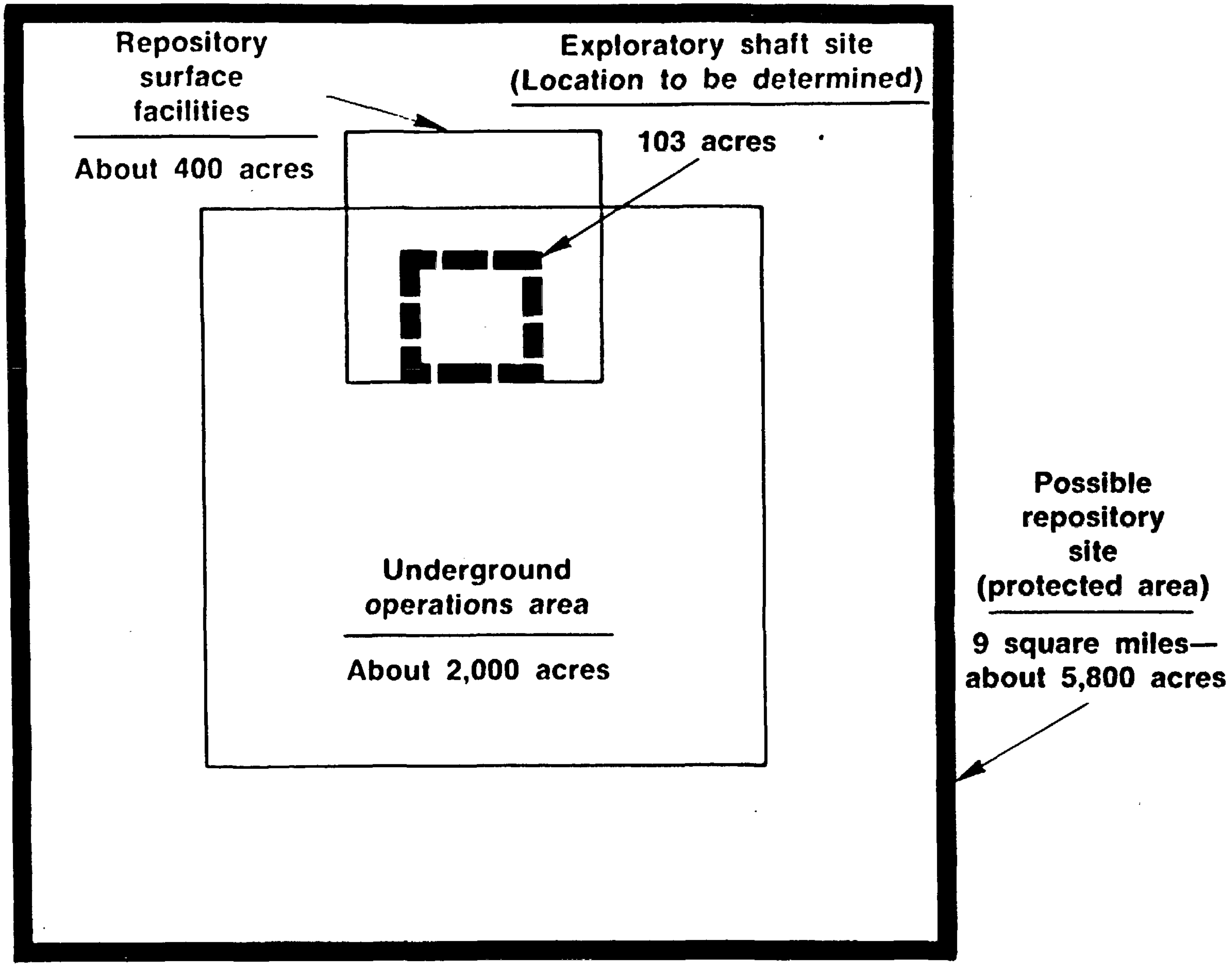
- AUTHORITY AND PROJECT
- PROCEDURES - CORP OF ENGINEERS PROCEDURES
- DESCRIPTION OF SELECTED SITE-TRACT NUMBERS, NAME OF LANDOWNERS, ESTATE PROPOSED FOR ACQUISITION
- RELOCATIONS - NEED FOR AND GROSS ESTIMATED COST OF RELOCATIONS
- OUTSTANDING INTERESTS AND RESERVATIONS - MINERAL RIGHTS, OIL AND GAS LEASES, WATER RIGHTS, AND THEIR VALUES
- VALUATION - GROSS COST ESTIMATE
- UNIFORM RELOCATION ASSISTANCE COSTS - NUMBER OF APPLICANTS AND REIMBURSEMENT COSTS
- RECOMMENDATIONS - LAND ACQUISITION, PROTECTION
- ADMINISTRATIVE COSTS - PHASE I, PHASE II
- SCHEDULE - PURCHASE OF ENTIRE AREA, PURCHASE AND LEASE.



Estimated Land Needs for Potential Site: Louisiana



Estimated Land Needs for Potential Site: Texas



Estimated Land Needs for Potential Site: Davis Canyon, Utah

NOTE
Reprinted from publication prepared by the Interagency Land Acquisition Conference, January, 1974.

How and Why the Federal Government Acquires Property for Public Purposes

Foreword

Wise John Adams reminds us that "property must be secured, or liberty cannot exist." In our country the power of government—local, state, and federal—must respect and protect the life, liberty, and property of our citizens.

There are however certain vital government functions essential to the survival, the general welfare and the progress of the nation which require land—specific land. A missile must have a launching site; a highway, a roadbed; a flood control and water conservation project, a resevoir basin. For the benefit of all the people, individual convenience must occasionally yield.

This brochure has been prepared by the Interagency Land Acquisition Conference so that every citizen may know how and why the Federal Government acquires land and understands his right to just compensation, if his property is needed for public use. It reflects the Federal Government's uniform land acquisition policies as expressed in Part III of Public Law 91-646 approved January 2, 1971, with particular relation to payment to owners of the full amount of just compensation. When doubt remains or a dispute exists, legal advice should be secured.

How can the United States acquire the property of one of its citizens?

Every Government has certain inherent powers which are essential to its existence and effective operation, such as the power to levy taxes and the power to maintain order. Another is the power to take private property for public use. This is known as the power of EMINENT DOMAIN. The rights of the individual are protected, however, by our CONSTITUTION, which guarantees that private property may not be taken by the Government except for PUBLIC USE and that JUST COMPENSATION must be paid to the citizen whose property is taken. This is vastly different from those countries which seize what they want, for whatever purpose they may choose and for whatever payment they wish to make.

When it acquires property the Government considers the NEEDS AND WELFARE OF ALL ITS CITIZENS. Land is necessary for military installations, for the space program, for naval stations and for training centers. It is required for post office and public building sites, for dams and reservoirs, for flood control and water conservation, for roads and highways, the national parks and recreation areas, and for many other uses essential to the well-being and protection of all citizens. Your property is not acquired because the Government wants it, but because the general public needs it.

What can't our Government buy the property it wants, like anyone else?

IT USUALLY DOES, but sometimes a property owner is not willing to sell his land. If the United States had no way to acquire property when the owner refuses to sell, essential governmental operations would be seriously hindered or even prevented entirely. Highways would have to wind around properties that could not be purchased. Post offices might have to be built in locations inconvenient for the general public. One owner of an acre or two in the middle of a reservoir site might prevent the construction of a reclamation project essential to the welfare of a vast region. Therefore, the Government must have the power to acquire land that is needed for the public benefit, whether or not the owner wishes to sell it. However, before exercising the power of eminent domain, the head of the Federal agency authorized to condemn property is required to make every reasonable effort to purchase your real property expeditiously by negotiation.

But couldn't the Government usually buy what it needs if it were willing to pay enough?

This probably is true, but it would be UNFAIR TO THE TAXPAYERS to inflate the cost of public works by paying landowners whatever price they chose to ask. Also property sometimes is needed immediately and there is insufficient time to locate the owners and negotiate with them; or the owners may not have clear title to the land and therefore cannot convey it. In such cases the power of EMINENT DOMAIN enables your Government to proceed without delay to do what is necessary in the public interest.

Who determines what public projects are necessary?

No public project or improvement can be undertaken without an authorization and appropriation by CONGRESS. Therefore, the final determination as to what public projects are necessary is made by the elected representatives of all the people.

How does Congress decide what projects to authorize?

A BILL IS INTRODUCED in Congress by a Senator or Representative who believes that the project will be beneficial, or sometimes the bill may be introduced at the request of a Federal agency which has decided, after careful study and preliminary planning, that a certain public project will promote the general welfare of our country. The bill is REFERRED TO A COMMITTEE and HEARINGS ARE HELD at which citizens may explain their reasons for favoring or opposing the project. The Federal agency responsible for the project usually presents at such hearings the results of detailed studies which it had made. The committee then reports its recommendation, Congress debates the bill, and it is passed or rejected.

Does this mean that Congress decides what particular land will be acquired?

NO. Congress usually does not make the decision: Of course, some projects, such as dams or harbor improvements, relate by their very nature to a specific location, but even in such cases Congress usually allows the Federal agency which will administer the project to adjust or modify its boundaries as may be necessary and desirable. Other projects, however, such as providing office space for a Federal agency, usually need not be located at a particular place, and in authorizing such projects Congress generally lets the Federal agency involved select the exact location. In any case, the BASIC AUTHORITY for a new Federal project is granted by CONGRESS and the FEDERAL AGENCY administering the project fixes the DETAILS within limits laid down by Congress.

Why must my property be acquired?

EVERY OWNER could ask this same question. No one likes to be told that he *must* do something, but someone's property must be taken or the development of our country would come to a standstill. It is unfortunate that one person must be inconvenienced for a program of the Government for the benefit of the public as a whole, but this happens to each of us, in one way or another, every day. This is essential to progress and is inevitable in a modern society.

How was the choice of location made?

The Federal agency responsible for the project makes CAREFUL STUDIES of possible locations, taking into account such matters as cost, engineering considerations and usefulness to the public. For example, a building site will be preferred that has soil in which foundations can be put down without excessive expense. A highway location should be as straight and level as possible. A post office should be located where it will best serve an area. And so far as possible a location is selected which will benefit rather than harm the immediate neighborhood. Thus, the final selection of a project site represents the meeting of many minds on ENGINEERING AND ECONOMIC CONSIDERATIONS, the GREATEST PUBLIC GOOD and the LEAST AMOUNT OF INJURY or inconvenience to the individuals affected.

If the United States buys my land, how much will it pay me?

Whether our Government purchases your land or acquires it by filing a condemnation suit in a Federal court, you will be paid its FAIR MARKET VALUE. This means the price that you could reasonably expect to receive if you sold your property on the open market—in other words, the price the property would bring in a sale between a WILLING SELLER and a WILLING BUYER, neither being under any compulsion to act. It does not mean some special value that your property may have to you or the value that it may have to your Government for the purposes of the particular public project for which it is needed. In addition to paying the fair market value for your property, the Government will pay certain expenses necessarily incurred in the transfer of title to the United States.

How is fair market value determined?

The United States employs competent and IMPARTIAL APPRAISERS who are familiar with property values. After a thorough examination and a study of market conditions, they prepare appraisals which give their opinion of the fair market value of your property on the date it was acquired by the Government. Such appraisal must be made before the initiation of negotiations for the purchase of your property. You or your designated representative will be given an opportunity to accompany the appraiser during his inspection. When the appraisers examine your property, you should assist them by answering any questions which they may have and also by pointing out any special features which you feel may add to the value of the property.

What if only a part of my property is taken by the Government?

IF the taking of a part of your property leaves the REMAINDER of your land LESS VALUABLE than it was before, you will be paid for that loss. In other words, you will be paid fair market value for the land which was taken by the Government, and in addition you will receive the amount by which your remaining land has been decreased in market value. However, if it is determined that the acquisition of only part of your property would leave you with an uneconomic remnant, the Government shall offer to acquire your entire property. Of course, if the public project will increase the value of your remaining land, this benefit will be offset against the compensation which will be paid to you.

What happens after an appraisal has been made of my land?

A GOVERNMENT REPRESENTATIVE will call upon you to see if you can agree on the terms of a sale. He will be familiar with the appraisals of your land and will be prepared to DISCUSS in detail the value of your property. You will be furnished with a written statement of the fair market value of your property and a summary of the basis for that value. The representative will then make an offer to acquire the property for the full amount of the approved appraisal. He also will answer any questions that you may have about the purchase of your property to the best of his ability. If you and the Government representative are able to reach an AGREEMENT, it will be reduced to writing, and upon approval by appropriate authority will become a binding agreement.

Do I have to accept the price put on my land by the Government's appraiser?

NO. You do not have to accept the Government's offer if you do not wish to do so; however, the owner and the Government's representative are usually able to reach a satisfactory agreement for the purchase of the property by the Government.

If I decide to sell, when will I be required to give up possession of my property?

This depends upon the particular PROJECT and the CIRCUMSTANCES of each case. The Government always tries to be reasonable, and usually a mutually satisfactory arrangement for transfer of possession can be worked out with the representative of the acquiring Federal agency. You will not be required to surrender possession of your property until you have been paid the agreed purchase price. Futhermore, you will not be required to move from your dwelling, or to move your business or farm operation without at least 90 days' notice in writing of the date by which your move is required, except in those unusual instances when there is an urgent need for your property.

May I keep my buildings and other improvements?

USUALLY the buildings and improvements will not be required for the project and in such a case YOU MAY RETAIN THEM. Of course, you will be required to move them to a location outside of the project area by a specified date, and the SALVAGE VALUE of the improvements will be deducted from the purchase price or condemnation award which you will receive.

What will the Government do if I have growing crops?

WHENEVER POSSIBLE, the acquisition of land by your Government is scheduled in order to allow for the HARVESTING by the landowner of growing crops. Of course, sometimes the land is needed before crops are ready to harvest, and in that case you will receive PAYMENT for your crops. You should discuss this with the representative of the acquiring Federal agency.

Will I be paid for my moving costs?

The purchase price does not include moving costs; however, you are entitled to receive separate payments for moving expenses together with relocation assistance, pursuant to Title II of Public Law 91-646, approved January 2, 1971. The local representative of the acquiring agency will supply full information and assist you in obtaining the authorized payment.

When will I be paid?

The United States will pay you AS SOON AS POSSIBLE after you and the Government representative have reached an agreement as to price and it has been approved by the Federal agency in charge of the project. Of course, payment is SUBJECT TO APPROVAL by the Government of the title to the property. If the title examination discloses that further proof is necessary to show that you have a clear title to the property, you can expedite the payment of the funds by assisting the Government's representative in obtaining such proof.

Will the money I receive for my property be subject to Federal taxes?

Responsibility for the administration of Federal tax laws rests with the INTERNAL REVENUE SERVICE, which is a part of the Treasury Department. These laws contain provisions with respect to gains derived from the sale of real property, including sales to the United States. Questions concerning the application of the internal revenue laws should be taken up with your attorney or with the DIRECTOR OF INTERNAL REVENUE in your district. He will be glad to answer your questions.

What happens if I decide not to accept?

Where an agreement cannot be reached, it will be necessary for your Government to file suit in Federal court in order to acquire your land. This is known as a CONDEMNATION case. The amount of just compensation to be paid to the property owner then will be judicially detemined and a judgment will be entered by the court fixing the amount which the landowner is entitled to receive.

If a condemnation suit is filed, how will I be notified?

The United States Marshal will serve you with a NOTICE that the United States has filed a "COMPLAINT," and usually also a "DECLARATION OF TAKING." This means that a condemnation suit has been filed. The Complaint may include not only your land, but the land of other property owners as well. Your notice, however, usually will describe only your particular tract of land. Ordinarily the local United States Attorney also advises landowners by mail of the filing of the condemnation suit and the amount of money which has been deposited as estimated just compensation, if a Declaration of Taking has been filed, and offers to assist in obtaining disbursement of such funds.

What is a Declaration of Taking?

A DECLARATION OF TAKING is a document which the Federal Government files in court. It contains a legal description of the land and interests to be acquired, together with an estimate of the amount of just compensation that your Government feels is due you. At the same time, the United States will DEPOSIT into court the amount of the ESTIMATED COMPENSATION. When this is done, title to the property passes to the United States and you have the right immediately to withdraw the amount of money which has been deposited for your land, subject of course to liens and other encumbrances.

Will I need a lawyer?

While you are not required to have a lawyer, it usually is desirable that you be represented by an attorney. He can ADVISE you about your RIGHTS and tell you what steps you should take next.

How is the market value of my land determined in a condemnation case?

The landowner and the Government both are permitted to introduce EVIDENCE as to the fair market value of the property and the court will hear the evidence and determine its fair market value. This decision may be made by the JUDGE, or by a JURY if either party asks for one, or the judge may appoint COMMISSIONERS to hear the evidence and make an award. As a landowner, you may testify as to your opinion of the land's fair market value, and you also may bring with you others who are qualified under Federal court rules to express an opinion on market value.

When will the Government take possession of my property if a condemnation suit is filed?

The Government will ask the court for an ORDER fixing a date upon which the possession of the property is required and on which the landowner must vacate the property. However, unless possession is urgently needed, you will not be required to surrender possession of your property until the Government deposits with the court for your benefit an amount not less than the acquiring agency's approved appraisal of the property; and, except in unusual instances when possession of your property is urgently needed, you will not be required to move from your dwelling, or to move your business or farm operation without a 90-day notice in writing of the date by which your move is required.

How do I get paid for my real property?

When a DECLARATION OF TAKING has been filed by the Government, money will have been deposited with the court to pay for your land. You must submit proof of ownership and show what mortgages, liens, or other encumbrances are against the land. The court then will allow you to WITHDRAW your share of the DEPOSIT. The local United States Attorney will assist owners in the withdrawals of funds deposited as estimated just compensation. However, if you are not the only person with an interest in the property, or if your TITLE is in dispute, this matter will have to be settled by the court. The Government normally does not participate in such hearings but will assist the court in seeing that title matters are cleared up. After a hearing, the court will enter a JUDGMENT fixing the amount of just compensation. The Government will pay the award as soon as possible. If the final award is more than the amount of money which you have withdrawn, you will get a judgment against the United States for the difference, together with interest. Of course, if the final award is less than the amount of money you have withdrawn, you will be required to refund the excess.

If I disagree with the court's award, what can I do?

Either the landowner or the United States can APPEAL from an award in a condemnation case. The appeal will be heard by the United States Court of Appeals for the circuit in which the land is located. However, this is not a new trial but a review by the appellate court to determine if there were any errors in the proceedings in the trial court.

Important:

Detailed information concerning the project for which your property is to be acquired will be made available by local representatives of the Federal agency responsible for the acquisition of land. You should not hesitate to seek information from the agency representative, who will be glad to assist you and to answer questions.

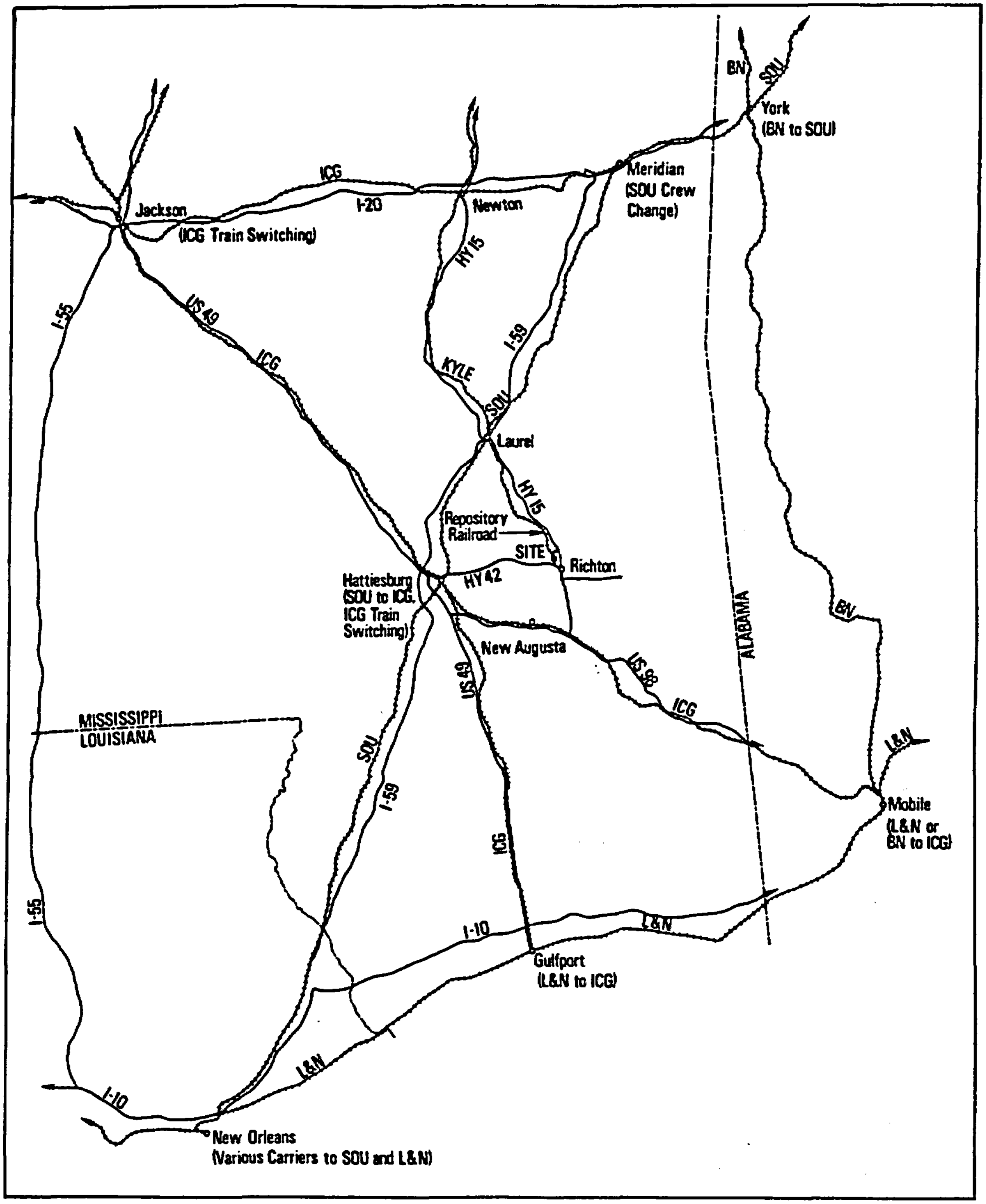
Interagency land acquisition conference

The INTERAGENCY LAND ACQUISITION CONFERENCE was established on November 27, 1968, by invitations issued from the Attorney General of the United States of America. This Conference has the responsibility for recommending uniform land acquisition policies for land acquisition agencies; coordination of land acquisition activities among such agencies and the Department of Justice; promulgation of uniform appraisal fee schedules, standards and guidelines for appraisal reports and review; improvement in liaison between agency field personnel and United States Attorney's offices; and consideration of any other matter relating to the land acquisition programs of the United States, looking on the one hand to protection of the public interest and looking to fair and equitable treatment of persons deprived of their lands for Federal use on the other. The Interagency Land Acquisition Conference is placed under the Chairmanship of the Assistant Attorney General of the Land and Natural Resource Division of the Department of Justice.

U.S. GOVERNMENT PRINTING OFFICE 1975 O—596-511

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402
Stock Number 027-000-00291-9
Catalog Number J1.2:P94/7

January 1974



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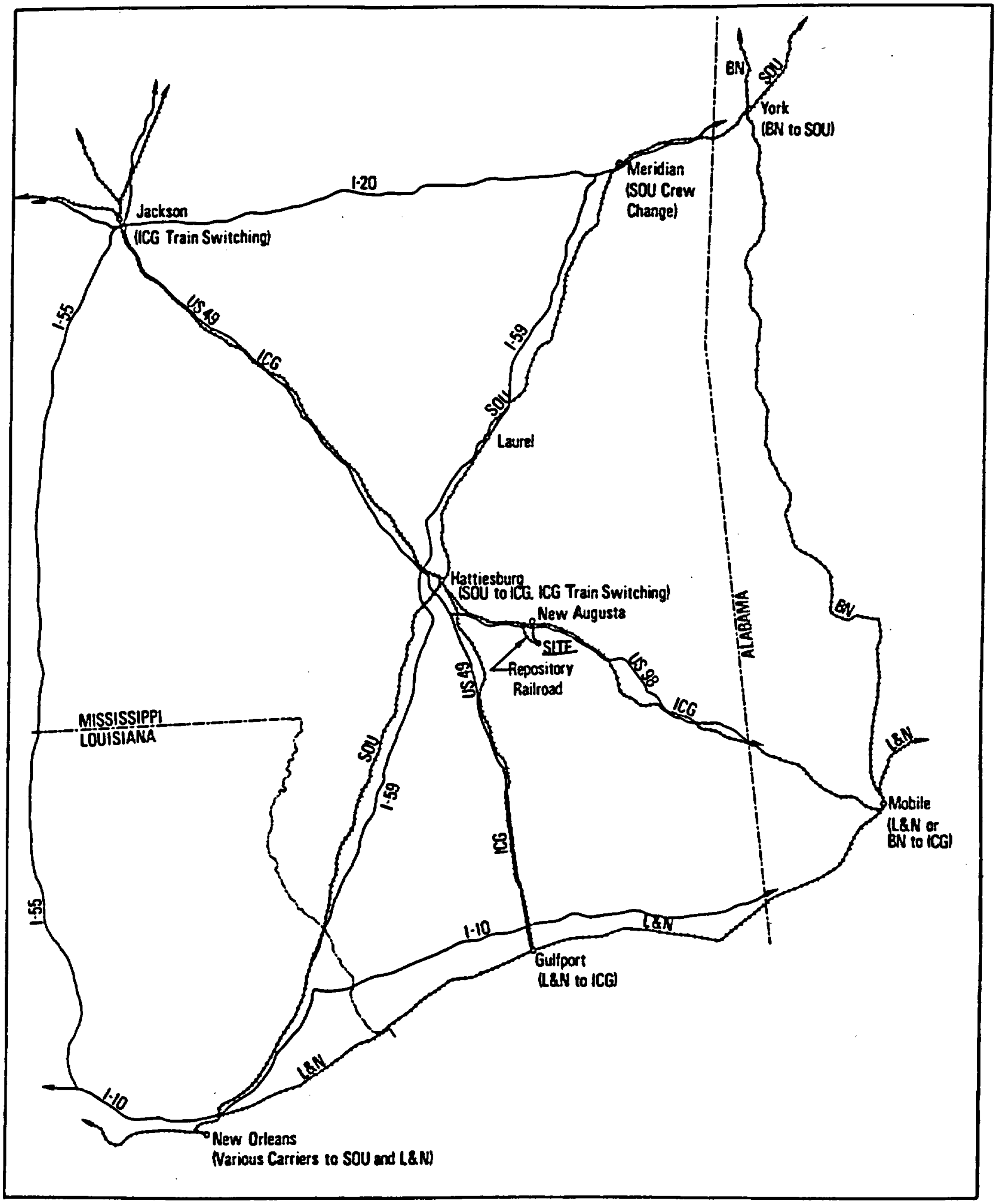

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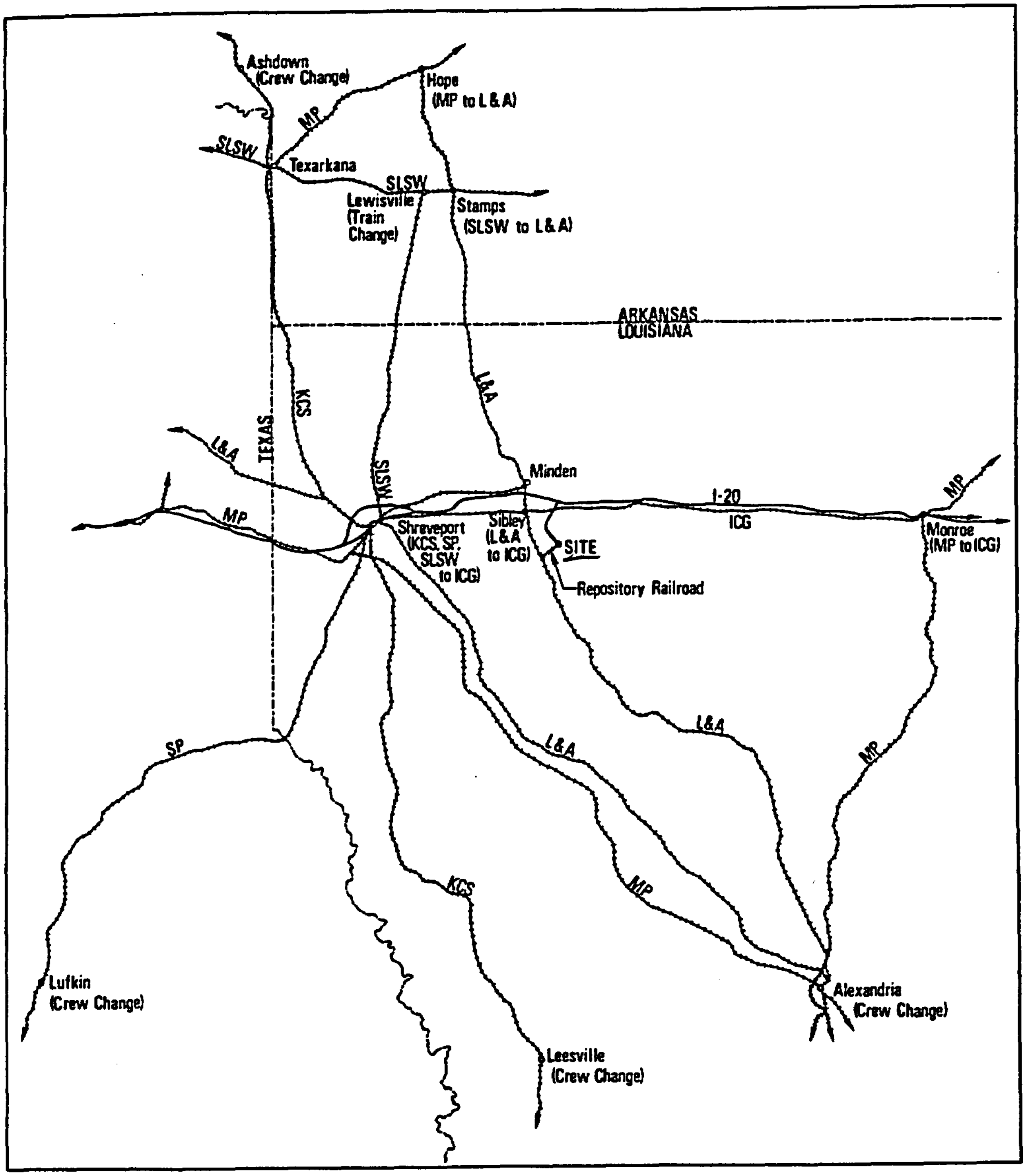

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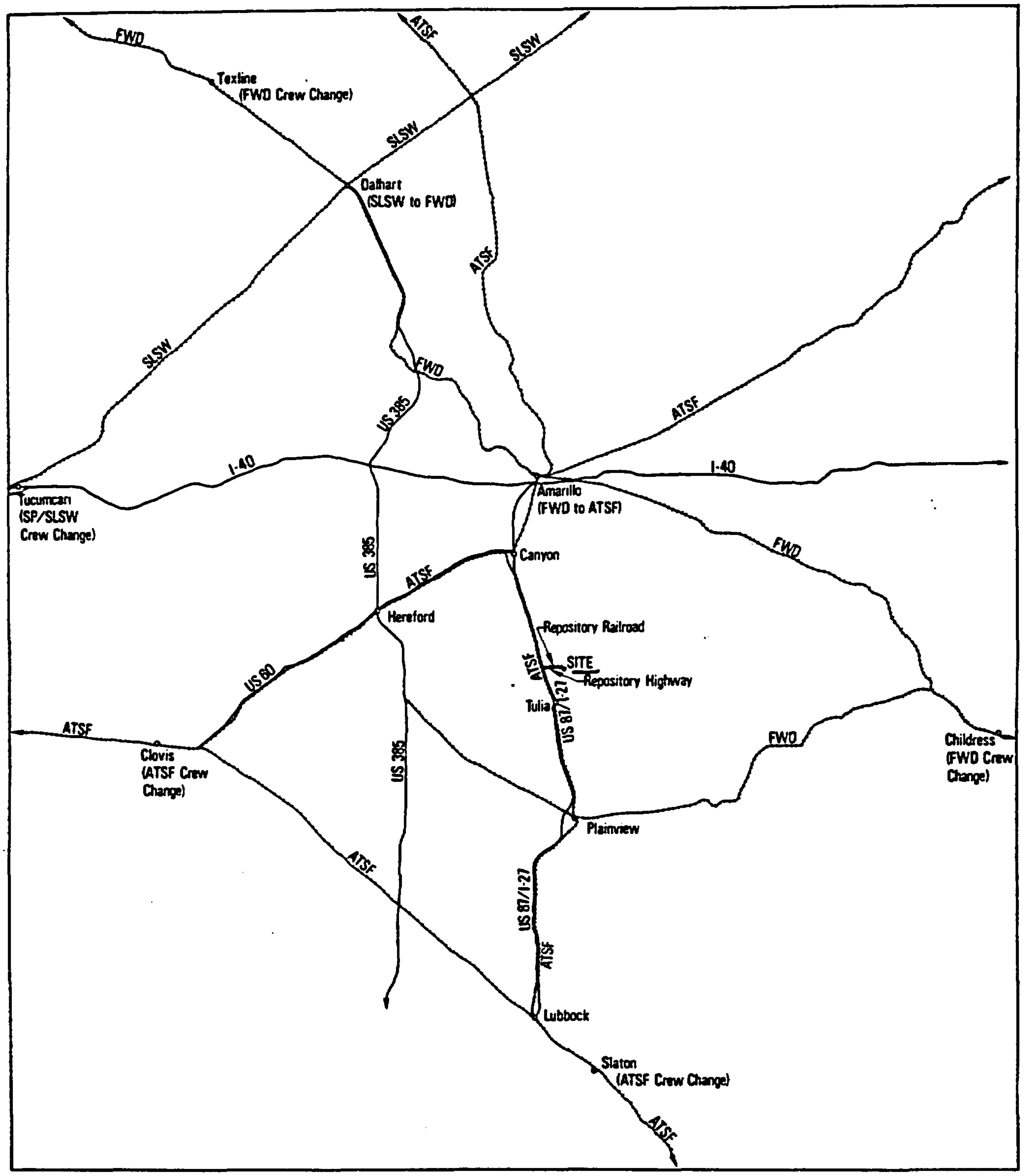

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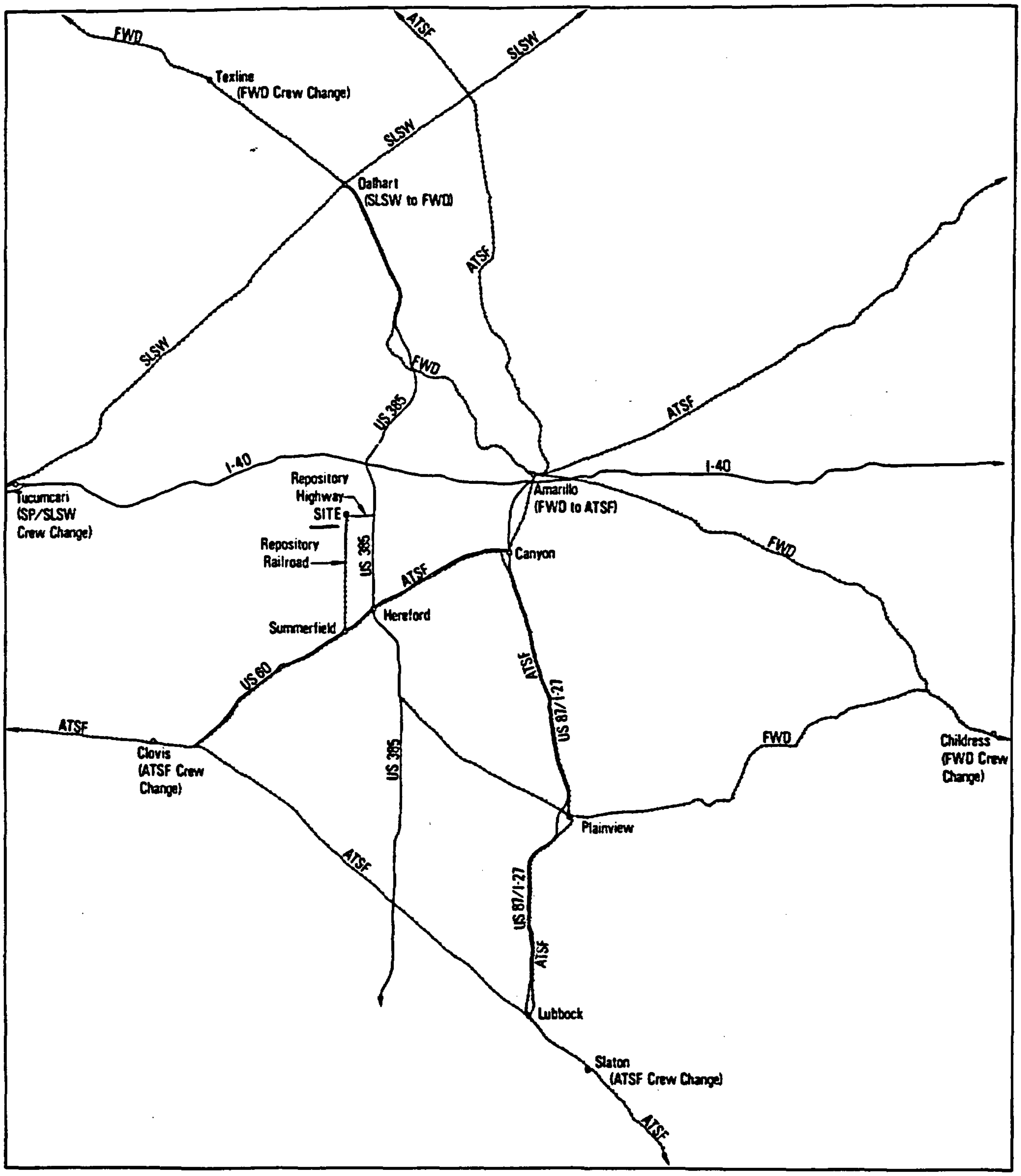

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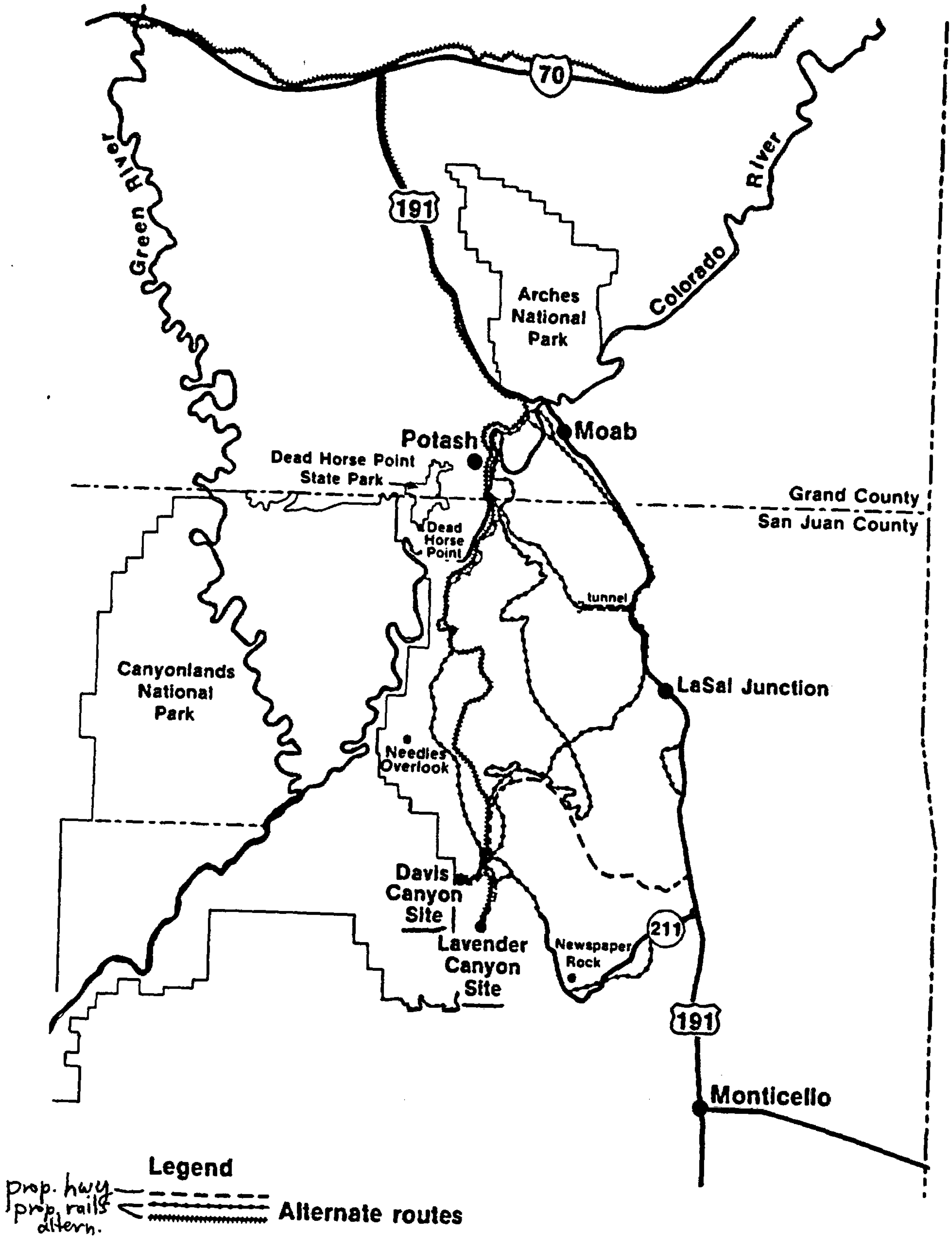

Alternative Highway and Railroad Access Routes Davis and Lavender Canyon Sites

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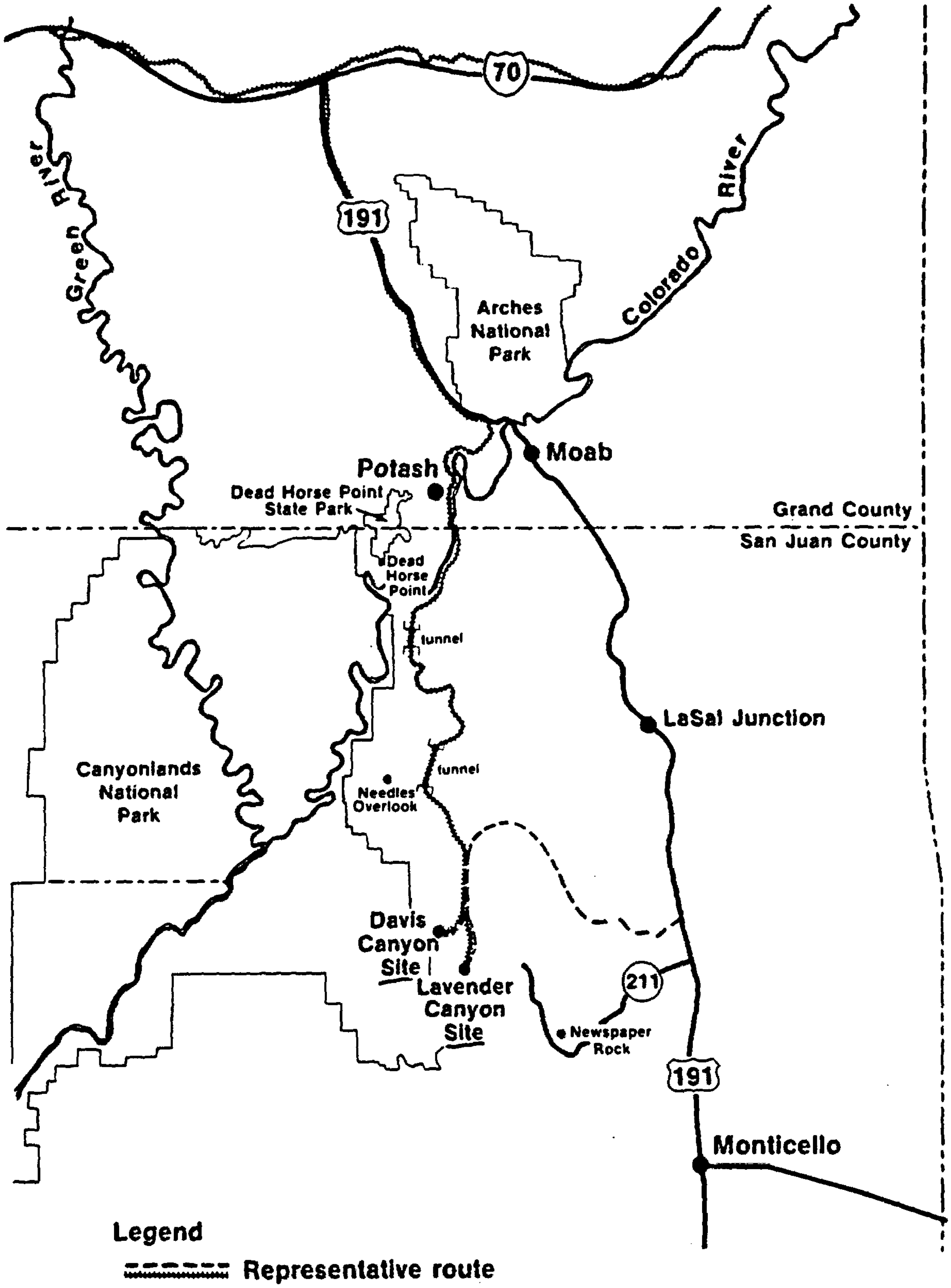

Representative Highway and Railroad Access Routes Davis and Lavender Canyon Sites

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Energy Issues In Perspective

Radioactive Shipments
Questions and Answers

I. THE ISSUE

Natural radiation is pervasive in our environment. Virtually everything in and around planet Earth, including our own bodies, contains natural radioactive materials in varying concentrations. Over the past half century, science has learned much about these substances — in fact probably more than about any other substance in our environment.

Today there are a wide variety of commercial, medical, research and other civilian uses for radioactive materials such as: making electricity (12 percent of the nation's supply); special and sometimes revolutionary medical treatment and diagnosis; research in biology, archeology and geology; and a variety of industrial processes. In order to derive these benefits from radioactive materials, we have had to learn to handle and transport them with care, and in particular to devise strong, reliable containers for transporting the highly radioactive spent fuel from commercial nuclear reactors. Much of the recent concern expressed over the transport of these materials largely overlooks the vast body of scientific and technical expertise that has resulted in an outstanding safety record in shipping for over thirty years. This paper provides some basic information and perspective on the issues surrounding the transportion of radioactive materials in the form of answers to common questions.*

II. BACKGROUND QUESTIONS

1. What kind of radioactive materials are transported?

There are two general categories of civilian radioactive materials: fuel cycle, and non-fuel cycle. The first category involves the fuel, materials and waste resulting from the production of electricity from nuclear energy. Less than 15 percent of radioactive packages shipped each year are associated with the nuclear fuel cycle.[1] The second category primarily includes radioactive elements and the wastes resulting from their use in medicine, research and industry.

The commercial nuclear fuel cycle involves the transportation of raw uranium fuel in various forms, completed uranium fuel assemblies, trash such as rags, tools, paper, coveralls and plastic which have been slightly contaminated with radioactivity during the fuel manufacturing process and nuclear power plant maintenance, and finally used, i.e. spent, fuel that is discharged from the reactor.

Most of the civilian radioactive packages shipped in the U.S. are in the second category. These materials include a wide variety of radioactive elements in the form of such things as machines containing radiation sources, solids, and small vials of solutions for medical diagnostics, treatment and research, and materials used in industry and agriculture. In addition, these materials, once they have been used up, together with any associated hardware, or rags, constitute a large volume of radioactive waste.

2. How much radioactive material is transported?

There are more than 100 million shipments a year of all types of hazardous materials in the U.S.[2] About three percent of these, or some three million packages, contain radioactive materials — of which about one-third are for medical purposes, about one-sixth are for the nuclear fuel cycle, and the balance for industrial and research activities.[3]

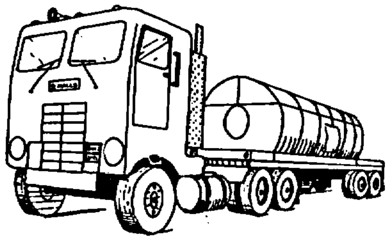
Shipments of wastes account for about 10 percent of radioactive packages transported each year.[4] Of this, the vast majority is low-level waste (55 gallon drums of such things as slightly contaminated rags, coveralls, tools, etc.) totalling some two million cubic feet a year.[5] The material frequently of public concern (and the material under the most restrictive regulatory and safety guidelines) is spent reactor fuel — i.e. high-level nuclear waste. The few hundred shipments a year of spent fuel amount to a tiny fraction of a percent of the total annual shipments of radioactive materials currently taking place.[6]

3. Why transport radioactive materials?

In order for society to derive the many benefits from radioactive materials, it must provide for their safe transport to the point of use and ultimately to a waste storage site.

For instance, uranium as a fuel for nuclear generating stations provides 12 percent of the nation's electricity, and more than 25 percent of the electricity for a dozen states.[7,8] For the future, nuclear energy accounts for about 40 percent of all the new electrical generation under construction or planned.[9]

Radioactive materials are used in procedures for half of all patients admitted to hospitals in the United States.[10] In addition, radioactivity is used in such things



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*This issue paper addresses the civilian, not military, uses and transport of radioactive materials. Military programs are clearly for different purposes and generally under different jurisdictions.

as smoke detectors, heart pacemakers, illuminated watches and signs, medical research, sterilizing medical supplies, improving crops, preserving foods, determining ground-water resources, x-raying pipeline and ship welds, controlling industrial processes, and in the exploration for oil and natural gas.

4. Will there by any increase in the amount of radioactive material transported in the future?

Yes. The use of radioactive materials can be expected to increase because they are so valuable as medical and industrial research tools. For example, radioactivity can be detected in incredibly small amounts, making it a valuable "tracer" for medical diagnosis. Also, as the nation's need for electricity increases in the coming years, uranium (along with coal) will be a large contributor. Thus, it is expected that by 1985 there will be some five or six million packages of radioactive materials shipped a year.[11] About 15 percent of these will probably be associated with the nuclear fuel cycle.[12,13]

5. How are the regulations and standards for radioactive materials transportation determined?

Standards and safety criteria for shipments of radioactive materials are established by the U.S. Nuclear Regulatory Commission. The U.S. Department of Transportation is responsible for regulating the transportation of all hazardous materials, including those that are radioactive. The Department of Transportation specifically establishes regulations for such things as packaging, handling, labeling, marking and routing. Standards are established on the basis of the best scientific and technical information available, are open to public scrutiny and review, and are based on national and international consensus resulting from more than 50 years of research on the effects of radiation.

6. Are the standards safe enough?

While no standard can provide absolute assurances, those which have been established for protecting the public from the effects of radiation are unprecedented in the extent to which they have been studied and reexamined to ensure that appropriate requirements have been used. Fifty years ago the highly respected and still active International Commission on Radiation Protection and the U.S. National Council on Radiation Protection and Measurements were formed to examine and propose standards. These organizations are composed of physicians, radiologists and scientists expert in the effects of radiation. In addition, independent reviews are provided by the National Academy of Sciences and by the United Nations Scientific Committee on the Effects of Atomic Radiation.

7. Would it cause a disaster if an accident occurred causing radiation release?

No, for two principal reasons. First, there is far too little radioactivity contained in the vast majority of the shipments to cause any harm to anyone or anything — much less a disaster. In fact, in many of the shipments the quantity of radioactivity involved is not much different from the amount of natural radioactivity contained in the human body[14].

Second, for those shipments that are much more radioactive (for example: spent reactor fuel, special medical irradiators for cancer treatment, or industrial irradiators for checking welds), the containers are specifically designed to withstand violent accidents and minimize the amount of radioactivity that could be released. In addition, the nature of the more radioactive material (almost always a solid) will inhibit the release of any radioactivity.

Furthermore, despite the fact that any incremental commercial releases of radioactivity are considered serious and carefully regulated by state and federal agencies, the effect on the environment is not unique or unpredictable because radiation is a natural, pervasive phenomenon. In fact, natural sources of radiation can often reach levels that would violate the Federal standards established to minimize exposure from man-made activities.[15,16]

III. TRANSPORTATION OF SPENT REACTOR FUEL

1. What is spent reactor fuel?

Commercial nuclear reactors are fueled with pure uranium oxide in the form of ceramic-like pellets stacked in long metal tubes which are grouped together in bundles (also called assemblies). After producing heat in a reactor core for about three years, each fuel bundle is removed, essentially unchanged in appearance and still retaining about 96.5 percent usable uranium. The fission process, which produced the energy, leaves behind a variety of highly radioactive waste products accounting for most of the remaining 3.5 percent of the spent fuel.[17] Spent fuel bundles are kept at the reactor site in large pools of water to cool them and shield the radiation until they can be shipped off-site. After a year or so, more than 90% of the radioactivity has dissipated as heat.[18]

2. Why does it need to be transported anywhere?

Twenty years of nuclear electricity has produced 8,000 tons of spent fuel.[19] Regardless of the future for new nuclear plants, this 8,000 tons already exists and is increasing each year from the output from plants currently on line. This spent fuel must ultimately be shipped to a disposal site when one is available. (Note: Because uranium is so dense, the 8,000 tons of fuel assemblies, if stacked together, would all fit in a box 45 feet on each side.[20])

Currently, spent fuel is stored in pools at reactor sites which are normally designed with sufficient capacity to hold the spent fuel discharged over a five- to 20-year period.[21] (At any given time, enough space is normally reserved to hold all of the fuel in the reactor core in the event that it should become necessary to remove it.) After on-site storage has been exhausted, some spent fuel will have to be removed and transported to another storage site or the reactor will be shut down. The Congressional Office of Technology Assessment estimates that numerous generating stations will face this dilemma before 1990.[22] According to the Department of Energy, Transporting coal also involves a risk, but for different reasons. While the coal itself does not present a risk, the nation's need for this energy commodity involves an immense number of rail shipments. Thus, accidents involving coal-carrying trains cause between 700 and 1300 public deaths a year.[64,65] (This form of risk is insignificant with regard to nuclear fuel since some 80,000 times less material is transported to produce the same amount of electricity.)

17. If there were an accident involving radioactive materials, who would respond?

In the event of an accident, the first and most rapid response would come from local fire and police departments, as well as the state or local agencies that have radiological expertise. If necessary, a community could call on civil defense personnel and the National Guard.

With regard to the special nature of spent fuel, the Department of Transportation has developed and distributed to each state a self-contained training course on handling radioactive materials transportation emergencies.[66] In addition, the Federal Emergency Management Agency is developing a guidance document on emergency planning for radioactive materials transportation.[67] In the event of a release of radioactive material, the Department of Energy operates a Radiological Assistance Program with eight regional offices staffed with experts in this area available for immediate assistance.[68] In addition, the electric utility industry has developed a voluntary mutual assistance agreement to provide additional help.

18. If there were a release of radioactive materials, who would be responsible for cleaning it up and paying for the cost?

Responsibility for dealing with a release involving a shipment of radioactive materials, as with other hazardous materials, is divided among carriers, shippers and government agencies. As the actual transporters, carriers have the basic responsibility for confining the spread of radioactive materials and for any necessary clean-up. Shippers are required to furnish information to carriers and government agencies about the characteristics of the shipment and any special precautions necessary. State and local government agencies, through their police and fire departments, are normally recognized as responsible for protecting people and property at the scene of an accident. Under the Motor Carrier Act of 1980 and the Price-Anderson Act, passed in 1957, there is extremely broad insurance and indemnity protection in the event of a serious accident which provides coverage for any damage, regardless of who is liable, currently up to a maximum of $560 million. There is also a "no fault" feature applicable to very serious releases of radiation from any aspect of the operation of commercial nuclear reactors, including transportation.[69]

19. What would happen if terrorists attacked a shipping cask?

This is considered the worst possible "accident" that could occur to a spent fuel shipping cask. In order to assess the consequences of such an event, scientists at the Sandia National Laboratories simulated such an "accident" on an actual cask containing segments of a fuel bundle, and precisely measured the amount of material released.[70] The experiment produced two interesting results. First, previous assumptions about the amount of radioactivity that could be released during a worst case breach of the cask were found to be too high by a factor of more than 100.[71] Second, the experiment showed that such an event would not cause any early radiation-related injuries or fatalities, and could lead to a maximum of one cancer fatality many years after the event.[72]

20. What would happen if terrorists hijacked a shipment of spent fuel?

First, a spent fuel cask weighs between 20 and 100 tons. It would thus be exceptionally difficult to steal one, and then escape and hide it. Second, because the spent fuel is very radioactive, it is encased in lead shielding that stops almost all the radiation. An attempt to destroy the cask and its shielding would not result in a significant risks (see Question 19).

If, on the other hand, terrorists were successful in removing the spent fuel from the cask — not in itself easy because the closure plugs themselves weigh many tons — their close proximity to the unshielded bundle could cause them to be exposed to lethal levels of radiation before anything significant could be accomplished.[73] Even were all these problems overcome, solid ceramic-like spent fuel would not prove very hazardous to the general public because it does not dissolve in water, makes a very heavy dust if pulverized (and thus would not be carried far by air currents), and is non-flammable. A wide variety of chemical toxins are far more dangerous, and are easier to acquire and distribute.

However, some people are concerned with the possibility of terrorists stealing spent fuel in order to obtain plutonium for the purpose of attempting to make a bomb. The solid ceramic-like pellets of spent fuel are about 95 percent uranium, four percent waste products and the balance, less than one percent, a mixture of different kinds of plutonium.[74] In this regard it is important to consider four facts: 1) it is far more difficult to make atomic bombs than is popularly believed[75,76]; 2) in order to obtain a reasonable amount of plutonium, several of the massive casks of spent fuel would be needed[77]; 3) the solid spent fuel must then be subjected to an elaborate and difficult chemical process called reprocessing, in order to dissolve it to separate out, purify and then resolidify the plutonium; and 4) the plutonium in commercial spent fuel is substantially different from weapons-grade material, thus making a bomb more difficult to assemble, less likely to work and far less effective as an explosive.[78]

travelling at 80 mph; dropped from a height of 2000 feet onto extremely hard ground; and burned in a pool of aviation fuel under conditions six times worse than regulations require.[40,41,42] In many cases the violent experiments proved less demanding than the construction specifications themselves.[43]

11. Have there been any accidental releases of radioactivity from spent fuel shipments, and if the number of shipments increases, is it likely that there will be releases in the future?

Four shipping casks have been involved in accidents since 1971, two empty and two containing spent fuel.[44] No radioactivity of any kind was released. Internationally, there has never been a radiation release during a spent fuel shipment either.

Ultimately, of course, as the number of shipments increase there is a very small, but nonetheless increasing, statistical possibility that an accident leading to the release of radioactivity could occur. It is estimated that by the year 1990 spent fuel shipments will cover a cumulative one million miles.[45] Thus, it is statistically estimated that there could be a dozen or so traffic accidents involving spent fuel casks in that year.[46] Most of these accidents are unlikely to occur in urban areas. Of those that may occur in urban areas, it is estimated that in more than 90 percent of the cases the conditions would not be severe enough to cause any radiation release. And, of those accidents that do release some radioactivity, it is further estimated that the potential public risk would be "comparable to a frequency of one latent cancer fatality in 2,400 years."[47]

12. What happens if a shipping cask breaks in spite of all the regulations?

Scientists are able to establish upper bounds on the worst that could be expected and do in fact make estimates about the consequences of an accident assuming that radioactivity *is* released.[48] It is possible to arrive at reasonable estimates, and to rule out far-fetched doomsday scenarios, because there is such a wealth of knowledge about and experience with the materials involved. If the worst set of events did occur, estimates are that the "maximum exposed individual" would receive an inhalation radiation dose of 14 rem (less than three percent of a fatal level of exposure).[49,50] While such an exposure would clearly be undesirable and far in excess of the maximum permissible for members of the public, it should be put into perspective. Smokers receive radiation exposures of two to eight rem to their lungs each year due to natural radioactivity in tobacco products.[51] In fact, natural background radiation itself can cause exposures of between one and five rem a year in a number of places in the world.[52]

13. Can nuclear fuel explode?

No. It is a physical impossibility for commercial reactor fuel to explode, whether new or spent, and whether by accident or sabotage.

14. Would a serious accident cause catastrophic property damage?

The Nuclear Regulatory Commission's (NRC) environmental impact statement estimates that the most severe urban accident would have the potential for costs of $200 million in an area such as New York City.[53] (N.Y.C. is chosen because it represents the "worst case" conditions of high population density and congestion.) A more recent draft study estimates a $2 billion cost for a worst case accident involving spent fuel in New York City with the probability of this occuring as less than one in a billion per year. However, the NRC has been evaluating this recent draft and found instances of great overestimation of cost as well as large uncertainties.[54] In any case, the potential loss of property is not substantially different from many other real and far more common natural and man-made events that society and the economy absorb every year. For example, a single hotel fire has lead to some $100 million dollars in damages[55]; and in the energy arena, a single oil spill has lead to damage claims of over $2 billion.[56] For additional perspective, floods lead to billions of dollars in damages each year and individual hurricanes have caused in excess of $5 billion in damages.[57]

15. Could an accident require evacuating a large city?

There is no series of events or accidents involving spent nuclear fuel that could cause sufficient potential risk for such a measure. First, the material involved, solid ceramic-like pellets of spent uranium fuel, does not have the potential to explode or cause a disaster of that magnitude. Second, the containers are virtually indestructible and even the worst accidents would only lead to localized damage and problems.[58]

16. What are the comparative risks of transporting spent fuel and other commodities?

The unparalleled safety record for transporting spent fuel and other radioactive materials has resulted in no radiation-related injuries or deaths to the public, consequently we can only examine the issue in terms of "what if". By contrast, the transportation of other energy-related commodities leads to damages, injuries and deaths every year. In terms of the statistical possibility of fatalities for every shipment made, the transportation of gasoline, propane and chlorine are from 300 to 30,000 times riskier than the shipment of all materials associated with the nuclear fuel cycle.[59] In fact, accidents involving chlorine-carrying trains typically cause nine public fatalities a year; in one case, a chlorine shipment accident caused the evacuation of 250,00 people.[60,61]

Fires resulting from accidents involving the transportation of gasoline on the nation's highways have taken 480 lives and injured another 3,500 between 1976 and 1980.[62] Similarly, there are each year some 100 to 150 explosions and fires causing some two dozen public fatalities resulting from the transportation of natural gas in pipeline systems.[63]

there are over two dozen facilities in this category.[23] In the event of a shut-down, the additional cost to replace a nuclear station's electricity would be about $500,000 a day if coal replacement power were used, or at least $1,000,000 a day if an oil-burning facility were substituted.[24]

3. How many shipments need to be made annually from a nuclear power plant?

A typical large nuclear power plant, which produces enough electricity for some 600,000 households, normally discharges about 30 tons of spent fuel a year in the form of 50 to 80 fuel assemblies. In order to transport this spent fuel, three to four truck shipments per month, or about one rail shipment every other month would be needed.[25,26]

4. How many shipments have there been in this country? How many are expected in the future?

To date, over 5,000 spent fuel assemblies have been shipped in this country without an accident causing radiation release.[27] By the late 1980s, it may be necessary to make several thousand shipments a year.[28] For comparison, during the same period, the Department of Transportation will oversee some 55,000 chlorine shipments, 3 million propane shipments and 14 million shipments of gasoline each year.[29]

5. How are highway shipping routes chosen?

Department of Transportation regulations require highway shipments to take the most direct interstate routes, and to bypass cities whenever an interstate bypass or beltway is available.[30] Thus, safety is enhanced by choosing the most direct route (i.e. limiting the number of miles to be travelled) and by using interstates whenever possible (since the frequency of accidents on these highways is less than for any other road). Also, under current regulations, any route for the shipment of spent nuclear fuel from commercial power plants must be approved by the Nuclear Regulatory Commission.

In general, populated areas are avoided whenever possible under the above-mentioned conditions. However, routes are sometimes chosen through populated areas because the risks of a serious accident are so small, and because shipping by more circuitous routes could be riskier due to poorer secondary road conditions.

For perspective, it is important to note that risks are associated with all systems for providing energy to the public. For example, many large population centers (up to 250,000 people in some cases[31]) are at risk living downstream from hydroelectric dams.

6. Do states and localities have any role in determining routes and procedures for shipping radioactive wastes?

Under the Department of Transportation's (DOT) regulations, states may designate preferred highway routes for spent fuel when they can be shown to be as safe as the ones specified by the DOT. States are required to consult with affected localities before establishing a preferred route.[32] There is also a provision for states to apply for a "nonpreemption determination" from the DOT in order to enable a state or locality to enforce any of its own requirements.[33]

7. How much radiation exposure would someone living on a shipping route receive?

There is essentially no risk from the radiation exposure during the normal transportation of spent fuel. An individual living 90 feet from a highway where 250 spent fuel shipments pass each year travelling at an average of 30 miles per hour would receive a radiation dose some 9000 times less than that received from natural sources — the sun, earth and radioactivity naturally in the human body. For comparison, the dose would be only slightly higher than that received from an ordinary smoke alarm in a year's time.[34,35,36] (Most smoke alarms contain tiny amounts of radioactivity in order to detect smoke.)

8. How is spent fuel shipped?

The bundles of solid spent fuel from commercial reactors are transported in specially designed shipping casks. These casks, possibly the strongest containers ever built, weigh from 25 to 100 tons and are constructed of layers of steel and lead or other dense metals. Depending on the specific type of fuel bundle and whether designed for truck or rail use, casks can hold between one and 24 fuel assemblies.[37]

9. Is every shipping cask actually tested?

No. It is unnecessary for the same reasons that not every bridge, high-rise building, or dam is tested. In these cases, public safety depends on establishing and achieving certain standards based on sound engineering principles, stringent regulations and with safety margins established over decades of experience. In addition, the design criteria and computer models used are tested for accuracy, providing guidelines more comprehensive and demanding than could be achieved by simple testing.

Unlike the containers for transporting essentially all other hazardous commodities — which are built in a manner adequate simply to carry the material — spent fuel shipping casks are designed and built to withstand a series of violent accident conditions without release of radioactivity: collision with an immovable object, an attempt to puncture with a six-inch steel post, a completely enveloping fire and submersion under water.[38]

10. Are the safety standards realistic?

At the Sandia National Laboratories, a number of casks that have been retired from service have been actually tested under some incredibly violent conditions and in every case the casks survived intact and proved the engineering and computer models and assumptions to be correct. In numerous instances the models and assumptions, designed to be very conservative, in fact significantly underestimated the casks' survivability.[39] Shipping casks have, for example been: loaded onto a truck which was made to crash, first at 60 mph then at 80 mph into a 700-ton concrete wall backed with 1700 tons of dirt; broadsided by a 120-ton locomotive

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21. U.S. DOE, "Spent Fuel Storage Requirements", SR-0007, March 1981, p. 14.
22. Ref. 19.
23. U.S. DOE, "Spent Fuel Storage Requirements", DOE/SR-0007, March 1981, p. 11.
24. — coal based on C. Mycoff, "U.S. Nuclear Generation Economics", *Nuclear Energy Digest*, Sept. 1981: avg. difference between nuclear and coal total generation costs — 0.35 to 0.68¢/kwhr; for 1,000 MW plant at 60% C.F. = $504,000 to $979,000/year additional.
    — oil based on 1982 oil-replacement costs.
25. Edison Electric Institute, Dept. of Statistics, Report Vol. 50 No. 1, June 22, 1982 — avg. residential customer 8932 kwhrs/yr: 1,000 MW nuclear station, 60% C.F. (Re: ref. 7 p 75); thus 588,000 residential customers/1,000 MW plant.
26. — based on an avg. of one bundle/truck cask and 10/rail cask, and moving one year's discharge each year.
27. Ref. 6.
28. — This assumes that: a) the reactors near completion are licensed; b) there is somewhere to ship the spent fuel; and c) there are enough casks available: for estimates of volume see "Radioactive Waste Materials Transportation", Information Booklet, Battelle Columbus Laboratory, May 1980.
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34. Ref. 2, 0.009 mR/yr.
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41. I. Waddoups, "Air Drop Test of Shielded Radioactive Material Containers", SAND75-0276, Sandia National Laboratories, September 1975.
42. H. Yoshimura, "Full Scale Simulations of Accidents on Spent-Nuclear-Fuel Shipping Systems", Proceedings Fifth International Symposium Packaging and Transportation of Radioactive Materials, Las Vegas, Nevada, May 1978.
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44. E. Emerson, J. McClure, "The Nature of Transportation Accidents Involving Radioactive Material Packagings", Sandia National Lab., SAND81-1330C.
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46. Ibid.
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48. Ref. 6.: Note that worst case assumptions generally assume the spent fuel to be fresh (or only six months old), that is, at the point in time when the amount of radioactivity is at its highest. Normal decay continues to eliminate the level of radioactivity. Most spent fuel shipped is many years old, thus with significantly less activity than used for calculations in worst-case assumptions.
49. Ref. 45, p. 3.
50. Ref. 15, p. 21.
51. National Council on Radiation Protection and Measurements, *Radiation Exposure From Consumer Products and Miscellaneous Sources*, Report No. 56, 1977, p. 56.
52. Ref. 15, pp. 199-204.
53. Ref. 45.
54. Ibid.
55. Insurance Information Institute, personal communication Re. November 21, 1980 Las Vegas hotel fire.
56. W. Keichel, "The Admiralty Case of the Century", *Fortune*, 23 April, 1979.
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58. Ref. 39.
59. Ref. 13, p. 13.
60. Ibid.
61. "Everyday Risks", *The Washington Post*, 26 Nov. 1979.
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63. Ref. 57, p. 145.
64. P. Gleick, "Health and Safety Effects of Coal Transportation: Reassessing the Risks", *Energy*, July 1981, p. 614.
65. Ref. 57. p. 65.
66. Ref. 39, p. 27.
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68. Ref. 38, p. 200.
69. Statement of the Electric Utility Companies' Ad Hoc Nuclear Transportation Group on Emergency Planning and Response for Transportation of Radioactive Materials, October 1978; Energy L. Serv. (Callaghan) Mono., 14A, pp. 61-62; Public Law 96-296, July 1, 1980, Section 30.
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77. — assuming 500 kg/bundle and 0.8% concentration all Pu isotopes (Ref. 74).
78. Ref. 75.

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Made possible by a grant from the
Electric Utility Companies'
Nuclear Transportation Group

numerous
transportation
docs
attached

NUREG-0170
VOL. 1

FINAL ENVIRONMENTAL STATEMENT ON THE TRANSPORTATION OF RADIOACTIVE MATERIAL BY AIR AND OTHER MODES

Docket No. PR 71, 73 (40 FR 23768)

Manuscript Completed: December 1977
Date Published: December 1977

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Office of Standards Development
U. S. Nuclear Regulatory Commission

SUMMARY AND CONCLUSIONS

This Final Environmental Statement was prepared by the staff of the Office of Standards Development of the U. S. Nuclear Regulatory Commission (NRC), Washington, D.C. 20555. Mr. Donald R. Hopkins is the NRC Task Leader for this statement (telephone: 301-443-6910).

1. This action is administrative.

2. This Final Environmental Statement has been prepared in connection with NRC reevaluation of its present regulations governing air transportation of radioactive materials in order to provide sufficient analysis for determining the effectiveness of the present rules and of possible alternatives to these rules. This statement is not associated with any specific rule change at this time but will be used as a partial basis for determining the adequacy of the present transportation regulations. If a rule change results from consideration of this statement, a separate or supplementary environmental statement will be issued with respect to that action.

When NRC was beginning work on this environmental statement, consideration was given to covering all aspects of the environmental impact resulting from the transport of radioactive material by air. At the Federal level, both the NRC and the Department of Transportation, particularly the Federal Aviation Administration (FAA), are involved in regulating the safety of such transport. Therefore, NRC proposed to the FAA that the statement be cosponsored by both agencies and that both the shipper-packaging aspects and the carrier-transport aspects be covered. In a meeting in early 1975, the FAA declined to actively support the development of such a statement. As a result, the scope of the statement was limited to the shipper-packaging aspects. The statement deals with the carrier-transport area only to the extent necessary to determine the influence of the conditions of transport on the shipper-packaging area, e.g., exposures of personnel from packages of radioactive materials under normal and accident conditions.

Development of the statement began with consideration of transport of radioactive materials by air. However, in order to examine the environmental impact of alternatives, other modes of transport were examined, again primarily from the standpoint of the effect such transport would have on packaging as related to exposure of people under both normal and accident conditions. During the development of the statement, special interest arose in the alternative of transporting irradiated nuclear fuel by special trains. Some detail was added in the section on special trains but the statement scope was not sufficiently broad to deal thoroughly with this subject. A separate statement on the use of special trains for transporting irradiated nuclear fuel has been issued by the Interstate Commerce Commission (ICC) with NRC cooperation. Some of the same methodology used in this generic statement is used in the ICC study.

As a result of the limitations on the scope of this generic statement, only limited study of the conditions of transport, carrier controls, and routing has been undertaken. For example, no evaluation has been made of safety aspects of the vehicles or of items related to carrier controls other than those directly affecting the shipper-packaging area.

Except as noted, this statement does not specifically consider facets unique to the urban environment such as high population densities, diurnal variation in population, convergence of transportation routes, shielding effects of buildings, or the effect of local meteorology on accident consequences. A separate study specific to such considerations is being conducted and will result in a separate environmental statement specific to such an urban environment.

This statement was started in May 1975 and was completed prior to President Carter's April 7, 1977, message on nuclear power policy regarding deferral of commercial reprocessing and recycling of plutonium. Therefore, the 1985 projection of numbers and types of nuclear fuel cycle shipments and their environmental impact that has been used in this study reflects the potential development of plutonium recycle to the extent described in the NRC's generic environmental statement on mixed oxide fuel (GESMO). Since the analysis on non-fuel-cycle shipments remains valid, as does the analysis of all 1975 radioactive material shipments, this statement is issued with the caveat that it does not reflect changes in national energy policy originating with the President's April 7, 1977, message.

Although this statement has not been modified to reflect the President's policy message, it is the NRC staff's judgment, based on related analyses, that the results presented as realistic in this statement would continue to be realistic and the conclusions reached would be essentially the same if changes were made in accordance with the President's message.

3. The environmental impact of radioactive material shipments in all modes of transport under the regulations in effect as of June 30, 1975, is summarized as follows:

a. Radiation exposure of transport workers and of members of the general public along the transportation route occurs from the normal permissible radiation emitted from packages in transport. More than half of the 9800 person-rem exposure resulting from 1975 shipments was received by transport workers associated with the shipments. The remaining 4200 person-rems was divided among approximately ten percent of the U.S. population. None of these exposures would produce short-term fatalities. On a statistical basis, expected values for health effects that may result from this exposure are 1.7 genetic effects per year and 1.2 latent cancer fatalities distributed over the 30 years following each year of transporting radioactive material in the United States at 1975 levels (Chapter 4, Section 4.9). More than half of this effect results from the shipment of medical-use radioactive materials where the corresponding benefit is generally accepted (Chapter 1, Table 1-2).

b. Transportation accidents involving packages of radioactive material present potential for radiological exposure to transport workers and to members of the general public. The expected values of the annual radiological impact from such potential exposure are very small, estimated to be about one latent cancer fatality and one genetic effect for two hundred years of shipping at 1975 rates (Chapter 5, Section 5.9). More than two-thirds of that impact is attributable to nuclear fuel cycle and other industrial shipments (Chapter 1, Table 1-2).

c. Radiological impacts from export and import shipments were evaluated separately and were determined to be negligible compared to impacts from domestic shipments (Chapter 5, Section 5.7).

d. The principal nonradiological impacts from the use of resources for packaging materials and from the use of, and accidents involving, a relatively small number of dedicated transport vehicles were found to be two injuries per year and less than one accidental death per four years (Chapter 5, Section 5.8).

e. Examination of the consequences of a major accident and assumed subsequent release of radioactive material indicates that the potential consequences are not severe for most shipments of radioactive material (Chapter 5, Section 5.6). The consequences are limited by one or more parameters: short half-life, nondispersible form, low radiotoxicity. However, in the unlikely event of a major release of plutonium or polonium in a densely populated area, a few individuals could suffer severe radiological consequences. One early fatality would be expected, and as many as 60 persons would be exposed to radiation dose levels sufficient to produce cardiopulmonary insufficiency and fatalities in some cases. The latent cancer fatalities associated statistically with such a major release are estimated to be as many as 150 over a 30-year period (Chapter 5, Section 5.6). Costs for land reclamation associated with such an unlikely accident could range from 250 million to 800 million dollars for 1975 shipments and up to 1.2 billion dollars for 1985 shipments. The probability of such an event is estimated to be no greater than 3×10^{-9} per year for 1975 shipping rates (Chapter 5, Section 5.6). It should be noted that, to obtain the above result, all of the following conditions would have to occur:

(1) A low-probability, extra severe accident would have to involve a vehicle carrying a bulk shipment of plutonium or polonium in an extreme-population-density urban area. There are presently about 20 large-quantity shipments of polonium per year and one of plutonium (Chapter 5, Section 5.2.2);

(2) One or more of the packages of plutonium or polonium that are designed to withstand severe accident conditions would have to be subjected to the highest of the forces developed in the accident so as to cause gross failure of the package and subsequent release of a significant fraction of the radioactive contents from the package (Chapter 5, Section 5.2.3);

(3) The accident would have to create conditions in which plutonium or polonium released from the package would escape from the vehicle in which it was being transported, and a significant amount of material would have to become airborne in respirable form (Appendix A, Section A.4);

(4) The meteorological conditions at the time would have to be such that the plutonium or polonium remains airborne and is dispersed in a way that significant numbers of people would breathe the air containing the material in high concentrations (Chapter 5, Section 5.3); and

(5) Mitigating actions such as evacuation of persons from the area are not taken.

4. Principal alternatives considered are the following:

   a. Transportation mode shifts for various components of the industry (Chapter 6, Section 6.2).

   b. Operational constraints on transport vehicles to minimize accidents (Chapter 6, Section 6.3).

   c. Changes in packaging requirements to minimize release of radioactive materials in an accident (Chapter 6, Section 6.4).

   d. Changes in the physical properties of radioactive materials to minimize consequences in the event of a release (Chapter 6, Section 6.4.1).

Preliminary analyses were made of a number of alternatives to the present regulations and methods of transport. A few of the alternatives examined were found to be cost effective. However, the cost-effective alternatives dealing with changes in mode of transport did not significantly reduce the radiological impact; the others must be analyzed further to determine whether their adoption would reduce the radiological impact and achieve an impact level as low as is reasonably achievable (Chapter 6).

The alternative of reducing the amount of radioactive material transported, either generally or selectively, was not considered on the assumption that the benefits associated with the use of presently transported materials outweigh the small risk of their transportation.

While future rulemaking may depend in part for its justification on the analysis and conclusions of this statement, no rulemaking is proposed with its present issuance. The primary function of this statement is to establish the NRC staff view of the environmental impact of present transportation of radioactive material and of the projected impact in 1985. This statement provides an overview of a number of alternatives to present transportation requirements and of the changes in impact produced by those alternatives. While this overview serves to limit the number of alternatives worthy of further consideration, any detailed study of alternatives in support of rulemaking activities will be considered separately.

The alternatives considered in this statement are limited to those possible with existing transportation systems. While it might be possible to conceptualize new transportation systems that might reduce environmental impact, it is considered unlikely that any could be justified on a cost-benefit basis because of the present low risk.

5. The following Federal, State, and local agencies commented on the Draft Environmental Statement (NUREG-0034) made available in March 1976. Their comments, along with those from other parties, are in Appendix J.

a. Tennessee Valley Authority
b. Department of Health, Education, and Welfare
c. Environmental Protection Agency
d. Department of the Interior
e. Federal Energy Administration
f. Energy Research and Development Administration
g. Department of Transportation
h. State of New Mexico
i. State of New York
j. State of Georgia
k. City of New York

6. A draft of this Final Environmental Statement was made available to the public in February 1977 at the NRC Public Document Room in Washington, D.C., and at NRC's field offices in King of Prussia, Pennsylvania; Atlanta, Georgia; Glen Ellyn, Illinois; Arlington, Texas; and Walnut Creek, California. Public comments received on that draft are contained in Appendix K.

7. This Final Environmental Statement was made available to the public, to the Council on Environmental Quality, and to the above specified agencies in December 1977.

8. On the basis of the analysis and evaluation set forth in this statement and after weighing the small adverse environmental impact resulting from transportation of radioactive materials and the costs and benefits of the alternatives available for reducing or avoiding the adverse environmental effects, the staff concludes that:

a. Maximum radiation exposure of individuals from normal transportation is generally within recommended limits for members of the general public (Chapter 3, Section 3.5). There are transportation operations at a few locations where some transport workers receive radiation exposures in excess of the recommended limits established for members of the general public. In most cases, these operations employ radiation safety personnel to establish safe procedures and to train and monitor transport workers as though they were radiation workers.

b. The average radiation dose to the population at risk from normal transportation is a small fraction of the limits recommended for members of the general public from all sources of radiation other than natural and medical sources (Chapter 3, Section 3.5) and is a small fraction of natural background dose (Chapter 3, Section 3.3).

c. The radiological risk from accidents in transportation is small, amounting to about one-half percent of the normal transportation risk on an annual basis (Chapter 4, Section 4.9).

d. For the types and numbers of radioactive material shipments now being made or projected for 1985, there is no substantial difference in environmental impact from air transport as opposed to that of other transport modes (Chapter 4, Tables 4-15 and 4-17 and Appendix I, Table I-9).

e. Based on the above conclusions, the NRC staff has determined that the environmental impacts of normal transportation of radioactive material and the risks attendant to accidents involving radioactive material shipments are sufficiently small to allow continued shipments by all modes. Because transportation conducted under present regulations provides adequate safety to the public, the staff concludes that no immediate changes to the regulations are needed at this time. The staff has already upgraded its regulations on transportation quality assurance while this environmental statement was being prepared and has begun studies of transportation through urban areas and of emergency response to transportation accidents and incidents. In addition, the staff is continuing to study other aspects of transportation, such as the accident resistance of packages and the physical/chemical form of the radioactive contents, to maintain the present high level of safety and to determine the cost-effectiveness of changes that could further reduce transportation risk.

9. Based on considerations related to security and safeguards for strategic special nuclear materials (uranium enriched to 20% or more in the U-235 isotope, U-233, and plutonium), spent fuel, and other radioactive materials in transit, the staff concludes that:

a. Existing physical security requirements are adequate to protect at a minimum against theft or sabotage of significant quantities of strategic special nuclear materials in transit by a postulated threat consisting of an internal threat of one employee occupying any position and an external threat of a determined violent assault by several well-armed, well-trained persons who might possess inside knowledge or assistance.

b. The level of protection provided by these requirements reasonably ensures that transportation of strategic special nuclear material does not endanger the public health and safety or common defense and security. However, prudence dictates that safeguards policy be subject to close and continuing review. Thus, the NRC is conducting a public rulemaking proceeding to consider upgraded interim requirements and longer-term upgrading actions. The objective of the forthcoming rulemaking proceeding is to consider additional safeguards measures to counter the hypothetical threats of internal conspiracies among licensee employees and determined violent assaults that would be more severe than those postulated in evaluating the adequacy of current safeguards.

c. The use of the ERDA (now the Department of Energy (DOE)) transport system is not, at this time, considered to be necessary for the protection of significant quantities of privately owned strategic special nuclear material because the present level of transport protection provided by the licensed industry is considered to be comparable to that presently required by ERDA (DOE). Similarly, the use of Department of Defense escorts is not presently needed to protect domestic shipments against the postulated threat because the physical protection deemed necessary to defeat this threat can and is being provided by the private sector.

d. Shipments of radioactive materials not now covered by NRC physical protection requirements, such as spent fuel (containing fission products and irradiated special nuclear materials) and large-source nonfissile radioisotopes, do not constitute a threat to the public health and safety either because of their limited potential for misuse (due in part to the hazardous radiation levels that preclude direct handling) or because of the protection afforded by safety provisions, e.g., shipping containers.

Based on the above conclusions, the NRC staff has determined that the risks of successful theft of a significant quantity of strategic special nuclear material or sabotage of radioactive materials in transit resulting in a significant radiological release are sufficiently small to constitute no major adverse impact on the environment.

10. The validity of the risk assessment has been seriously challenged within the NRC staff. The challenge is with respect to the assessment of the overall level of accident risk and the relative levels of risk of the various types of shipments on which the total accident risk is based. The challenge results from the acknowledged conservative assumptions used in the accident assessment where valid data are not available to support more realistic values for certain parameters. Principal among these are package release fractions (Chapter 5, Table 5-8), particle size (Appendix A, Table A-7), fraction of released materials becoming airborne (Appendix A, Table A-7), and areas contained within dose isopleths (Chapter 5, Figure 5-7). These assumptions are not applied uniformly in the accident analysis over the various types of shipments (e.g., more data is available on plutonium shipment behavior in an accident situation than is available for polonium shipments; therefore, more conservative assumptions were applied to the polonium accident assessment). The resulting challenge is that the assessment is excessively conservative and shows the total accident risk to be greater than a more realistic assessment would show and that the values of risk assessed for different types of shipments may incorrectly show that certain types of shipments are more hazardous than others. However, since the conclusion drawn from the accident assessment is simply that the total accident risk is small compared to the normal transportation risk, the assessment is considered to support that limited conclusion and therefore to be adequate for that purpose, at this time. Nonetheless, further studies to develop additional data and refine the assessments are planned for the future; some are already underway in connection with the generic study on Transport of Radionuclides in Urban Environs and other detailed accident studies. Furthermore, rulemaking actions to reduce the risk in specific areas will not be taken until a more realistic risk assessment has been completed and the specific costs and the benefits have been evaluated.

NUREG/CR-2325
SAND81-0118

The Transportation of Radioactive Material (RAM) To and From U.S. Nuclear Power Plants

Draft Environmental Assessment

Manuscript Completed: September 1983
Date Published: December 1983

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NRC FIN A1087

ABSTRACT

This report analyzes the radiological consequences and risks of transporting radioactive material (RAM) to and from U.S. nuclear power plants. The analysis defines risk paths along which the RAM transport occurs. Shipment information and unit-values of radiological consequence and risk are developed for each risk path and these are combined to determine annual radiological consequence for normal (incident-free) transportation and annual radiological risk due to RAM transport accidents. The results of the analysis are presented for the years 1985 and 1990.

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Department of Energy
Washington, D.C. 20585

DEC 1 1983

Honorable J. James Exon
United States Senate
Washington, D.C. 20510

Dear Senator Exon:

We are pleased to provide, in the enclosures to this letter, our responses to the important questions you recently posed on the transportation of nuclear waste to storage or disposal facilities. Because the Nuclear Regulatory Commission has already replied to Questions 1, 2, and 3 of Study #2, we have only supplemented their response, in Enclosure 1, with information specific to the Department of Energy.

In addition to answers to your specific questions, we are enclosing two recent reports that address, in detail, many of the general concerns reflected in your questions regarding shipping risks and volumes and emergency responses to accidents. We also note that the Nebraska Energy Office has asked similar questions on routing, and we have enclosed our response to them for your information.

We very much appreciate your interest and trust that our reply will be adequate for your needs. Please feel free to contact us again should you have further questions or wish any clarification or further elaboration.

Sincerely,

R L Morgan
Robert L. Morgan
Acting Director
Office of Civilian Radioactive
Waste Management

4 Enclosures:
Answers to Specific Questions
International Conference on Radioactive Nuclear Waste Transportation to Potential Repository Sites, IAEA-CN-Y3/243, May 1983, T. I. McSweeney/R. W. Peterson
Guidance for Development of State and Local Radiological Emergency Response Plans and Preparedness, FEMA-REP-5, March 1983
Letter, Roy Garrison to Ms. Kandra Hahn, dated October 26, 1983

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Letter, Roy Garrison to Ms. Kandra Hahn, dated October 26, [illegible]

ANSWERS TO SPECIFIC QUESTIONS RAISED BY SENATOR J. JAMES EXON

Study No. 1

1. For the nine possible sites for the national high-level nuclear waste repository (one in Louisiana, two in Mississippi, one in Nevada, two in Texas, two in Utah, one in Washington), what are the likely transportation routes for highway shipments? For rail shipments? What volume can be anticipated for each route segment (e.g., in truckload per month)?

Answer - Department of Transportation (DOT) regulations, 49 CFR 177.825 (Docket HM-164), require that a carrier and any person operating a motor vehicle carrying a "highway route controlled quantity" of radioactive material use the interstate highway system except when moving from origin to interstate or interstate to destination. Other preferred routes may be designated by any state to replace or supplement the interstate highway system provided that the selection process (1) follows DOT Guidelines, (2) is appropriately documented, (3) includes consideration of neighboring state jurisdictions, and (4) does not have the effect of prohibiting travel or compromising overall safety. In addition, DOT requires the carrier to operate over preferred routes selected to minimize transit time and radiological risk. Within this framework, the actual truck routes to be used are selected by the carrier. In selecting routes from origin to interstate highways and interstates to destination, the carrier is required to minimize radiological risk. Routes used by a carrier are also influenced by season of the year, weather conditions, and construction delays.

There are no regulatory requirements governing routing of rail shipments. Rail shipment routes depend largely on the railroad to which the shipment is originally consigned and how that (and each successive) railroad handles interconnection to other railroads until the line serving the destination is reached.

If a state is on or near a straight line connecting a point of origin and a destination and has interstate highways or major railroad lines through the state, then it is likely that some shipments between those points will be on those transportation links. Regarding the use of the Oak Ridge National Laboratory computer program, we are enclosing a copy (enclosure 4) of our response to the State of Nebraska Energy Office on this matter.

With respect to estimates of volumes, we would note that shipments to repositories may include both rail and highway shipments. The split of shipments between these modes is conjectural at this time because it depends on many factors including repository design and location and available transportation services and economics at the turn of the century when operations are expected to begin. Since a rail shipment can include greater quantities of waste than a truck shipment, the number of shipments would be minimized if all transport is by rail and is maximized if all is by truck. The number of shipments in either mode will also vary depending on the waste type and treatment selected. One estimate of the annual number of repository spent fuel shipments expected early in the next century indicates about 500 if all are made by rail, and about 3200 if all are made by truck.

If the spent fuel rods are consolidated (close-packed) a 50 to 100 percent increase in fuel material per shipment and corresponding decrease in number of shipments might be attained.

In Nebraska, there is one East-West interstate highway (I-80) of the seven that cross the central plains and there are no North-South interstates. For rail there is a similar situation. There are four East-West main line rail routes which pass through Nebraska of the 18 to 20 which cross the central U.S., and there are no North-South main line routes.

2. Same questions for the possible interim storage sites in Idaho and Tennessee?

Answer - Since no nuclear utility has yet stated its intention to request Federal interim storage of spent fuel, and DOE has therefore not selected a site for such storage, routing and volumes of such shipments would be highly speculative. However, the same routing considerations given above would apply.

3. For each of these routes, how many shipments of high-level waste have occurred in the last five years?

Answer - No shipments of commercial solidified high-level waste have been made to date, since reprocessing facilities which produce this type of waste are not yet operating. Spent fuel shipping activity over the past six years is summarized in Table 1. Over the past 2 years, shipments of spent fuel have amounted to less than 300 shipments per year. Most shipments were between spent fuel pools belonging to single utilities; however, some interstate shipments have been made between reactors and the General Electric facility at Morris, Illinois and between reactors and DOE research facilities. Specific approved spent fuel routes and information on the origin, destination, and number of shipments are published periodically by the NRC in a public information circular, NUREG-0725.

Table 1 - SPENT-FUEL ASSEMBLY SHIPMENT SUMMARY

Shipment Year	Number of Assemblies shipped to a Reprocessor/AFR NFS	Number of Assemblies shipped to a Reprocessor/AFR GE-MSF	Number of Assemblies that were transshipped between reactors On-site	Number of Assemblies that were transshipped between reactors Off-site	Number of Assemblies shipped to a Research Facility	Total Number of Assemblies Shipped	Actual Number of Truck or Railcar Shipments
Before 1977	2465	690	197	-	15	3367	*
1977	-	485	323	42	2	852	*
1978	-	19	350	116	17	502	*
1979	-	8	71	109	16	204	*
1980	-	16	1	32	5	54	28
1981	-	-	220	27	4	251	244
1982	-	-	284	13	-	297	297
TOTAL ASSEMBLIES SHIPPED	2465	1218	1446	339	59	5527	*

*Number of shipments prior to 1980 are not available at this time.

Study No. 2

1. For the states (like Nebraska) which could become major corridors for high level nuclear waste shipments to the permanent repository or interim storage sites, is the Price-Anderson Federal nuclear insurance ceiling on liability at $570 million realistic?

    a. Compared to worst-case estimates for an urban area accident for short and long-term health effects and property damage?

    b. Same questions for rural accident?

    c. Is the data base of available studies adequate? What level of certainty is there for estimates of the likelihood of accidents?

2. Under what conditions are state and local governments reimbursed by the Federal Government under Price-Anderson for their expenditures for emergency services to protect their citizens during a radiation accident? Are states granted indemnification coverage under Price-Anderson?

3. What is the scope of Price-Anderson coverage and what are its omissions? Is there liability under these circumstances:

    a. A transportation accident occurs but there is no radiation release?

b. A criminal act of theft or sabotage occurs in transportation or after a successful diversion of nuclear material?

c. Radiation-induced health effects manifest themselves twenty years or more after an incident?

Answer - While questions 1 through 3 of Study 2 were answered in the October 11, 1983 letter to you from William J. Dircks, Executive Director for Operations, NRC, we would like to provide supplementary information pertinent to the Price-Anderson system as it applies to DOE.

As pointed out by Mr. Dircks, $570 million is presently available to pay public claims arising out of transportation accidents for nuclear waste shipments moving either to or from NRC-indemnified facilities and the liability limit is presently $500 million for shipment to or from DOE indemnified facilities. While we agree that either limit is sufficient to satisfy public liability claims should a severe accident or sabotage event occur, we have recommended, in our August 1982 Report to Congress on the Price-Anderson Act, that the DOE indemnification and limitation on liability be equivalent to that afforded by the commercial nuclear sector. This would, however, require an amendment to the Atomic Energy Act of 1954.

NRC has noted, in response to your question 3, that the Price-Anderson Act does not provide coverage for spent fuel at interim storage facilities (non-DOE storage facilities), spent fuel not in transit either to or from an indemnified nuclear facility, or acts of theft or sabotage if transportation has ended or is interrupted (i.e, diverted from its normal course of shipment).

With regard to Federal interim storage facilities, if that program is activated, we fully expect that the storage facilities will be covered by the Price-Anderson Act. We also anticipate that spent fuel moving to a repository pursuant to the Nuclear Waste Policy Act of 1982 will be covered by the Price-Anderson Act because the repositories will be indemnified facilities. On April 18, 1983, DOE published a final rule establishing a standard contract to be used by DOE in furnishing disposal services to owners or generators of spent nuclear fuel or high-level radioactive waste under the Nuclear Waste Policy Act of 1982 (NWPA). Article XIII of that standard contract states that, DOE will include in its contract(s) for the operation of any DOE disposal facility an indemnity agreement that would provide Price-Anderson coverage at any such facility.

In response to your question 3.a., the NRC explained that the primary and secondary insurance policies furnished by large power reactor licensees do not use the definitions contained in the Price-Anderson Act, which are included in section 11 of the Atomic Energy Act of 1954, as amended. Since the DOE does not require private insurance of its contractors, the definitions in the insurance policies referred to by NRC do not apply to DOE indemnified facilities. The definitions used in section 11 of the Atomic Energy Act of 1954, as amended, apply.

4. Unless a special agreement was reached between a State and the Department of Energy (such as that between New Mexico and DOE, December 1982, "Supplemental Stipulated Agreement Resolving Certain State Off-Site Concerns over WIPP"), or new Federal legislation was passed:

a. Can a state independently monitor the transportation of high level waste en route to an interim or permanent national repository? Conduct point-of-entry inspections of trucks? Review all information derived from DOE's health monitoring program concerning that State?

Answer - Yes, a State can independently monitor transportation of radioactive materials as it can with any other commodity, provided it is done consistent with DOT regulations. This could include, for example, reasonable arrangements for point-of-entry inspections of trucks if a State felt that such arrangements were necessary. Hopefully, each State will become convinced of DOE's and its private sector contractors' dedication and ability to provide safe shipments and will not feel that such inspections are necessary.

It should be noted that existing Federal regulations, namely 49 CFR 177, Appendix A, provide guidance to a State or local government on the relationship of State and local rules to Federal rules and how a State can exercise its authority over motor carriers under its own laws in a manner that the DOT considers to be consistent with its rules. The letter to you of October 31, 1983, from Mr. Howard Dugoff, Administrator, Research and Special Programs Administration, DOT, provides additional detail on the subject of consistency between Federal and State transportation regulations.

A State would be welcome to review all information related to any off-site health monitoring program sponsored by DOE in that State. All of DOE's civilian radioactive waste management programs are conducted openly.

b. Can a State require prior notification of all such shipments of waste?

Answer - As indicated in the letter to you of October 31, 1983 from Mr. Dugoff of DOT, current Federal regulations already require that shippers pre-notify the Governor or designated representative of shipments of spent fuel and high-level waste and pre-notification requirements imposed through State or local regulation would be inconsistent with the DOT regulation. The DOE Office of Civilian Radioactive Waste Management (OCRWM), which is responsible for transportation of commercial power reactor spent fuel and high-level waste under the Nuclear Waste Policy Act, intends to comply with Federal regulations governing prior notifications that are in effect at the time of such shipments.

We also note that, pursuant to section 117(c) of the NWPA, the Secretary of Energy is required to seek to enter into a consultation and cooperation agreement with a State that has a site that was approved for site characterization or, if requested by the State, with a State that has a potentially acceptable site for a repository. Any such agreement is required to include procedures under which the Secretary shall notify such State prior to the transportation of any high-level radioactive waste and spent nuclear fuel into such State for disposal at the repository.

c. Will the Federal Government supply funds to upgrade highways or rails to make them safer for high-level nuclear waste transportation?

Answer - First, we would make clear that no waste would be transported over highways or railroads known to be unsafe. Therefore, an inadequate route would have to be upgraded or else by-passed. Considering that shipments of high level waste do not pose highway or railroad track-bed requirements that differ from those posed by other commodities, any of the primary transport routes (i.e., interstate highways or main line railroads) maintained suitably for general use, including hazardous material shipments, will be suitable for nuclear waste shipments.

d. Will DOE respond to transportation accidents?

Answer - Yes, DOE has responded in the past and will continue to respond to transportation accidents. DOE is a participant in a national radiological assistance plan for dealing with a real or suspected radioactive material release from a shipment while in transit. Under this plan, DOE will make available from its resources such radiological advice and assistance as is requested and appropriate to protect the public health and safety and to cope with radiological hazards. DOE personnel will respond to requests from NRC licensees, Federal, State, and local authorities and private persons or companies, including carriers. Assistance can be obtained from any one of eight DOE regional areas or jurisdictions shown in Enclosure 3, Appendix C.

e. Will DOE pay all cleanup costs for any transportation accident?

Answer - Since the waste and spent fuel shipped under the NWPA will be owned by DOE and shipped under DOE's general direction and guidance, DOE will assume initial responsibility for any cleanup that may be necessary in the unlikely event of a radiological hazard resulting from a transportation accident involving such shipments. Of course, the assumption by DOE of such initial responsibility would not relieve other persons of their responsibilities regarding safe transport and clean-up of such materials.

f. Will DOE provide technical assistance, funding, and equipment to aid state emergency response preparedness?

Answer - In host States for DOE facilities, written agreements will be negotiated which can address assistance and funding for emergency response preparations. In other States, limited funding, or assistance in lieu of funding (e.g., training courses, equipment, etc.), may be available through Federal Emergency Management Agency (FEMA) or other Federal agencies. More information on Federal planning and coordination on this topic is available in Enclosure 3.

Examples of the type of assistance already provided by the Federal government are the Emergency Response Workshops sponsored by DOE at various locations in the country each year as part of its compliance training program. Responses from participants in these workshops indicate that they are very informative and beneficial, and we anticipate that special workshops will continue to be provided upon request. See also our response to Question 4(h).

g. Will the Federal Government pay for long-and short-term health studies of communities on the route, rail workers, truck drivers or other directly affected groups if, in the opinion of the State, a significant level of radioactive material has been released into the biosphere in connection with transportation to a Federal high-level waste storage site?

Answer - Precedents have been established for Federal studies of the after-effects of accidents. DOE cannot commit at this time, however, to initiating major studies based solely on the opinion of need by a State. Provisions for Federal and State agreement on the need for such studies and for actually conducting the studies can be made when the time comes to begin working with specific States and the need can be justified.

h. Are agreements provided for in the National Waste Policy Act of 1982 between a State and DOE about questions of State liability arising from accidents, necessary road upgrading, ongoing emergency preparedness and emergency response, monitoring of transportation of spent fuel through the State and baseline health studies of communities exposed to radiation, etc. [Section 117 (c) (5)], limited to States which contain a repository within their borders or can any state negotiate such an agreement under the Act?

Answer - Section 117(c) of the Nuclear Waste Policy Act of 1982 provides that the Secretary of Energy shall seek to enter into a binding written agreement with an affected State or Indian tribe not later than 60 days after either --

> "...(1) the approval of a site for site characterization for such a repository under section 112(c), or (2) the written request of the State or Indian tribe in any affected State notified under section 116(a) to the Secretary, whichever, first occurs..."

Hence, a State that has been notified that it has a potentially acceptable site for a repository pursuant to section 116(a) may request the Secretary of Energy to enter into an agreement under section 117(c) of the Act, and the Secretary is directed to enter into such an agreement with a State wherein a site has been approved for site characterization. The actual existence of a repository is not necessary to trigger application of section 117(c) provisions.

The Act does not provide for agreements under section 117(c) for States other than those specifically notified pursuant to sections 112(c) or 116(a). However, in keeping with the spirit of the Act, DOE plans to work with groups of States surrounding potential host States to resolve their transportation related concerns. It would be desirable to interact with these States on a regional basis, but written agreements with individual states to document mutual understanding on specific concerns could be negotiated, if necessary.

5. What would be the State and national totals of costs if each State that could have a significant traffic in high-level waste to interim storage or the permanent repository were to negotiate an agreement equivalent to New Mexico's for the WIPP for insurance, route maintenance, emergency services, etc?

Answer - The Waste Isolation Pilot Plant (WIPP) agreement is of limited benefit in trying to project the costs of potential future agreements between DOE and States through which shipments of a major portion of the wastes might pass. As the host-state for the WIPP site, New Mexico can expect all shipments in that State to converge on its secondary highways and railroads. Such shipments could add significantly to the nature and volume of traffic on the final rail and secondary highway links close to the WIPP site, whereas they would not add significantly to the volume of traffic on primary roads and interstate routes to and through New Mexico enroute to WIPP. Thus we would expect DOE agreements with non-host States to be substantially different than our agreements with States that are hosting a major waste facility. With this perspective, additional information on the insurance, route maintenance and emergency service costs resulting from the WIPP agreement are given below.

On the insurance matter, the State of New Mexico felt that the $500 million coverage provided by the Price-Anderson Act might not be sufficient and asked DOE to consider supplementing this to cover an additional $60 million of possible damages. DOE has explpred the possibility of securing such extra coverage from private insurers and found that it could probably be provided for a cost on the order of $125,000 per year. However, final arrangements for such coverage have not yet been made; accordingly, actual cost and availability are not assured.

No DOE funds are being provided for route maintenance. In this case, the State of New Mexico applied for additional Federal funding, through the New Mexico Congressional Delegation, on the grounds that certain State roads needed to be upgraded to better serve the WIPP site. DOE supported this New Mexico request and eventually Congress appropriated limited funding for planning and preliminary engineering.

Federal aid for State emergency response preparedness was discussed in our response to question 4.f. In the case of New Mexico and the WIPP project, DOE agreed to furnish some assistance through training and instrumentation, but not through direct funding.

6. Will any Federal agency monitor radiation exposure to rail workers, truckers, and communities on major routes under routine conditions? How thorough is the program?

Answer - While both NRC and DOT have the authority and responsibility to do such monitoring, no such programs have been found necessary. On a few occasions, both DOT and NRC personnel have responded to specific requests from State officials to observe or monitor transportation operations in certain areas when there was cause for concern over adequate containers, radiation exposure or contamination. However, the key control over exposure to transport workers and the public is exercised at the point of origin of a shipment through proper preparation and both physical inspection and radiological survey to ensure that the shipment is in compliance with all applicable Federal regulations and other requirements prior to release of the shipment to the carrier for transport.

Department of Energy
Washington, D.C. 20545

OCT 26 1983

Ms. Kandra Hahn, Director
Nebraska Energy Office
P.O. Box 95085
Lincoln, Nebraska 68509-5085

Dear Ms. Hahn:

This will acknowledge receipt of your letter dated September 8, 1983, expressing your desire for certain spent nuclear fuel routing data from our contractor, the Oak Ridge National Laboratory. The routing information which you have requested is in a generic radioactive materials routing model developed primarily for assessing transportation risks. The routes provided for the analysis of risk are selected from historical routing data and may or may not reflect the exact route that future shipments would actually travel.

Since selection of the first Federal repository has not yet been made and only preliminary estimates of utility shipments of spent fuel for 1998 are currently available, projections of probable shipment routes through Nebraska would be premature at this time. In addition to being highly conjectural, our Oak Ridge contractor has indicated that such a study at this stage to try to determine probable shipment routes through Nebraska in 1998 would be costly and no funds are currently budgeted by this Department for such an undertaking.

All shipments of spent nuclear fuel by commercial carriers are currently required to be routed in accordance with the Department of Transportation Regulation, Highway Routing of Radioactive Materials (HM-164). This Regulation designates the interstate highway system as the basic Federal framework for providing safe and efficient routes for such radioactive shipments; however, it also provides the states with the option of designating alternate proposed routes through their jurisdictions.

Should you have any further questions on this or any other transportation related matters, please do not hesitate to contact me.

Sincerely,

Roy F. Garrison, Manager
Transportation Operations
and Traffic

DATED OCT 31, 1983

The Honorable J. James Exon
United States Senate
Washington, D.C. 20510

Dear Senator Exon:

Thank you for your recent letter concerning issues relating to high-level nuclear waste. We understand that the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE) are also responding to the specific questions you have posed. In most cases, those agencies are responsible for, and can provide you with, appropriate responses. Since we have learned that those agencies will be responding to your request directly, it is not necessary for us to await their input, as was suggested in my interim response. However, I would like to respond generally from the perspective of the Department of Transportation to the issues raised in Study #1 and specifically to two questions posed under Study #2.

Answering the questions posed under Study #1 would require in-depth analysis of current and projected transportation factors involving 11 possible shipping destination and origin points all across the nation. The Nuclear Waste Policy Act of 1982 requires the performance of such analyses, but only for each of that subset of sites which is approved by the President for characterization as candidate sites for permanent repositories. Once the site characterization process begins, we expect to work closely with the DOE in analyzing those site-specific transportation factors of concern to Study #1. Therefore, please be assured that the issues raised in Study #1 will receive thorough and comprehensive examination before any candidate site is selected for a permanent or interim repository.

Under Study #2, question 4.a. asks whether a state can independently monitor the transportation of high-level waste enroute to its destination, and if point-of-entry truck inspections can be conducted. If a state is conducting monitoring and inspections to assure the compliance of shipments with state requirements which are consistent with the Federal Hazardous Materials Regulations (see Title 49, Code of Federal Regulations (CFR), Parts 170-179), then the answer to both aspects of question 4.a. is yes. However, particularly in the area of routing (and related areas such as time-of-day restrictions, and prenotification - see below), inconsistent State and local transportation requirements can operate to frustrate the Department's ability to assure the execution of its Congressional mandate to provide a uniform national regulatory scheme for all hazardous materials transportation.

To foster a balance between the goal of national regulatory uniformity and the legitimate safety interests of State and local jurisdictions, Congress provided in the Hazardous Materials Transportation Act (HMTA) (49 U.S.C. 1801 et seq.) the mechanism for determining inconsistency, the declaration of preemption of inconsistent State and local requirements, and the redemption of those requirements through a waiver of preemption. This statutory and procedural framework was recently upheld in the United States Court of Appeals for the Second Circuit in a case involving the transportation of high-level radioactive waste (City of New York, et al., v. United States Department of Transportation, et al., Docket Nos. 82-6094, 82-6200; August 10, 1983).

Question 4.b. asks whether a state can require prenotification of all such shipments of waste. The Department addressed this issue in the advisory opinion which accompanied its rulemaking on highway routing of radioactive materials and was retained as Appendix A to 49 CFR, Part 177. Appendix A states, inter alia, that prenotification requirements imposed through State or local regulation would be inconsistent with the Hazardous Materials Regulations. This opinion is based on the fact that the Federal regulations already provide for advance notification of the states. (See 49 CFR 173.22(c).) Therefore, State or local prenotification requirements would be duplicative and contrary to the Congressional intent in enacting the HMTA ". . . to preclude a multiplicity of State and local regulations and the potential for varying as well as conflicting regulations in the area of hazardous materials transportation." (S. Rep. No. 1192, 93rd Cong., 2nd Sess. 37 1974). I should note that the State of Ohio is currently challenging the validity of Appendix A in the United States District Court for the Northern District of Ohio (State of Ohio v. United States Department of Transportation, Case No. C81-1394). We will continue to support the Justice Department in its defense to the suit.

I hope that the information I have provided gives you an adequate basis for understanding the relevance of the Department's programs to the issues you have raised. If you would like further information, please let me know.

Sincerely,

Howard Dugoff

RRawl:DMT-223:kps:62311:10/20/83
Rev/Ret per DCC-1: 10/26/83
cc: DMT-/1/20/22/223
DRP-1/FHWA/FRA/P/C/I/DMA-16/

FILE#: ______________

OSP- AR5307

OCT 11 1983

The Honorable J. James Exon
United States Senate
Washington, DC 20510

Dear Senator Exon:

We are pleased to provide in reply to your August 31, 1983 letter to the Nuclear Regulatory Commission, the enclosed responses to Questions 1, 2 and 3 of Study #2 on coverage of the Price-Anderson Act for transportation incidents involving high level nuclear waste.

Sincerely,

(Signed) William J. Dircks

William J. Dircks
Executive Director for Operations

Enclosure:
As stated

Distribution: Indemnity Q&As
OSP:SLR R/F
Dir. R/F
G. W. Kerr
J. Saltzman
D. Nash
I. Dinitz R/F
I. Dinitz
ELD
NMSS (FCTC)
RES (TMRB)
EDO - 13552
SECY - 83-2256
OCA
EDO RF
H. Denton
L. Underwood

(Note: Pages 1 & 2 revised in Office of the EDO)

EDO

OSP:SLR	OSP:SLR	OSP:SLR	ELD	NMSS(FCTC)	RES(TMRB)	OSP
IDinitz:cb	DNash	JSaltzman	[illegible]	CMacDonald	[illegible]	GWKerr
9/28/83	9/28/83	9/28/83	[illegible]	[illegible]	[illegible]	9/3

1. Q. For the states (like Nebraska) which could become major corridors for high level nuclear waste shipments to the permanent repository or interim storage sites, is the Price-Anderson federal nuclear insurance ceiling on liability at \$570 million realistic?

   a. Compared to worst-case estimates for an urban area accident for short- and long-term health effects and property damage?

   b. Same questions for a rural accident?

   c. Is the data base of available studies adequate? What level of certainty is there for estimates of the likelihood of accidents?

A. Before discussing your specific question, we should indicate that while \$570 million is presently available to pay third party public claims arising out of transportation accidents for nuclear waste shipments moving either to or from NRC-indemnified facilities, the liability limit is presently \$500 million for shipments moving to or from Department of Energy contractor-indemnified facilities. Either limit, however, is considered sufficient to satisfy public liability claims should a severe transportation accident or a sabotage event occur, both of which are considered highly unlikely.

Studies have evaluated the health and economic impacts of significant radioactive material releases in a variety of population zones varying from rural to high population density areas, such as New York City. These studies are "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes," NUREG-0170, December 1977 and "Transportation of Radionuclides in Urban Environs: Draft Environmental Assessment," NUREG/CR-0743, July 1980 (copies enclosed). Several tests have measured release fractions under potential field conditions. Results of the tests and studies, coupled with recent experimental information on explosive interactions with a spent fuel assembly, indicate the estimated health consequences from highly unlikely sabotage or severe accident events to be as follows:

(1) In a highly urbanized area, no early fatalities from radiation exposure, less than four latent cancer fatalities from the reference sabotage event and one latent cancer from the severe accident scenario, and

(2) in rural areas, no radiation related fatalities (assuming the number of expected fatalities is related directly to population densities).

The economic impacts, estimated in NUREG-0170, resulting from accidents ranged as high as \$400 million for events in extreme density urban areas to \$1-10 million in rural and farmland areas. ? For sabotage events, the impacts could be an order of magnitude less than the above values.

By contrast, NUREG/CR-0743 has projected economic impacts as high as $2 billion in high population density-urban areas. The recently measured radiological source terms from explosive interactions with spent fuel indicate that the assumptions regarding material release, which have been made in the above evaluations, may be highly conservative. In addition, the high economic cost is associated with highly speculative costs assumed for loss of the use of land (~95% of total costs). The evaluations, especially the economic impacts, are very uncertain since there is no direct experience with an accident of this nature. The results are only attainable through a series of assumptions or significant extrapolations from applicable smaller scale events.

As is apparent, the available data used in making health and economic consequence estimates is limited due to the nature of the rare events being analyzed. For example, the occurrence frequency of the severe accident event assessed in NUREG-0170 was estimated at one event per 100 billion road miles traveled. There is no sound basis for an estimate of occurrence frequency for the sabotage event; however, the explosive threats considered are far more severe than those experienced against other targets. The limit of liability in the Price-Anderson Act is believed to be "realistic" because it is sufficient to cover all but extremely rare severe transportation accidents.

2. Q. Under what conditions are state and local governments reimbursed by the federal government under Price-Anderson for their expenditures for emergency services to protect their citizens during a radiation accident? Are states granted indemnification coverage under Price-Anderson?

A. State and other local governmental authorities are "persons" under the definitions in Section 11 of the Atomic Energy Act of 1954, as amended. As such they can file claims under Price-Anderson with the insurance pools providing nuclear liability insurance to NRC licensees to collect for damages arising out of a nuclear incident. If the pools do not pay the claims on the basis of their normal claims handling procedures, the state could file suit and a court would have to determine legal liability arising out of the accident and the extent of claims to be paid. The statutory provisions, as supported by the legislative history of the Price-Anderson Act, would seem to support the position that claims submitted by states for offsite property damage would more likely be paid than claims for emergency services. These latter claims might be construed by a court to be part of the normal governmental expenses that states incur.

Following the Three Mile Island accident, the Commonwealth of Pennsylvania and a number of localities filed suit in the U.S. District Court for the Middle District of Pennsylvania (Civil Action Nos. 81-0419, 81-0437) to recover, among other things, the cost of overtime and operational expenses incurred in responding to the TMI accident. In an August 17, 1982 decision, the District Court stated that since the legislative history of the Price-Anderson Act did not discuss the recovery of expenses by a state, the Act clearly stated the Congressional intent of not interfering with state law. The Court further pointed out that whenever disasters occur, local government has traditionally borne the resulting costs and any decision to change the law should be made by the legislature and not the courts.

3. Q. What is the scope of Price-Anderson coverage and what are its omissions? Is there liability under these circumstances?

a. A transportation accident occurs but there is no radiation release?

b. A criminal act of theft or sabotage occurs in transportation or after a successful diversion of nuclear material?

c. Radiation-induced health effects manifest themselves twenty years or more after an incident?

A. Under the Price-Anderson Act, there is a system of funds presently totaling $570 million to pay public liability claims for personal injury and property damage resulting from a nuclear incident. The Act requires licensees of commercial nuclear plants having a rated capacity of 100,000 electrical kilowatts or more to provide proof to the NRC that they have financial protection in the form of private nuclear liability insurance, or in some other form approved by the Commission, in an amount equal to the maximum amount of liability insurance available at reasonable cost and on reasonable terms from private sources. That financial protection, $570 million, consists of a primary layer of nuclear liability insurance of $160 million and a secondary retrospective premium insurance layer. In the event of a nuclear incident causing damages exceeding $160 million each commercial nuclear power plant licensee would be assessed a prorated share of damages in excess of the primary insurance layer up to $5 million per reactor per incident. With 82 commercial reactors currently under this system, the secondary layer totals $410 million. In November 1982, when the two insurance layers reached $560 million, government indemnity was eliminated. The present $570 million limit will continue to increase in increments of $5 million for each new commercial reactor licensed to operate. Modifications and extension of the Price-Anderson Act, which expires in August 1987, will be considered by the Congress in the forthcoming months. While $570 million represents the current liability limit, this figure may be altered after further consideration.

Both the private nuclear liability insurance policies and the indemnity agreement that the Commission enters into with licensees are "omnibus" in nature. That is, in recognition of the requirement of the Act to provide coverage for the licensee and other "persons indemnified," the policies cover not only the named policy holder (the utility) but also persons who may be liable for the accident.

The scope of Price-Anderson coverage includes any incident (including theft or sabotage) in the course of transportation of nuclear fuel to the site, in the storage of nuclear fuel at the site, the operation of the reactor including discharges of radioactive effluents, in the storage of nuclear waste at the reactor site, and in the transportation of radioactive material from the reactor.

The Act does not provide coverage for spent fuel stored at interim fuel storage facilities, spent fuel not in transit either to or from an indemnified nuclear facility, acts of theft or sabotage occurring after transportation has ended, or to materials licensees other than those operating production or utilization facilities. The Commission has the discretionary authority to extend Price-Anderson coverage to materials licensees which it has done for certain fuel fabricators possessing specified quantities of plutonium.

a. The term "public liability" defined in section 11w. of the Atomic Energy Act of 1954, as amended, states in part ". . . any legal liability arising out of or resulting from a nuclear incident. . ." Further, the term "nuclear incident" is defined in section 11q. as "any occurrence, including an extraordinary nuclear occurrence, within the United States causing, within or outside the United States, bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear, or byproduct material. . ." Therefore, if no radiation were released in an accident, the incident would not be a "nuclear incident," as defined in the Act. However, the primary and secondary insurance policies furnished by large power reactor licensees as evidence of financial protection do not use the definitions contained in Section 11 but a different set of definitions. The policies will pay claims for "bodily injury" and "property damage" arising out of the "nuclear energy hazard." The term "property damage" is defined as "physical injury to or destruction or radioactive contamination of property, and loss of use of property so injured, destroyed or contaminated, and loss of use of property while evacuated or withdrawn from use because possibly so contaminated or because of imminent danger of such contamination." (Emphasis added.) Therefore, in the absence of a radiation release, coverage may exist if the "imminent danger" provision had applicability.

b. As previously stated, Price-Anderson coverage applies to any incident (including theft or sabotage) in the course of transportation of nuclear fuel to the site and in the transportation of radioactive material from the reactor. If an act of theft or sabotage occurs after transportation has ended or if transportation has been interrupted, the Act would not provide coverage. For your information, the Commission in 1975, studied the question of Price-Anderson coverage as it related to sabotage and theft and the study entitled "Nuclear Regulatory Commission Staff Study Concerning Financial Protection Against Potential Harm Caused By Sabotage or Theft of Nuclear Materials" (copy enclosed) was sent to Senator John Pastore in June 1975.

c. Since the Price-Anderson Act establishes a twenty-year statute of limitations for injuries arising out of a nuclear incident if the incident is declared by the Commission to be an "extraordinary nuclear occurrence," radiation induced health effects manifested more than twenty years after the occurrence would not be compensable under the Act. However, the twenty-year statute would supersede any shorter state statutes of limitation.

ENCLOSURES TO QUESTIONS AND ANSWERS

1. Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes, NUREG-0170

2. Transportation of Radionuclides in Urban Environs: Draft Environmental Assessment, NUREG/CR-0743

3. Nuclear Regulatory Commission Staff Study Concerning Financial Protection Against Potential Harm Caused by Sabotage or Theft of Nuclear Materials

SAND82-2778

TTC-0403

TRANSPORTING SPENT REACTOR FUEL ALLEGATIONS & RESPONSES

R. M. Jefferson
Manager, Nuclear Materials Transportation Technology Department
TRANSPORTATION TECHNOLOGY CENTER

Introduction

In January of 1982 the Council on Economic Priorities devoted their entire monthly newsletter to present allegations that the transportation of spent nuclear fuel as currently conducted in this country is unsafe. The charges made in those articles were stated to be based on the results of a study to be released in the spring on 1982. A draft copy of that study was recently acquired by the Transportation Technology Center and reviewed. This paper is an analysis of that report prepared at the request of the Department of Energy (DOE).

General Comments

The CEP report is so filled with allegations supported by inuendo, incorrect or substantially misleading information that point-by-point refutation would be unnecessarily tedious. Further, in the draft in hand, internal inconsistencies further increase the difficulty of review.

The DOE has conducted research in the area of transportation of spent fuel and other radioactive materials since the early 1970's. In 1978 various transportation research activities were consolidated with the formation of the Transportation Technology Center at Sandia National Laboratories. It is from this extensive background of information that this reply is composed. It must be recognized that simple, one sentence allegations concerning complex issues require lengthy rebuttals. The following material is an attempt to address the principal allegations of the CEP in the form of a brief overview of the facts as they apply to each issue. The report differs only slightly from the aforementioned newsletter[1] in the allegations it makes.

Allegation 1

The regulations covering the shipping of spent fuel are inadequate to provide the necessary protection to the public. This inadequacy is partially the result of a lack of applicable design and operations standards.

Response

The regulations covering the shipment of spent fuel in the U.S. were first established in 1948 by the National Academy of Sciences and were later adopted by the International Atomic Energy Agency. The U.S. regulations are updated on a regular interval (most recently in 1963). Because the initial requirements were drawn up with a combination of technical expertise and conservatism, few changes have been made since their initial drafting in spite of exhaustive reexamination.

By far the major confusion in this area arises from the fact that the U.S. regulations are based on engineering criteria and are not intended to simulate actual accidents. While it is virtually impossible to accurately simulate the multitude of possible events in every real accident, it is relatively easy to establish engineering criteria which will produce damage equivalent to that experienced in real accidents. Furthermore, the criteria require the sequential application of these engineering conditions, thus adding additional severity and conservatism to the requirements. The engineering criteria which form the basis for proper design have proven to be sufficiently severe to encompass all but the most extremely severe accident situations. A brief review of two of these engineering test conditions will serve to illustrate this point.

Impact--The regulations require spent fuel shipping casks to survive a 30-foot drop onto an unyielding surface. This unyielding surface not only is non-existent in the natural and man made structures around us, but it is even extremely difficult to achieve for test purposes. Tests have shown that the damage created by realistic hard targets such as rock outcroppings or bridge abutments, would require velocities on the order of 70-80 miles per hour in order to be equivalent to the 30-foot drop (30 mph) on the unyielding target. For softer targets such as concrete pavements, retaining walls, other vehicles, earth embankments and the like, the velocity required to produce equivalent damage exceeds 200 miles per hour. In spite of research supporting these findings, the CEP report leans heavily on a study[2] involving the collision of a theoretical spent fuel cask with an absolutely unyielding 1 1/2 meter diameter bridge support (it is impossible to construct this target). In this study the cask impacts the column sideways at its exact center of gravity so that none of the collision energy is expended in rotating the cask. Under these "theoretical" conditions, it was calculated that a large hollow lead cylinder would "fail" when impacting at a velocity of 12 1/2 miles per hour. Failure was defined as deformation of the cask to the point where wall thickness was reduced to half of its original thickness. This highly stylized analysis has little application to spent fuel casks which are constructed of heavy stainless steel concentric inside and outside walls with lead between the two shells.

Fire--The important consideration in determining the thermal effect upon a spent fuel shipping cask is the product of time, temperature, and surface exposed. Regulations require exposure to a temperature of 1475°F for 30 minutes over the entire surface of the cask. Again, this is an engineering condition which encompasses fires which are burning at higher temperatures for longer periods of time. In order to have the entire surface of the cask exposed to the fire, the cask would have to be suspended approximately four feet above the surface of the fuel. This total surface exposure requirement encompasses such events as torches which are directed at one portion of the cask. Thermal modeling and tests have confirmed that these torches are much less severe than the regulatory requirement even when the torch temperatures approach 2000-2200^{O}F. Since under most accident conditions the heavy cask would end up on the bottom of the debris, the actual accident conditions cannot duplicate the total surface exposure. Further, in spite of the fact that some materials burn at higher temperatures, they do not radiate at their adiabatic (theoretical) temperatures. Further, if the fire is not sufficiently thick, the cask can radiate heat back through the flames, thus reducing the severity of the environment.

Likewise some fires experienced in actual accident conditions do burn for times exceeding the regulatory 30-minute fire, but fires which burn for long periods of time either burn at lower temperatures (consuming slower-burning materials such as wood) or are concentrated over small areas thus being insufficiently large to envelop the entire cask. It is extremely difficult to conceive of an accident sequence which would produce a thermal environment exceeding that called for in the regulations. For example, the recent Caldecott Tunnel fire in California (a very unusual fire situation) appears to have approximately matched the thermal input required in the current regulations.

Allegation 2

Transportation accident probabilities utilized by the Nuclear Regulatory Commission (NRC) and DOT are underestimated.

Response

Since 1954 Sandia National Laboratories has been collecting statistics on the frequency and severity of accidents involving road, rail, and air transport modes. Over that period of time a number of changes in our transportation network have occurred. For instance, highway speed limits went from 60 to 70 and finally to 55 miles per hour. Evaluations of these data as they respond to system changes such as these develop confidence in the validity of this collection. Since 1971, similar data have been kept on hazardous materials, out of which a subset on radioactive materials has been compiled. In efforts to validate this subset, Sandia has utilized not only the DOT reporting system, but has augmented that with NRC reports, newspaper stories and inquiries to state department of transportation, police departments, and highway department personnel. On the basis of this extensive validation effort we believe that the data base on radioactive materials accidents is indeed comprehensive and accurate. Studies of shipping volumes involved, coupled with accident data, show that the transport of radioactive materials has a lower frequency of accidents and incidents than do other hazardous materials. Of particular note is the fact that in the 10-year period following 1971, a total of 1114 packages of radioactive materials were actually involved in vehicular accidents. Of these, 48 were packages of the type used to ship spent fuel (only 2 of these accidents actually involved spent fuel). None of these accident-resistant packages released any radioactive material. Of the remaining 1066 packages of radioactive material involved in accidents during that 10-year period (none of which were designed to survive accident environments), only 58 or about 5.4% sustained enough damage to cause them to release radioactive materials. Of all the hazardous materials being transported in our society, only radioactive shipments such as spent fuel are required to be packaged in accident-resistant containers. The result of this requirement has been, as the data indicate, a very high level of public safety.

Allegation 3

The response of spent fuel shipping casks to the insults suffered under actual accident conditions is not well understood. Minor accidents could cause pressure relief valves to fail, thus releasing radioactive steam. The testing conducted to date does not cover the full range of expected environments and was performed using obsolete casks.

Response

A fundamental precept in the practice of engineering is that products can be designed using widely accepted analytical techniques and materials properties data to produce structures which behave as predicted. It is this approach which enables modern society to build such complex structures as high rise buildings, bridges, dams and pipelines. In keeping with that precept of engineering, the DOE and Sandia have conducted a number of full scale tests supported by an even larger number of subsystem and component experiments. To examine the effects of actual accidents on large spent fuel shipping casks and the ability to analytically model the pertinent phenomena, these full scale tests involved high speed collisions of truck mounted spent fuel shipping casks against massive targets exceeding anything available for such impacts along our nation's highways. Two additional tests involved a simulated grade crossing accident where a locomotive impacted a spent fuel cask and a severe rail crash followed by a fire involving a shipping cask in its railcar.

The objective of these tests was to verify that the analytical methods used to design and evaluate shipping casks were accurate. Even though the casks used in these tests had been retired from service because they no longer could meet the current quality assurance requirements, their general design is quite similar to those currently in use. Therefore, the validation of analytical techniques can be carried out equally as well on these as any other cask. The tests proved the accuracy of the analytical models used to predict such behavior, thus a high level of confidence can be placed in the ability of shipping casks to survive even the most severe accidents.

The pressure relief valve issue is significant because of the confusion it introduces into the discussions. Most shipping casks currently in use in this country were originally designed to use liquid coolants (water). However, due to the fact that the only fuel being shipped or planned to be shipped in the foreseeable future has been out of the reactor a minimum of five years, it is no longer necessary to use the liquid coolant and therefore, <u>all</u> shipments being conducted in the United States at the present time are being made in dry casks which do not utilize pressure relief valves. Thus, the whole discussion of relief valves and losses of liquid coolant and pressurization of casks by boiling the coolant and steam entrained contaminants being released from the cask are all imaginary situations under the present circumstances.

Allegation 4

The consequences of accidents involving spent fuel shipments are substantially underestimated.

Response

The CEP, in its discussion of accidents involving spent fuel shipments, consistently uses data derived as the result of studies of sabotage. It is generally conceded that the worst credible "accident" that could possibly be encountered is one involving a deliberate attempt to open the cask and release its radioactive contents. In the studies sited by the CEP, extremely conservative estimates were made on the amount of material that might be removed from the cask in this way. Subsequent experiments utilizing explosive attacks on actual shipping casks (contained in chambers which allowed complete collection of all released materials) indicate that these earlier estimates were indeed very conservative. Based on the data from these tests, it has been concluded that, were a successful terrorist attack to be carried out in a metropolitan area such as Manhatten, the subsequent release of radioactive materials would not cause any early fatalities and could possibly lead to a maximum of one cancer fatality years later in a population where the normal incidence of cancer would produce about 250,000 deaths. These estimates are based upon computer models (CRAC and METRAN) designed specifically for examining the consequences of radioactive release in urban areas. METRAN includes the unique characteristics of large cities such as canyon winds and extensive vertical surfaces. These models are intentionally conservative and generally overestimate the consequences of accidents. As additional information becomes available as the result of tests and validation procedures, the models will continue to be updated. The CRAC model was updated approximately 1-1/2 years ago to resolve most of the limitations cited by CEP.

All of the CEP claims concerning underestimation of the consequences of an accident involving a spent fuel cask are based on the amount of material released from the cask. While CEP insists that the amount of radioactivity that could be released is far greater than the best scientific estimates to date, such claims are unsupported by either experience or experiments. Spent fuel is a solid ceramic-like material consisting primarily of uranium oxide. Most of the radioactive materials are also solids contained as an integral part of this ceramic material. In the original assessments of accidents, it was assumed that none of the solid but all of the volatile radioactive materials and all of the inert radioactive gases contained in the fuel would escape in a very severe accident. Analyses and tests have shown that this is a gross overestimation. Unlike Three Mile Island where the fuel melted, there is no mechanism available for the release of large portions of these materials. Thus, allegations of large releases and comparisons of spent fuel shipping accidents to reactor accidents and atomic explosions are extremely misleading.

Allegation 5

The quality assurance on spent fuel shipping casks is inadequate.

Response

As with most activities in a free society, the quality assurance function is provided by the manufacturer and the owner with the regulatory bodies providing review of the documentation produced. Thus, it is unnecessary for the regulatory agencies to provide direct quality assurance functions. The fact that the quality assurance program works is borne out by those few occasions cited by CEP where the industry has revealed to NRC those variations which occurred. In all the cases cited, a very conservative approach was taken to assure cask safety and in every case the variation was resolved and the casks returned to service.

Allegation 6

Emergency response capabilities at the local level are non existent or inadequate.

Response

In its analysis of emergency response the CEP views the emergency response capabilities of localities from a perspective inconsistent with that which actually takes place. There are basically three phases to emergency response and three different response groups are involved. The initial phase which must be handled at the local level has been found to be quite adequate. While local officials and response personnel have not been trained in the fine points of radiation safety, they have available response techniques and decision bases which are quite adequate to handle the initial situation. The second phase involves the use of experts who are available throughout the country on a rapid response basis. The existence and location of these secondary response personnel are known by the states and by private emergency information systems such as CHEMTREK. The third and final phase of accident response is handled by commercial firms with great expertise. The accusations leveled by CEP would indicate that local personnel are not capable of second and third level responses which, while true, is unnecessary.

Allegation 7

Insurance to cover the costs of a nuclear transport accident is either unavailable or inadequate.

Response

Since the safety record in the nuclear industry is so good, there has been little experience in utilizing the insurance currently available to cover accidents including those occurring during transportation. A careful review of the applicable federal legislation and insurance industry coverage indicates that all transport of spent fuel, including empty, but internally contaminated casks, is covered either by private insurance or by federal insurance under the Price Anderson Act. Because of this industry and federal protection, the insurance industry has taken an action to prevent double coverage and the attendant legal snarls involved, by excluding nuclear coverage on homeowners' policies. While CEP construes this to be an insufficient or non-existent coverage, the fact is that nuclear insurance is provided by the federal government instead of the individual homeowner. A recent DOE study confirms this position[3].

The above allegations are the primary ones contained in the Summary of Findings of the draft CEP report. The report closes with a chapter of recommendations, although there is one recommendation contained in the Summary of Findings which is quite interesting. The CEP states that it would be possible to solve the transportation problem by shutting down all nuclear power reactors. This simplistic recommendation assumes among other things that the existing spent fuel will remain where it is ad infinitum.

The CEP makes nine recommendations in its report. A review of those nine recommendations also reveals severe misinterpretations.

1. Cask standards must be made more severe.

   As pointed out in the review of the summary of findings, the cask standards as they currently exist are indeed adequate to provide total protection of the public in all but the most extremely severe accidents, and even then the public involvement would be minimal.

2. Casks in operation today have serious design and construction defects and should be withdrawn from service.

   Cask designs are carefully reviewed by regulatory bodies which also require extensive quality assurance procedures be followed to assure that the cask as manufactured conforms to the design. While several cases have arisen where casks were not manufactured to design specifications, the industry has reported those and has submitted to the Nuclear Regulatory Commission analyses evaluating the effect of such variations. Only after these analyses were completed and performance capabilities verified, were these casks returned to service.

3. One copy of each cask model should be physically tested.

   As explained under the summary of findings, this is totally unnecessary since it challenges the very basis of competent engineering.

4. HM164 should be withdrawn because it will increase accident probability and consequences.

   Since the risk to the public safety in transporting spent fuel and other high level radioactive materials consists primarily of the non-nuclear hazard of traffic accidents, any attempts to move these shipments on higher quality roads over the minimum distance significantly reduces this non-nuclear risk. Therefore, H4164 as it currently stands, does reduce accident probabilities and thereby it also reduces overall consequences.

5. Since communities have no emergency response capability, local personnel should be trained and equipped at the expense of the carriers.

   Again this shows a total lack of understanding of emergency response as pointed out in the Summary of Findings.

6. In order to reduce the number of shipments, the practice of making smaller shipments should be re-evaluated in favor of consolidating shipments of spent fuel in order to make fewer but larger movements.

   While this recommendation may have value, there are other considerations involved which must be included in the evaluation process. These considerations include carrier capability for moving larger casks, access to point of origin and point of destination, radiation exposure to handling crews and other similar factors.

7. The use of barge shipments as a means of reducing the number of shipments and the accident severities should be evaluated particularly for those shipments in densely populated urban areas.

   This recommendation may have some value and efforts to evaluate barge transport are underway at Sandia.

8. Until shipping casks of a more rugged design are developed and manufactured, the transportation of spent fuel should be halted.

   This recommendation is based on the assumption that current design standards are inadequate (see recommendation 1). Since analyses, tests, and experience indicate that the current generation of casks is adequate, this recommendation, if adopted, would introduce economic consequences without any commensurate benefit.

9. Dry storage casks are the preferred reactor storage option.

While this recommendation and the related comments in the summary section of the report have only indirect application to transportation, it should be pointed out that the assumptions used by the CEP to come to this conclusion are shaky at best. Unlike the remainder of the CEP report where problems are magnified and benefits are minimized, in the treatment of dry storage casks precisely the opposite approach was taken.

This is an abbreviated analysis of the CEP report and as such does not address much of the fine detail included in that report. Every allegation and accusation contained in the report could be dealt with on a more detailed basis. Such a detailed evaluation would reveal that at best, erroneous information has been utilized as the basis of the CEP recommendations. In many cases existing data have been misinterpreted, distorted or otherwise convoluted to reach a preconceived conclusion.

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The results of this full-scale test indicate that approximately 6×10^{-4} % of the total solid heavy metal inventory (0.5 t) could be released as a respirable radioactive aerosol as a result of an explosive attack on a single-PWR fuel assembly truck cask. The measured respirable release fraction has been determined to within $\pm 0.4 \times 10^{-4}$ % using standard error propagation techniques; however, release fractions for the volatile fission products will be larger than that for the actinides. Experimental studies are currently underway to provide data characterizing the release of the volatile fission products.

The expected health consequences were calculated using the derived release fraction of 6×10^{-4} percent as the primary input to the consequence reactor safety model called CRAC.[4] The release conditions such as population distribution and weather conditions were assumed to be equivalent to those of the Manhattan borough of New York City. The results of this consequence analysis indicate that one peak latent cancer fatality and no early fatalities or early morbidities could occur as a result of this postulated radioactive release from a single PWR spent fuel truck cask in downtown New York City.

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Vol I

IMPACTS OF NUCLEAR MATERIAL FLOWS ON TRANSPORTATION ROUTING ALTERNATIVES*

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INTRODUCTION

Research and development activities to support the U. S. Department of Energy (DOE) sponsored efforts in nuclear waste transportation are coordinated through the Transportation Technology Center (TTC) at Sandia National Laboratories. Computerized logistics and routing models have been developed at Oak Ridge National Laboratory under the sponsorship of the TTC. These models are utilized to predict future flows of nuclear waste materials, forecast transportation requirements, and identify corridors through which these materials might be shipped.

Routing alternatives for shipment of these materials between sites are evaluated with the HIGHWAY (truck) and INTERLINE (rail and barge) computer models. While actual routings of shipments are usually determined by the carrier, use of these models allows simulation and evaluation of applicable alternatives.

Originally developed to more accurately simulate travel distances, times and resultant costs for input into analyses of waste management system parameters, these models also allow material flow information to be graphically depicted on a realistic transportation network. By utilizing the material flows estimated by the Nuclear Materials Transportation Logistics Model (NMTLM) together with the graphic routing capabilities, flow densities are illustrated on the routing network for scenarios of interest.

This capability is utilized to identify significant transportation corridors, thus providing a definitive characterization of transportation logistics for specific waste management requirements.

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*This work supported by the U. S. Department of Energy under Contract DE-AC04-DP00789.

ROUTING MODELS

The HIGHWAY and INTERLINE computer models are applied to simulate possible transport routes associated with the movement of nuclear waste by truck and rail, respectively.

The HIGHWAY model is based upon a commercially available data base (COMPU.MAP) which has been modified to meet the specific needs of the DOE program sponsors. The COMPU.MAP data base, licensed by Logistics Systems, Inc., is essentially a computerized road atlas, containing data describing over 15,000 road segments (links) and approximately 10,500 intersections (nodes). The data base includes interstate highways, the U.S. highway system, and most principal state highways. Data for each of the links includes highway identifiers, distance, and estimated driving speed. Node descriptions include intersection identifiers, latitude and longitude.

The INTERLINE model uses the Federal Railroad Administration data base which has been updated to include recent rail mergers and line abandonments and contains over 20,000 links and 15,000 nodes. Rail link descriptions include track classification, ownership and distance. Applicable barge routes have also been added to the INTERLINE data base.

Prediction of rail routings must reflect the ownership of track and equipment by the approximately 100 independent companies. These companies simultaneously compete for business and cooperate with each other to ensure delivery. Since the originating railroad will attempt to schedule the long haul, the route between two sites is often a function of direction, i.e. a different route would be used for an eastbound shipment as compared with a westbound shipment. In addition, the railroads tend to concentrate traffic on the better maintained routes, even though the trip might be lengthened. The INTERLINE model simulates these operational characteristics to aid in the determination of accurate trip distances and transportation costs.

These models are used to better identify travel routes and times, thus permitting greater accuracy in projected costs of transportation. Mapping algorithms have been linked to the routing models, enabling graphic depiction of the routes between waste source and destination.

LOGISTICS MODEL

The Nuclear Materials Transportation Logistics Model (NMTLM) is used evaluate the impacts of changes in various waste management system parameters upon projected transportation requirements, as well as the sensitivity of these projections to changes in specific transport characteristics. System parameter options such as storage or packaging facility locations, receiving and processing rates and facility operational dates are varied at the request of the program sponsors. Transport characteristics, such as operating speeds, routing restrictions, turnaround times, and

shipment mode options are specified in accordance with the objectives of each analysis. Transportation requirements are often reported as numbers of shipments and shipping containers as well as total capital and operating costs.

The NMTLM has three basic functions:

1) to prepare a shipment schedule that depicts the rate at which radioactive waste shipments enter and leave the transportation system,

2) to evaluate the appropriate shipment destinations and packagings (should choices be available) using an optimization technique to minimize transportation costs, and

3) to calculate and report the transportation data describing the information gathered above for the particular scenario under consideration.

Scenarios of recent interest have focused on spent nuclear fuel, using the planning base case spent fuel discharge rates projected by the DOE[4,5]. This case assumes maximum utilization of existing storage and the reactor sites but allows for a full core reserve.

FLOW DENSITY DIAGRAMS

Illustrations of the transportation flow densities shown in Figures 1-4 are generated by linking the routes predicted with the HIGHWAY and INTERLINE models with the material quantity schedules forecast by the NMTLM. The width of the line graphically depicts the relative quantity of spent fuel shipments forecast to utilize the route.

The examples cited in this presentation were generated for the National Academy of Sciences and are used for illustration purposes only. Although a number of storage/disposal facility options were investigated, a single, national facility located in the west and a regional storage concept are used to illustrate the projected shipments in the year 2004. Two types of transportation systems were analyzed, a truck-only system and a mixed truck and rail transportation system. The latter of these options assumes that a reactor will ship by rail if that mode is available on site. Intermodal shipments were not included in this analysis. Federal, state, and local regulations prohibiting the transport of nuclear wastes through specified metropolitan or other land areas are not illustrated in the attached figures. Such constraints could, however, affect the routes chosen for the routes chosen for the scenarios of interest.

Figures 1 and 2 illustrate the projected annual spent fuel shipments for a mixed truck and rail system to a single western storage site in 2004. Rail shipments are concentrated in a corridor stretching from northeastern Kansas to southern Nevada. A

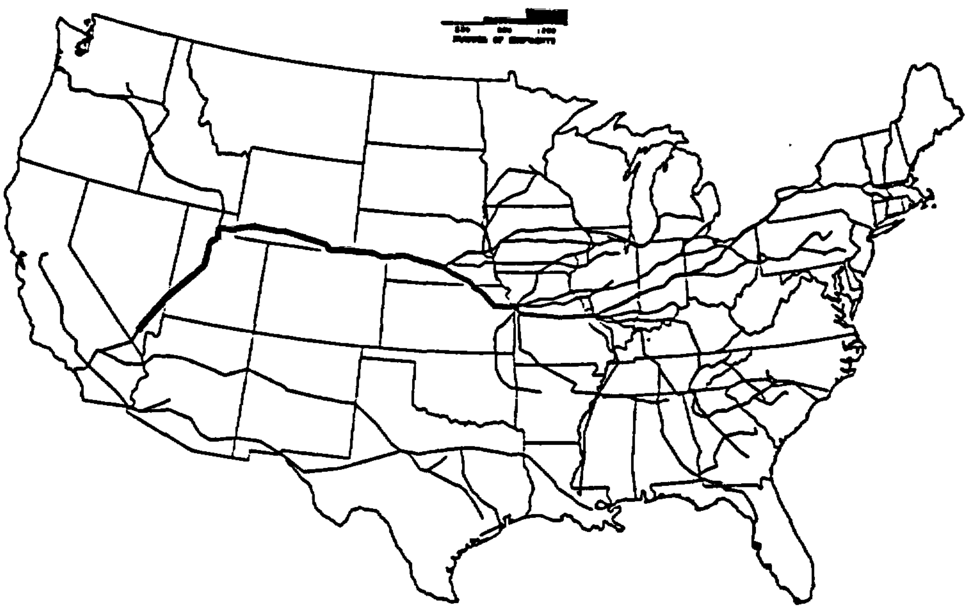

Fig. 1. Projected Annual Spent Fuel Shipments to a Western Storage Site in 2004. Basis: Reactors with rail service (for demonstration purposes only).

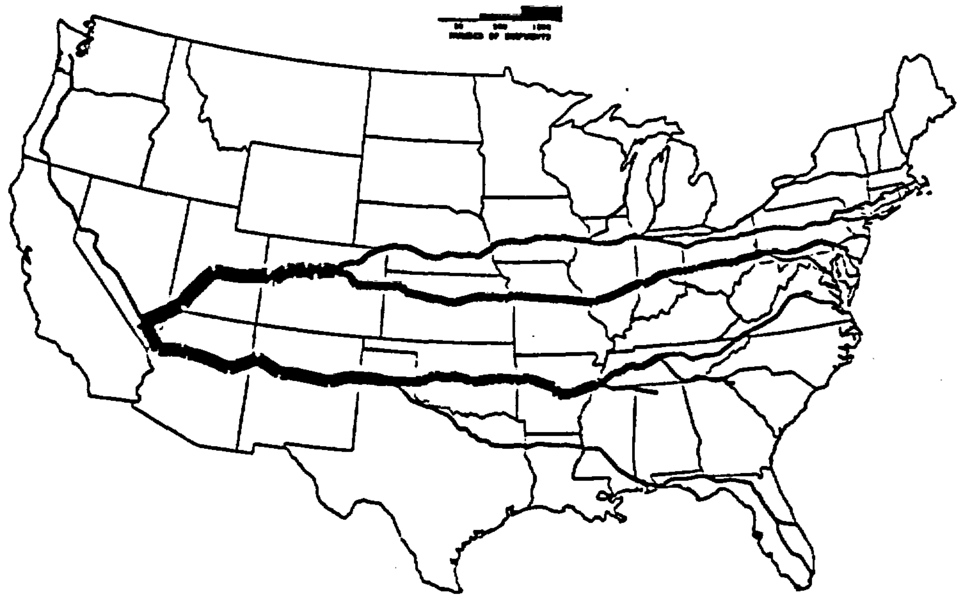

Fig. 2. Projected Annual Spent Fuel Shipments to a Western Storage Site in 2004. Basis: Reactors with truck service only (for demonstration purposes only).

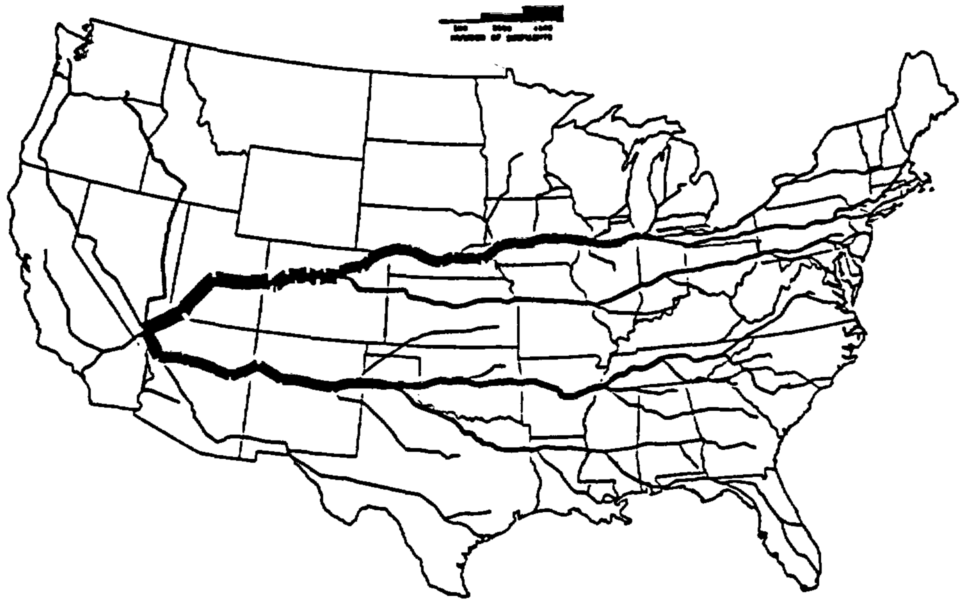

Fig. 3. Projected Annual Spent Fuel Shipments to a Western Storage Site in 2004. Basis: Truck shipments from all reactors (For demonstration purposes only).

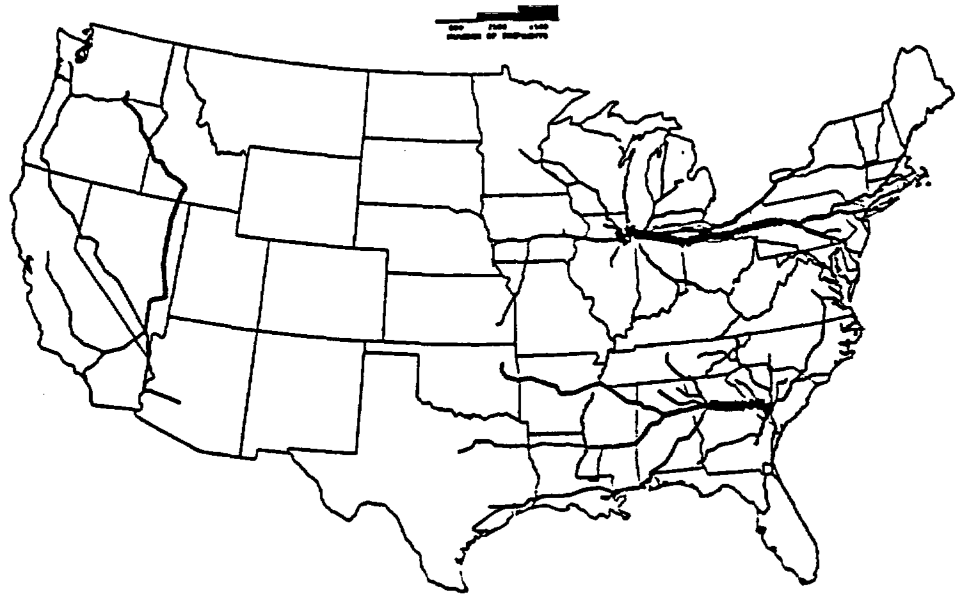

Fig. 4. Projected Annual Spent Fuel Shipments to Regional Storage Sites in 2004. Basis: Truck shipments from all reactors (For demonstration purposes only).

number of populated areas lie along this corridor, reflecting the development of urbanized areas along major transportation routes.

The highway shipments form three separate east-west corridors. The southern corridor follows I-40 from Tennessee to southern Nevada. The northern corridors follow I-70 and I-80 westward from the eastern states, joining in northeastern Colorado. The combined flows then follow I-70 and I-15 to southern Nevada. As with the rail corridors, a number of large urban areas lie along these routes.

Figure 3 illustrates the flow density diagram for a truck-only shipment scenario. The change in scale of the bandwidth between this and the previous figures should be noted. Flow densities along the I-40 corridor and the western I-70 corridor are 3-4 times greater than for the mixed-mode option. The I-70 corridor east of Colorado does not appear to experience a large change in shipping density, however, the northernmost corridor (I-80) is substantially impacted by the all-truck alternative.

The shipment patterns for the regional storage concept, assuming all shipments would be made by truck, is illustrated in Figure 4. In this example, the three regional storage sites are located in the southeast, midwest and western areas of the country. The scale compares with that of Figure 3. As can be noted, the trip patterns for the regional concept eliminate the large, cross-country corridors in the western and southwestern areas of the country shown for the single facility example. Two heavily-traveled corridors are identified: I-80 between Pennsylvania and Illinois and a southern corridor along I-20 in South Carolina, Georgia and Alabama.

CONCLUSIONS

The illustration of material flows along a transportation network provides DOE program sponsors with a new method of communicating the potential impacts of various waste management scenarios. While the method combines the outputs of other tools utilized to evaluate system impacts, it also must be utilized with an appropriate amount of caution. Routes projected by the HIGHWAY and INTERLINE models are mathematical simulations of carrier transport and are not intended to explicitly define the actual routes. Determination of the actual routes will depend upon facility operational constraints such as construction, road conditions, weather, and constraints imposed by federal, state and local governments. Routes will thus be selected at the time the shipment is being scheduled by the shipper and carrier.

Within the limitations of the available input data, the flow density diagrams graphically depict possible traffic impacts for a given scenario. This information allows identification of affected states or regions and can provide an assessment of the relative influence of this traffic upon the highway and railway networks.

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PATRAM '80

THE OAK RIDGE SPENT FUEL LOGISTICS MODEL*

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In response to continuing interest in the shipment of radioactive materials and as a mechanism for detailed transportation analyses, a Spent Fuel Logistics Model[1] (SFLM) has been developed at the Oak Ridge National Laboratory. The model was designed to evaluate the impact of waste management policy decision on the transportation requirements for moving spent fuel from the reactors to alternative away-from-reactor (AFR) storage facilities and geological repositories. This effort is currently being funded by the Department of Energy (DOE) through the Transportation Technology Center (TTC) at Sandia National Laboratories.

The model has three basic functions: (1) to prepare a shipment schedule that depicts the rate at which the fuel assemblies will enter and leave the transportation system; (2) to evaluate the appropriate shipment destinations (if multiple storage facilities are in operation, the model selects the appropriate destination to minimize transportation costs); and (3) to calculate and report the transportation data describing the particular scenario under consideration.

The transportation network being analyzed includes shipments between reactors and AFRs, AFRs and repositories, and direct reactor-to-repository shipments. The model is currently designed to handle problems that could involve ten AFRs, ten repositories, and a study period of 80 years.

A computerized nuclear reactor data base, which is included as part of the SFLM, contains information for all reactors in the United States which are either operating, under construction, or are firmly planned through 1990. Among other information, the data base contains a summary of historical and projected spent fuel discharges, historical fuel shipments, and onsite storage pool capacities. The data are based on information collected during the summer of 1979 in the Department of Energy Spent Fuel Survey. The basic data have been modified to include more recent information relating to delayed startup dates and cancellation of proposed nuclear plants.

In order to make long-range spent fuel shipment projections, it is necessary to estimate how the nuclear industry will change after the early 1990s. Since detailed reactor information is not available for this time period, the model has been designed to automatically schedule and site a series of standard size expansion reactors to span the gap between the nuclear data base and the capacity projection of interest. The user does have control over how the expansion reactors will be geographically distributed across the country.

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*Research sponsored by the Office of Nuclear Waste Management, U.S. Department of Energy under contract W-7405-eng-26 with the Union Carbide Corporation, through the Transportation Technology Center, Sandia National Laboratories.

**System Development Corporation, Oak Ridge, TN (formerly with the Chemical Technology Division, Oak Ridge National Laboratory).

Once all the reactors have been defined, the spent fuel shipping schedules are generated. For the reactors in the data base, it is assumed that a full-core reserve will be maintained at each reactor site. Options are available which control the onsite storage capacity and whether interreactor shipments will be allowed. Two onsite storage capacities are included in the nuclear data base: the first represents the current storage capacity, which reflects any announced additions; the second includes the utilities projection of the maximum storage capacity available at that site. If interreactor shipments are permitted, the user can specify which set of reactors will share storage facilities. This option delays the necessity of making a shipment to an AFR but fills the combined storage facilities selected more rapidly. Figure 1 shows two separate shipping projections. The solid line represents the case where there are no interreactor shipments; the dashed line indicates the case with interreactor shipments. All interreactor shipments were assumed to remain within a given utility. Notice that when interreactor shipments are included, the shipping rate is lower prior to 1998. After this date, however, a greater percentage of the reactors have filled their storage facilities, and this option actually produces an increased number of shipments each year. Since onsite storage capacities for the expansion reactors are not known, shipments from these reactors are based on a specific cooling time of the discharged assemblies in the storage pool.

The second basic function of the SFLM is to determine the destination of the projected fuel shipments. If only a single destination is available, no decisions are required. However, if multiple destinations happen to be available, the optimal destination will be selected based upon minimizing transportation costs or public radiation exposure. The optimization techniques can be controlled to minimize shipments to a set of AFRs only or to include AFR-to-repository shipments in the objective function. This latter option will have a significant impact on projected AFR inventories. In the first case, the reactors will make fuel shipments to the nearest AFR. However, in the second case, the total transportation costs are minimized, and reactors could be directed to ship to a more distant AFR if the subsequent cost of the AFR-to-repository shipment would result in an overall savings.

Two different optimization techniques are available. The global optimization technique, which utilizes linear programming, operates upon all of the independent variables simultaneously and generates the lowest cost solution. The second approach is a year-by-year optimization technique where a number of small transportation problems are solved sequentially. Each technique has its own advantages and disadvantages. While the particular problem being analyzed dictates which optimization technique will be selected, both techniques will give identical results in most cases.

In order to reflect the actual operational characteristics of the transportation system and receiving facilities (AFRs or repositories), a number of constraints have been incorporated into the model. These constraints regulate the opening and closing dates, fuel receiving rates, and storage capacities at the various receiving facilities. The numerical values of the constraints can be changed annually to reflect changing characteristics as a function of time. Any of the transportation links can be blocked to allow the analysis of regionalized AFRs and repositories. In this type of study, a particular AFR is allowed to receive shipments from a selected set of reactors. While a specific set of regional boundaries can be imposed for a particular scenario, the model has been designed to calculate the optimal regional boundaries that minimize transportation costs. The mode of transportation used to make the shipments can also be influenced. The model is designed to select the optimal transportation mode.

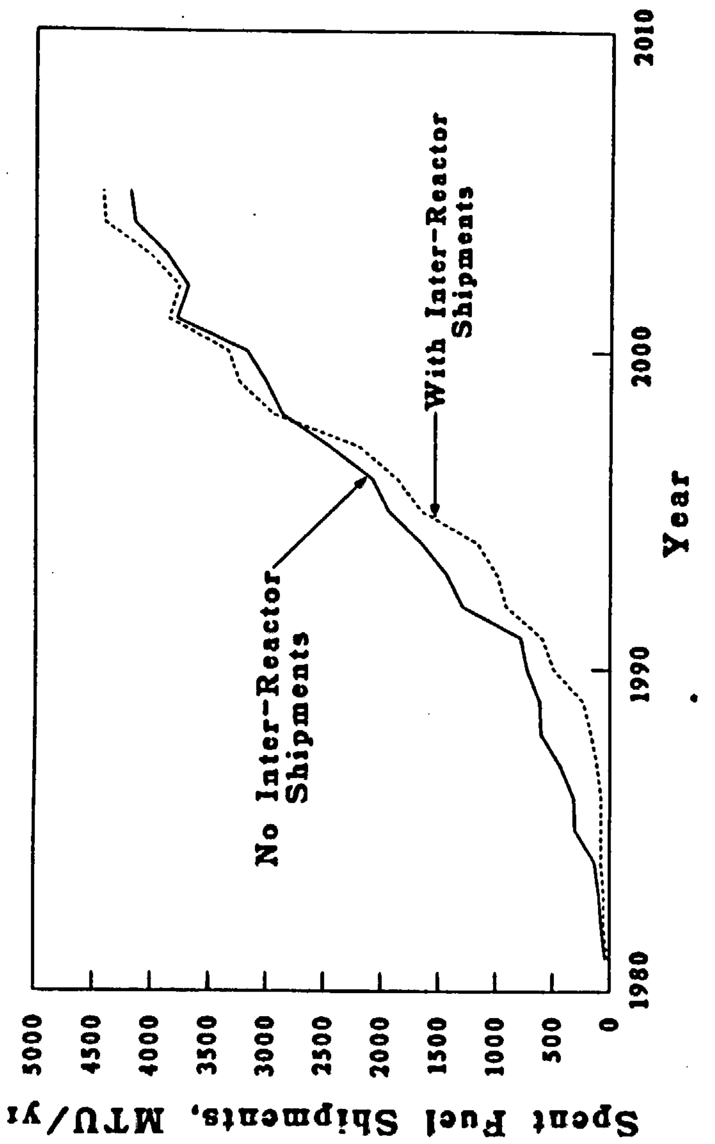

Fig. 1. Projected spent fuel shipments 1981 - 2005.

However, it is possible to maximize rail shipments by requiring all reactors with direct rail access to make all shipments by rail. The relative amount of rail or truck shipments which will be used to transport fuel to a particular receiving facility is calculated in the model. The modal mix is a dependent variable and not an independent variable to be specified at the start of a run as is done in some other transportation models.

A large amount of transportation data is tabulated for each run, and the output report supplies the following information for each year covered in the study: (1) a schedule and destination for all shipments, (2) inventories of fuel at reactors, AFRs, and repositories, (3) transportation distance and cost, (4) radiation exposure to the public, (5) cask fleet requirements, (6) ratio of rail and truck shipments received at an AFR or repository, and (7) the age distribution of fuel being shipped or stored.

An example of some of the output information is shown in Figs. 2-4. The projected spent fuel shipments (assuming no interreactor shipments) were shown as the solid line in Fig. 1. For these shipments, the estimated rail cask fleet size by year for transporting all of the fuel to an AFR in the southeastern United States or all of the fuel to an AFR in the northwestern United States is shown in Fig. 2. A similar estimate of the truck cask fleet requirements is given in Fig. 3. The data used in generating this information assume a rail cask capable of moving 10 pressurized-water reactor (PWR) or 24 boiling-water reactor (BWR) assemblies and a legal-weight truck cask with a capacity of 1 PWR or 2 BWR assemblies. In Fig. 4, the relative amount of fuel transported by rail is outlined. Since only a single AFR site was assumed (either in the southeast or the northwest United States), this information is not dependent upon AFR location. If more than one AFR was available, the relative amount of rail or truck shipments would become a function of the individual reactors making shipments to a particular receiving facility.

Over the past two years, the SFLM has been used in several studies for the Department of Energy (DOE), the Transportation Technology Center (TTC) at Sandia Laboratories, the Office of Nuclear Waste Isolation (ONWI), and Savannah River Laboratory (SRL), which are reported in refs. 2-5. The specific studies include (1) an AFR siting study,[2] (2) a logistics support for SRL participation in congressional hearings, (3) an ONWI regional repository study,[3-5] and (4) a logistics analysis for an AFR Environmental Impact Statement.

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2. D. S. Joy and L. B. Shappert, The Effects of AFR Storage Location on Spent Fuel Transport, presented at the American Nuclear Society meeting, Atlanta, Georgia (June 1979).
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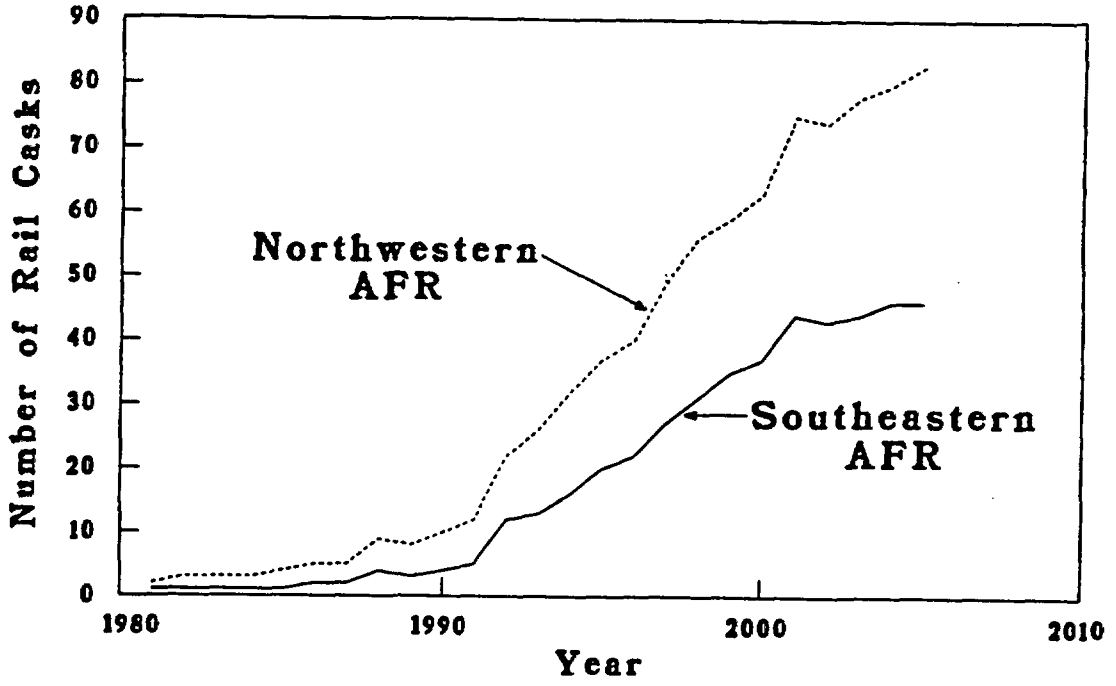

Fig. 2. Projected rail-cask requirements 1981 - 2005.

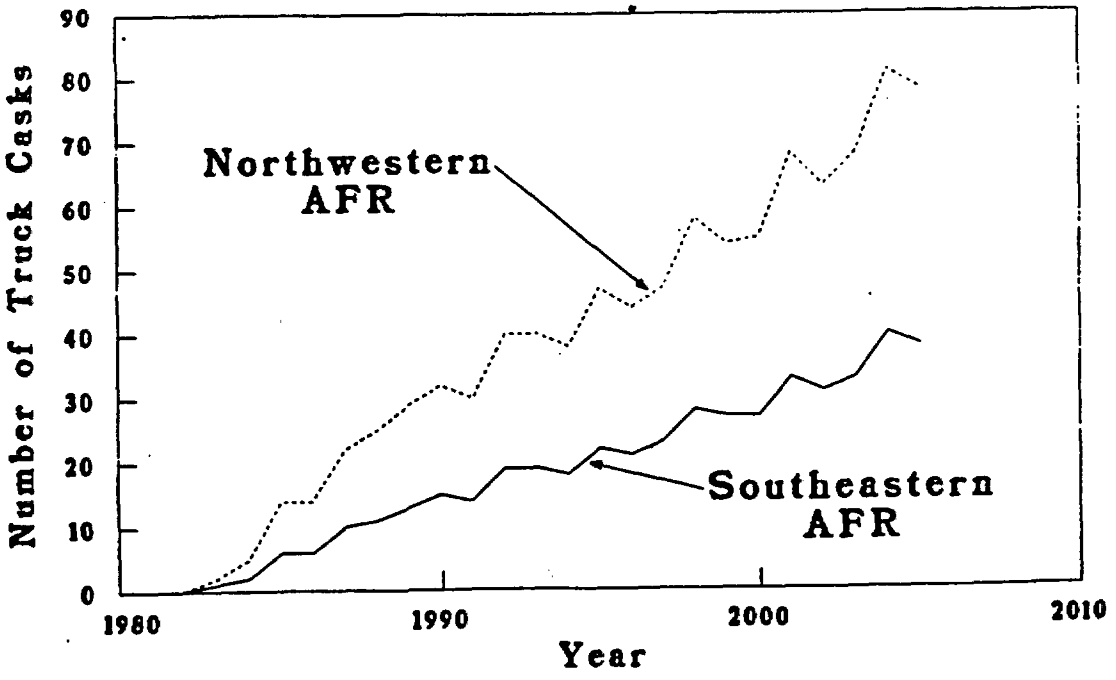

Fig. 3. Projected truck-cask requirements 1981 - 2005.

EL. Wilmot

SANDIA REPORT SAND81-1703 • Unlimited Release • UC-71
TTC/0236

Printed February 1982

Non-Radiological Impacts of Transporting Radioactive Material

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Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789

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NON-RADIOLOGICAL IMPACTS OF TRANSPORTING RADIOACTIVE MATERIAL*

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February 1982

ABSTRACT

Estimates of health effects that result from exposure to air pollutants generated during normal (accident-free) transport of radioactive materials and from accidents are provided for use in preparation of environmental impact statements. The results are presented for truck and rail modes and uncertainties associated with these results are discussed. Since these health effects have no relation to the radioactive material being hauled, their measure is applicable to shipments of all similar weight loads. The pollutant health effects are calculated for and applicable to urban areas only while the accident health effects are averages over all population zones in the U.S.

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*This work was supported by the U. S. Department of Energy (DOE) under contract number DE-AC04-76DP00789.

SANDIA REPORT SAND80-1943 • Unlimited Release
Printed October 1982 TTC-0239 UC-71

RADTRAN II: Revised Computer Code to Analyze Transportation of Radioactive Material

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Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789

SUMMARY

The RADTRAN code[1] was developed in conjunction with the preparation of the Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes[2] to analyze the radiological impact of the transportation of radioactive material. This report describes an interim revised version of that code which combines meteorological, demographic, health physics, transportation, packaging, and material factors to obtain the expected annual radiological consequences resulting from transportation of radioactive material. The code, written in FORTRAN, is designed to be used on both CDC 6600 and CDC 7600 equipment.

Methodology

Figure 1 is a basic block diagram of the methodology used in RADTRAN II. Two principal computations are performed by the code: computation of the radiological impact due to "incident-free"* transportation of radioactive material and computation of the radiological impact of vehicular accidents involving radioactive material shipments. This figure illustrates the informational flow through the various submodels used to yield the final result. Each of these models will be addressed briefly in this section.

Basic Transportation Scheme and the Standard Shipments Model

Transport of a radioactive material can involve a wide range of events that can have environmental consequences. To make the source of these consequences clear, the sequence of events in a radioactive material shipment must be considered. For most shipments, the material is first placed in a package meeting regulatory standards; the radiation exposure levels are noted; the package is labeled with the appropriate information; a shipping bill is prepared; and the package is put aside until the transportation process actually begins.

The transportation process may take on one of several forms. The package might be loaded onto a vehicle that will take it directly to its ultimate destination. However, most packages undergo a secondary mode of transport, e.g., a truck or light duty vehicle, which takes the package to a terminal where it is assigned to a primary vehicle along with other parcels. The primary vehicle takes it to a terminal near its destination where it is again loaded onto a secondary-mode vehicle that takes it to its ultimate destination. In some other instances packages are picked up by or delivered to a freight forwarder and are consolidated with other packages into a single shipment. This shipment may consist of a large number of packages obtained from a number of different shippers. When the shipment arrives at its destination, it is separated into individual packages that are delivered to the consignees. Handling and warehouse storage can also occur during and between these transport phases as the package moves between modes or carriers. RADTRAN II allows the user to select one of 13 shipment scenarios for each of his shipments.

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*See Glossary

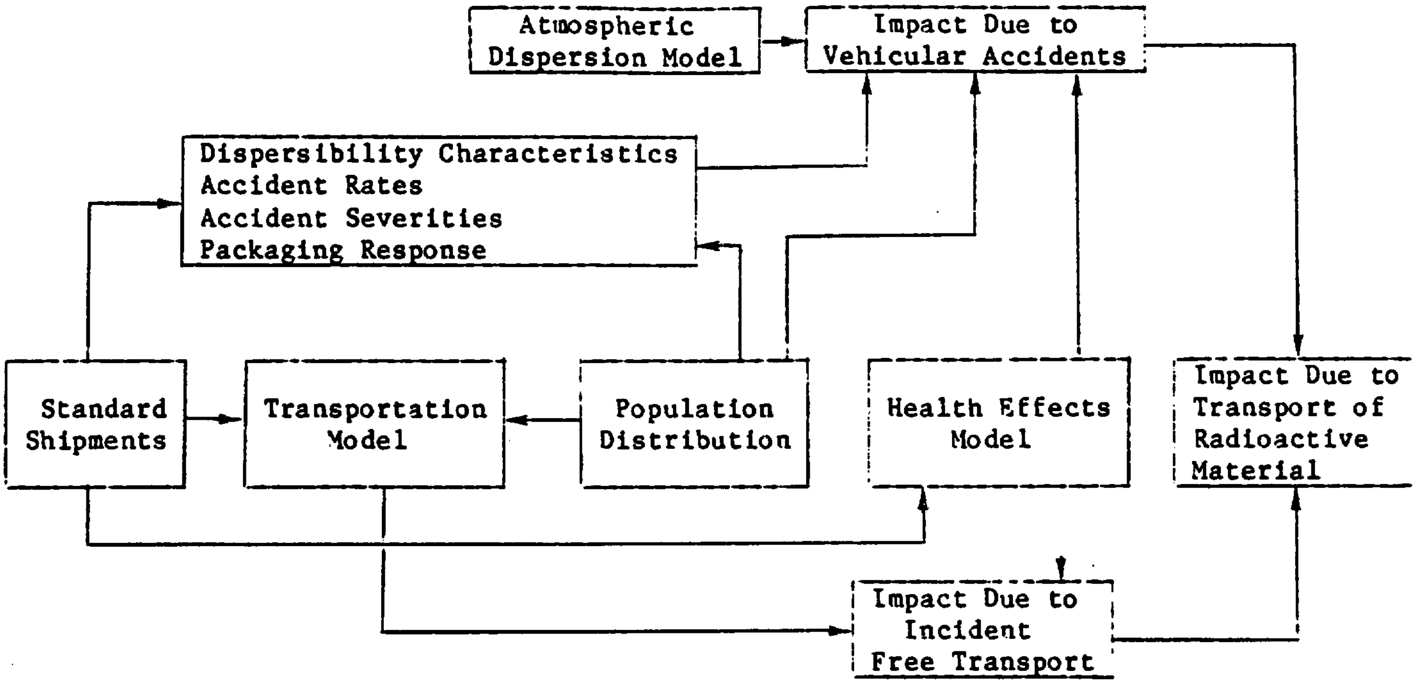

Figure 1. Block Diagram of Overall RADTRAN II Methodology

RADTRAN II allows the user to input up to 200 shipments specified by material, material dispersion category, curie content, transport index (TI),* type of packaging, number of shipments per year, distance per shipment, shipment mode,* etc.

Transportation Model

The transportation model used in RADTRAN II is subdivided into three sections: an accident rate section, a traffic pattern section, and a shipment information section. The accident rate section contains the annual accident rate for each mode of transportation, subdivided according to the severity of the accident and the population zone in which the accident is assumed to occur. The traffic pattern section contains the fraction of travel which occurs on various types of roads, in various population zones, and under rush-hour and normal traffic conditions. The shipment information section contains the number of passengers or crew per vehicle, dose rate conversion factors, crew separation distances for various vehicle types, handling and storage times, length and number of stops, etc.

Accident Severity and Package Release Model

The accident severity model divides all accidents into eight severity categories keyed to the fractional release of material from packagings. These categories may be related to the fire, crush, impact, and puncture forces encountered in an accident as in reference 2 or they may be related to other abnormal environments of specific interest to the user. The package release model combines the user-specified fraction of material which is released (from each package type considered and for each severity of accident) with the fraction of material which becomes airborne and the fraction of respirable size. These latter fractions are based on a material dispersion categorization. These results are combined with the accident rates for each severity category, the distance per shipment, and the number of shipments per year, to determine the expected annual release of each material in each population zone.

Meteorological Dispersion Model

Any dispersion model may be used to describe the diffusion of the cloud of aerosolized debris released at the site of the accident since the basic dispersion calculations are not performed within RADTRAN II. Instead the user provides atmospheric dilution factors which are converted to airborne dispersion and ground contamination factors by RADTRAN II.

Population Distribution Model

The population distribution model specifies population densities in up to three population zones. In addition, numbers of exposed persons for certain

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*See Glossary

specific areas such as pedestrian walkways, warehouses, and air terminals are specified.

Health Effects Model

The health effects model for RADTRAN II is based on that developed in the Reactor Safety Study.[4] The relative toxicity of the materials shipped is analyzed in terms of potential for producing early fatalities,* early morbidities,* latent cancer fatalities,* and genetic effects.* The analysis is based on the computed dose received by various organs.

Radiological Impact Due to Accidents

The radiological impact from vehicular accidents is evaluated in terms of level of consequence, probability of occurrence, and level of risk. The radiological consequences which are evaluated include health effects and economic impacts. Risk is evaluated in terms of the annual expected value of each of these effects. This risk figure-of-merit is computed by forming the product of the probability of each specific accident and its particular level of consequence and summing these products over all accidents.

Radiological Impact Due to Incident-Free Transportation

The accumulation of relatively small doses which result from exposure of population to the radiation emitted by radioactive material packages is computed in RADTRAN II by combining the population distribution model, the traffic pattern model, and the transportation model to compute the annual dose (in person-rem) to a set of specific population subgroups. Currently, eight subgroups are used although this number could be expanded if the need arises. These doses can be combined and expressed in terms of expected latent cancer fatalities and genetic effects. Because of the quantity and material form restrictions imposed by current regulations, no early effects are possible from incident-free transport.

Capabilities of RADTRAN II

The output of RADTRAN II is expressed in terms of expected numbers of chronic health effects from transportation accidents and incident-free transportation and the annual probability of specific level of health effects and economic consequences from transportation accidents. Individual shipments are also analyzed for their contribution to the total radiological impact. The code has been developed in a generalized format to permit a wide variety of potential applications. These include analysis of the current radioactive material transport scheme; analysis of proposed alternative schemes such as mode shifts, packaging changes, routing changes, etc; and detailed consideration of specific sectors of the radioactive material industry.

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*See Glossary

SAND82—2681
TTC—0399
Unlimited Release
Printed February 1983

Distribution
Category UC—71

RADTRAN II User Guide

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Abstract

A user guide is presented for the RADTRAN II code, which has the capability to predict the radiological impacts associated with specific schemes of radioactive shipment and mode-specific transport variables. The code, written in FORTRAN, is operational on the CDC 7600 computer. Input descriptions, applications, and example problems are included.

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SAND80-2124
TTC-0156
UC-71

TRANSPORTATION ACCIDENT SCENARIOS FOR COMMERCIAL SPENT FUEL

Edwin L. Wilmot

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February 1981

ABSTRACT

A spectrum of high severity, low probability, transportation accident scenarios involving commercial spent fuel is presented together with mechanisms, pathways and quantities of material that might be released from spent fuel to the environment. These scenarios are based on conclusions from a workshop, conducted in May 1980 to discuss transportation accident scenarios, in which a group of experts reviewed and critiqued available literature relating to spent fuel behavior and cask response in accidents.

Contents

TRANSPORTATION ACCIDENT SCENARIOS FOR COMMERCIAL SPENT FUEL

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Printed July 1981

The Probability of Spent Fuel Transportation Accidents

James D. McClure

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789

SAND80-1721
TTC-0139
UC-71
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THE PROBABILITY OF SPENT FUEL TRANSPORTATION ACCIDENTS

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July 1981

Abstract

The transported volume of spent fuel, incident/accident experience and accident environment probabilities were reviewed in order to provide an estimate of spent fuel accident probabilities. In particular, the accident review assessed the accident experience for large casks of the type that could transport spent (irradiated) nuclear fuel. This review determined that since 1971, the beginning of official U. S. Department of Transportation record keeping for accidents/incidents, there has been one spent fuel transportation accident. This information, coupled with estimated annual shipping volumes for spent fuel, indicated an estimated annual probability of a spent fuel transport accident of 5×10^{-7} spent fuel accidents per mile. This is consistent with ordinary truck accident rates. A comparison of accident environments and regulatory test environments suggests that the probability of truck accidents exceeding regulatory test for impact is approximately 10^{-9}/mile.

E. L. WILMOT 978

SANDIA REPORT SAND82—2365 • TTC—0398 • Specified External Distribution Only*

Printed June 1983

An Assessment of the Safety of Spent Fuel Transportation in Urban Environs

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Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
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SF 2900-Q(6-82)

ABSTRACT

The results of a program to provide an experimental data base for estimating the radiological consequences from a hypothetical sabotage attack on a light water reactor spent fuel shipping cask in a densely populated area are presented. The results of subscale and full-scale experiments in conjunction with an analytical modeling study are described. The experimental data were used as input to a reactor safety consequence model to predict radiological health consequences resulting from a hypothetical sabotage attack on a spent fuel shipping cask in the Manhattan borough of New York City. The results of these calculations are presented in this report.

7th International Symposium
on Packaging and
Transportation of Radioactive
Material (PATRAM)
May 15-20, 1983
New Orleans, LA

PATRAM'-83

AN ASSESSMENT OF THE SAFETY OF SPENT FUEL TRANSPORTATION IN URBAN ENVIRONS

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INTRODUCTION

In 1978 a study of radiological impacts from transport of radioactive material through urban areas, the 1978 Urban Study,[1] indicated very severe consequences from a successful malevolent act on spent fuel shipments. On the basis of that analysis the NRC instituted stringent physical security requirements[2] for spent fuel transport which were designed to prevent sabotage events in urban areas. A subsequent version of Reference 1, the 1980 Urban Study,[3] reduced the postulated release quantity by a factor of 14 and thus showed reduced numbers of early fatalities, morbidities and latent cancer fatalities. As a result of the second report, the NRC reduced the stringency of the physical security measures, but they remain a serious restriction on the shipment of spent fuel and have resulted in increased shipping costs.

Since no relevant experimental data base was available for use in the Urban Studies, source term estimates were based upon assumed physical and chemical characteristics and estimated quantities of the released fuel. Consequently, there was a high degree of uncertainty in the estimated source terms and radiological consequences. A need existed to provide experimental data characterizing the quantity, physical, and chemical form of the fuel released from hypothetical attacks on spent fuel shipping casks.

This report describes the results of a program conducted at Sandia National Laboratories (SNL) to provide the experimental data base for estimating the radiological consequences from a hypothetical sabotage attack on a spent fuel shipping cask. The primary objectives of the program were limited to (1) evaluating the effectiveness of selected high energy devices in breaching full-size spent fuel casks, (2) quantifying and characterizing relevant aerosol properties of the released fuel, and (3) using the resulting experimental data to evaluate the radiological health consequences resulting from a hypothetical sabotage attack on a spent fuel shipping cask in a densely populated area.

Subscale and full-scale experiments in conjunction with an analytical modeling study were performed to meet the programmatic objectives. The program was divided into the following tasks.

HED Evaluation

An extensive survey of available high energy devices (HEDs) was performed to select those that might be capable of breaching a full-size spent fuel truck cask. From the many different types of attack devices considered in the survey, four general types of HEDs were selected for testing and further evaluation. These devices were those discussed in the 78[1] and 80[3] Urban Studies:

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* Operated by Sandia Corporation under contract No. DE-AC04-76, DP00789.

1. Conical-shaped charges.
2. Contact-breaching charges.
3. Platter charges.
4. Pyrotechnic torches.

Tests subjecting both simulated and actual spent fuel truck casks to the four types of HEDs were performed to provide data for final selection of a reference HED which showed the greatest potential for penetrating a full-size cask and dispersing its contents.

An HED was selected from the four types tested and was used as the reference attack device for the full-scale source term characterization test from which the needed source term data base was obtained.

Subscale Tests

Five subscale tests subjecting 1/4-scale casks containing full-size fuel pins made up of unirradiated depleted UO_2 pellets to scaled versions of the selected reference HED were conducted. These tests provided initial experimental data characterizing the fuel material released from a cask subjected to a simulated sabotage incident.

Full-scale Tests

A full-scale test subjected a 25.45 t generic spent fuel shipping cask containing a single pressurized water reactor-like unirradiated fuel assembly to the reference full-scale HED. The full-scale test provided a source term data base for the reference event which, in conjunction with the results of the subscale experiments performed in Task 2, were used as primary input and data base to the Consequence Reactor Safety Model (CRAC)[4] for estimating the radiological consequences.

Correlation Tests.

Effects of the high energy environments created by a variety of HEDs on breakup and particulation of spent commercial nuclear reactor fuel (H. B. Robinson Unit-2) and its surrogate, depleted uranium dioxide were evaluated in a series of single pellet tests. Tests conducted on single irradiated fuel pellets and single depleted UO_2 pellets enabled measurement of the radioactive aerosols produced by the four types of high energy devices. Correlation functions were obtained from both filter and sieve data relating particle size distributions for fracture, breakup, and aerosolization of depleted UO_2 fuel to that of irradiated fuel.

Health Effects Evaluation

To complete the study, an evaluation of the radiological health effects was performed using the experimental data derived in the subscale, full-scale, and correlation tests as input to the Consequence Reactor Safety Model, CRAC,[4] used in

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the Urban Studies.[1,3] The expected health consequences from an attack using the reference HED of this study on a three-PWR fuel assembly truck cask were calculated assuming a release in the Manhattan borough of New York City.

SUMMARY OF RESULTS

Subscale Tests

Figure 1 is a schematic of the steel confinement chamber which was used in the subscale tests. The steel cylindrical chamber was a 28.9 m^3 (net volume) pressure vessel sealed at one end and having an air-tight door at the other end. The HED was mounted externally to the chamber and fired into the chamber through a 6.4-mm-diameter port in a flanged assembly mounted externally to the chamber. An explosively actuated isolation slide valve between the HED and the chamber was used to prevent release of gases and dispersed fines from the chamber.

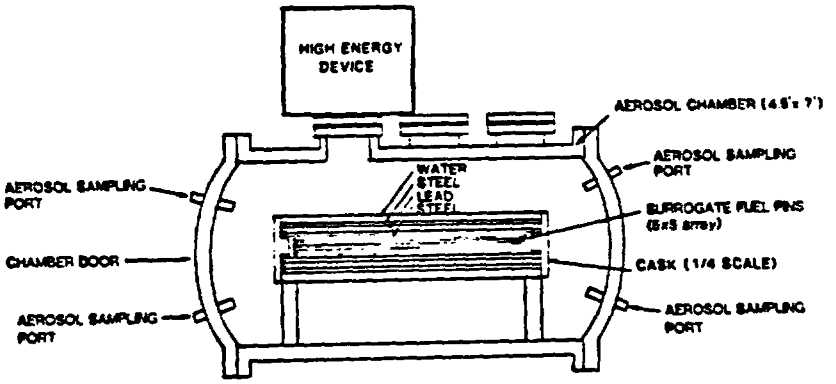

Figure 1. Schematic of Confinement Chamber and 1/4-scale cask used in subscale tests.

Five sampling ports penetrated the chamber in various locations. The ports were closed by remotely operated pneumatic 2.5 cm diameter valves. The valves were kept closed until after detonation to prevent damage to the aerosol sampling equipment by the shock wave. Since no single aerosol instrument can size particles over the size range of interest (from 0.01 m to about 2 mm diameter), a battery of instruments was selected to measure the size and mass of particles collected. Aerosol size parameters as a function of time were determined from cascade impactor samples obtained at various time intervals after HED detonation. Similarly, filter samples provided a time history of the change in mass concentration. Changes in morphology were shown by sequential electrostatic precipitator (ESP) samples and changes in number concentration were shown by continuous recording condensation nuclei counters. After each test, all debris was collected from surfaces inside the test chamber and separated into material not containing uranium and materials suspected of containing uranium. All uranium containing material was sieved, the mass determined, and uranium fluorometric and wavelength dispersive x-ray fluorescence analyses performed. Transmission (TEM) and scanning (SEM) electron microscopy and energy dispersive x-ray analysis (EDXA) were used to determine the elemental composition and morphology of particles collected by ESPs.

The aerosol-sampling procedure was designed to provide a time history of selected aerosol parameters (such as concentration, particle size distribution, and morphology) in the chamber. From the aerosol time history, calculations could be performed to determine initial release parameters. The results of these experiments indicated that approximately 48.6 ± 5 g of UO_2 fuel mass was released from the 1/4-scale cask as a result of the attack. Approximately 1.6 percent (0.78 g) of the total released UO_2 mass was in the respirable size range (ie, less than 10 microns aerodynamic diameter). Calculations of fractions of released airborne respirable aerosol for a full-size event assuming a three PWR fuel assembly cask (1.4 t of heavy metal (tHM) inventory) of the type used in the Urban Study [1,3] were made based on the measured 1/4-scale release parameters. This calculation assumed the longest path of interaction through the cask together with rupture of, and subsequent release through the cask's walls. The results of these extrapolations of the scaled tests indicated that approximately 0.0023 percent (32 g) of the total solid fuel inventory could be released from a full-scale event as respirable radioactive materials.

Full-Scale Test

Figure 2 is a diagram of the test setup for the full-scale test and shows the spent fuel shipping cask inside the aerosol containment chamber. The surrogate fuel assembly consisted of 223 fuel pins configured in a 15 X 15 array and weighing 258.048 kg. Each fuel pin was made of 1.2 m long zircaloy tubing filled with depleted UO_2 fuel pellets (9.33 mm diameter by 15.2 mm length). The dimensions and mass of the UO_2 pellets were similar to those of fresh reactor fuel pellets. The stainless steel/lead cask wall consisted of a 2.54 cm thick stainless steel outer shell, 21.3 cm thick lead middle shell and a 1.9 cm stainless steel inner shell. The cavity dimensions were 38 cm in diameter and 356 cm in length. The shipping cask was placed inside a 3.1 m diameter by 0.02 m thick x 6.1 m long cylindrical chamber for aerosol containment. The HED was mounted and detonated externally to the chamber. An explosively actuated sliding isolation valve placed between the HED and chamber port was designed to close milliseconds after detonation in order to prevent the release of the source aerosol and fragments to the surrounding area. Eleven sampling ports penetrated the chamber at various locations. These 2.5-cm I.D. sampling ports were closed before and during detonation by remote controlled pneumatically actuated ball valves and were opened shortly after detonation in order to allow sampling of the aerosol.

The sampling procedure was designed to provide measurement of high velocity particles as well as the lower velocity aerosols within the chamber. From these data, calculations could be performed to determine the initial release parameters, such as initial fuel mass aerosol concentration and released fuel mass.

After detonation, 198.504 kg of the UO_2 fuel remained in the cask; 2.549 kg of UO_2 was released from the cask as a result of the event. Approximately 0.115 percent (2.94 g) of the released UO_2 fuel was airborne aerosol and all of the airborne UO_2 aerosol was assumed to be respirable. Fifty percent (111) of the 233 fuel rods sustained some degree of mass loss (damage). Approximately 10.3 percent (20.820 kg) of the pretest UO_2 fuel mass was fractured. The maximum

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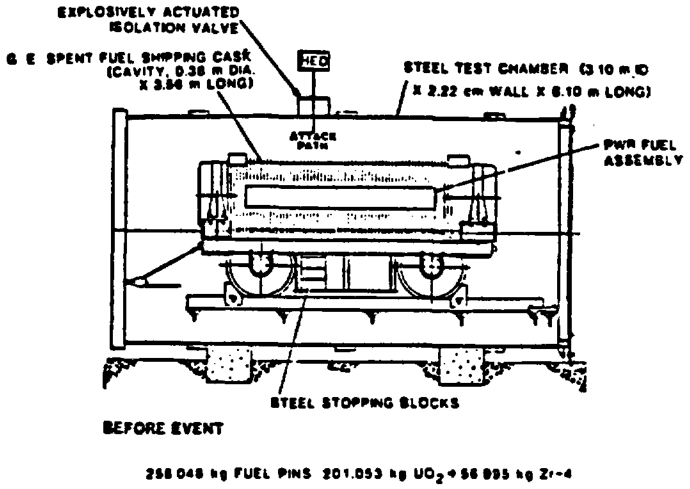

Figure 2. Schematic of the Full-Scale Reference Test Configuration Before Detonation Showing Finned Cask Inside Pressure (Aerosol Confinement) Chamber.

missing (removed as a result of the energy loading) fuel pin length was 76 mm. The entrance hole in the 2.54 cm thick stainless steel skin was approximately 15.25 cm in diameter (average). The opposite cask wall was not completely penetrated but the 1.9 cm thick inner stainless-steel shell and 14.29 cm of the 21.3 cm thick lead shell was penetrated. The outer 2.54 cm thick stainless-steel skin was not breached. A maximum UO_2 aerosol mass concentration of 23.8 g/ was detected in the pressure chamber at 12 seconds post-detonation. Using the containment chamber volume of 42.29 m^3 and a measured uniform spatial concentration of 23.8 g/ , a total released UO_2 aerosol mass of 1.01 g was calculated. Another 1.93 g of UO_2 was collected by the high pressure fiberglass filter assembly. Assuming that 100 percent of the measured UO_2 aerosol mass is in the respirable size range, a total respirable UO_2 mass of 2.94 ± 0.30 g was released from the cask as a result of the event.

The results of the single fuel assembly cask test can be extrapolated to that for a three fuel assembly cask sabotage event. Assuming the largest damage path for the action of the HED on the fuel, only two out of three fuel assemblies could sustain maximum damage for a three-PWR fuel assembly truck cask configuration. Therefore, based upon the full-scale test data, the maximum release of respirable unirradiated fuel from a three-PWR assembly cask sabotage event is 6 ± 0.8 g.

Correlation Tests

Tests performed at EG&G/INEL involved single fuel pellets of both depleted uranium dioxide and H. B. Robinson Unit-2 spent fuel subjected to attack by a scaled version of the reference base attack device. Two types of measurements were made that can be used in calculating a spent fuel to depleted uranium dioxide aerosol production correlation. The first measurement type was obtained from filters which collected aerosols generated from exposure of both spent and depleted

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uranium dioxide fuel pins to HED attacks. Because of their refractory nature the nuclides 154-Eu and 144-Ce were used as a tracer for uranium in the spent fuel pellets; amounts of these two fission products were determined by gamma spectroscopy. For the case of depleted uranium dioxide the total mass of aerosolized materials collected on the filter was 17 mg (gravimetrically determined). Assuming that the total mass consists of combustion products, fuel pin cladding and pellet material, an estimate of the relative masses represented by the three main components was made. It was estimated that 25 percent of the total collected aerosol mass was combustion products. The pellets consisted of 89 percent by weight of UO_2 for experiments with either spent fuel or depleted uranium dioxide. Therefore a 17 mg aerosol sample implied that 11.4 mg was uranium dioxide. The measured mass of aerosolized spent fuel for the same test correlations was found to be 5.95 + 1.67 mg. This analysis suggests a ratio of spent fuel to depleted uranium dioxide mass of 0.53:1.

A second series of measurements used for calculating the spent fuel versus depleted uranium dioxide correlation was based on wet sieving of debris resulting from identical experiments involving spent fuel and depleted uranium dioxide. Sieves used for classifying particles ranging in size from 5 m diameter to 212 m diameter were used to separate masses of spent fuel and depleted uranium dioxide. The mass remaining on each sieve was then used to calculate a ratio of spent fuel to depleted uranium dioxide for each sieve size fraction. A regression line was fitted to the data and a ratio extrapolated for the respirable size range (_3 m actual particle diameter). For particles 3 m and smaller, this analysis suggests the ratio of spent fuel to depleted uranium dioxide is 5.6:1.

In considering which correlation ratio is appropriate for use in risk analysis and calculation of radiological impacts, it would seem that a value of unity is most appropriate. This implies that the aerosolized release from the reference HED attack on a three PWR fuel assembly truck cask would yield approximately 6 g of spent fuel as a respirable aerosol. However, for conservatism in the health risk assessment, a maximum value of 5.6 will be used. This implies that the maximum aerosolized respirable release from a three PWR fuel assembly cask subjected to the reference HED attack would be 33.6 g of spent fuel and for a single PWR fuel assembly truck cask a release of 16.8 g.

Health Effects Evaluation

The Reactor Safety Consequence Model, CRAC,[4] was used in the Urban Studies[1,3] to estimate human health consequences from an attack using the reference HED on a three PWR fuel assembly truck cask. The basic scenario as defined in the Urban Studies was (1) the attack occurred in the borough of Manhattan in New York City, (2) the attack occurred on a weekday, midafternoon, (3) the spent fuel inventory was typical of PWR assemblies after 150 days cooling at the reactor, (4) all consequence estimates were made without any evacuation to avoid early exposure. For this scenario the 1978 Urban Study[1] estimated the health consequences to be 4/60 (mean/peak) early fatalities, 160/1600 (mean/peak) early morbidities and 350/1300 (mean/peak) early latent cancer fatalities. Using the same CRAC[4] model and assumptions and this study's experimentally determined release fractions for the same attack mode on a single PWR fuel assembly truck cask (0.5 tHM, 150 days cooled), values of health consequences were found to be 0/0 (mean/peak) early fatalities, 0/0 (mean/peak) early morbidities, 0.3/1.3 (mean/peak) early latent

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cancer fatalities, and 2/7 total latent cancer fatalities. Extrapolating this study's experimentally determined release fractions to the 1978 Urban Study[1] three PWR fuel assembly cask scenario, an estimate of the health consequences of 0/0 (mean/peak) early fatalities, 0/0 (mean/peak) early morbidities, 1/3 (mean/-peak) early latent cancer fatalities, and 4/14 total latent cancer fatalities were obtained. These newly calculated latent cancer fatalities are smaller by a factor of 350/433 (mean/peak early latent cancer fatalities) than the original 1978 Urban Study predictions upon which the NRC interim regulations[2] for US transport of spent fuel were based.

Conclusions

The data from this program indicate that the Urban Studies[1,3] greatly over-estimated the impact of malevolent acts directed at spent fuel casks in urban environs. From that standpoint this work could be the basis of additional regulatory revisions of the NRC physical protection requirements. In a larger sense this work can also be the basis of more credible "worst case" analyses since it defines the actual result of an event which is well beyond any expectation of cask failures in accident environments. Thus this experimental program has provided significant new information on the behavior of spent fuel and surrogate materials under severe shock and thermal environments. These data can be the basis of a better understanding of spent fuel transport risks and safety analyses.

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INTERNATIONAL CONFERENCE ON RADIOACTIVE WASTE MANAGEMENT

Seattle, WA, USA, 16–20 May 1983

IAEA-CN-43/243

ASSESSING THE ESTIMATED COST AND RISK OF NUCLEAR WASTE TRANSPORTATION TO POTENTIAL COMMERCIAL NUCLEAR WASTE REPOSITORY SITES

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IAEA-CN-43/243

ASSESSING THE ESTIMATED COST AND RISK OF NUCLEAR WASTE TRANSPORTATION TO POTENTIAL COMMERCIAL NUCLEAR WASTE REPOSITORY SITES

ABSTRACT

To support the selection of the first commercial nuclear waste repository in 1987, the cost and risk of transporting waste to candidate sites is being evaluated. The method of assessment is described and some preliminary results are presented for a reference scenario.

In reference scenario 36 000 tonnes of spent fuel are shipped directly to the repository and an equal amount to Barnwell, South Carolina for reprocessing with the resultant wastes then going to the repository. The scenario also includes 6 720 waste logs from Savannah River and 300 from West Valley.

For the five repository sites considered, total transportation costs range from 1.3 to 2.2 x 10^9 dollars, statistically based accident fatalities from 5 to 12, injuries from 50 to 110, and calculated latent cancer fatalities (LCFs) from 13 to 27. Less than 0.02 LCFs are attributable to postulated releases from extremely severe accidents.

The cost and risks, while significant, are small, in comparison with other costs and risks generally encountered. Repositories are estimated to cost US$ 5 x 10^9. Fatalities from cargo transport by railroad and truck during a comparable 26-year period would total almost 100 000 in the USA; this scenario would add less than 0.02% of fatalities to this number. The population exposures (LCFs) shown here are less than 0.03% of those attributable to background radiation. The maximum exposed individual would receive about 1 percent of background during a typical year.

Sensitivity analyses show that the volume of reprocessed waste and the speed of trains are sensitive parameters. By reducing the stop time of trains by half, the LCFs could be reduced almost by half and a significant reduction in the required rail cask fleet would also be possible. Additional data on population exposure at stops is being obtained.

It is expected that studies similiar to the one reported here will make it possible to identify additional ways to reduce nuclear waste transportation risks.

1. INTRODUCTION

Research and development efforts in nuclear material transport have been striving to develop the capability to evaluate the cost and risks associated with transport for the nuclear fuel cycles being postulated. The capability to model future transport systems and estimate their costs and risks is important for informed decision making. Such models should build on currently available experience and information and be capable to project future impacts.

In this paper, the first part briefly describes the types and sources of information that are being used to make cost and risk assessments. Particular emphasis is given to the analysis models that have been developed and the types of information they use. The second part is devoted to showing some preliminary results for a specific transport scenario. The last part presents the results of some sensitivity analyses made to identify key areas needing further study.

The work shown is the product of the coordinated activities of Edwin Wilmot, Marcella Madsen, and Jon Cashwell of the Transportation Technology Center at Sandia National Laboratories, David Joy of Oak Ridge National Laboratories and the authors. Without such coordination, analysis of the costs and risks for tranport to sites being evaluated by the National Waste Terminal Storage (NWTS) Program would not have been possible.

2. TRANSPORT SYSTEM CHARACTERIZATION

One of the more complex aspects of evaluating the costs and risks of a transportation operation is defining the transport systems characteristics. The steps in this process are shown schematically in Figure 1. Beginning at the top, the first step is to identify the quantities of waste and their geographic distribution relative to the proposed disposal sites. The Spent Fuel Storage Program provides annual updates[1] of the spent fuel inventories and projected discharges for each reactor operating, under construction or planned in the United States.

Waste characteristics are specified using burn-up simulation codes such as ORIGEN2[2]. Reprocessing waste volumes and characteristics are obtained from published sources[3] or from special studies performed to evaluate specific reprocessing strategies.

Based on the waste characteristics, cask designs must be evaluated to determine the quantity of a particular waste type that can be transported without exceeding transport restrictions. The number of shipments can then be calculated from the previously determined logistical data.

The next step is to characterize the transport routes and the impacts of both normal transport and from accidents that have the potential to release some of the radioactive material in the cargo. The specification of route characteristics begins by taking the shipment and waste logistics information and using two routing models, HIGHWAY[4] for truck and INTERLINE[5] for rail, to identify some typical routes. Distance data is used to estimate cask fleet size. The routes identified by HIGHWAY and INTERLINE are then evaluated along with demographic data for the United States to determine the fraction of the routes passing through rural, suburban and urban areas. These fractions and the total distance transported are basic parameters used with RADTRAN-II[6]. RADTRAN calculates the impact of normal transport and the consequences of release in each of the population zones for each waste type and shipment made.

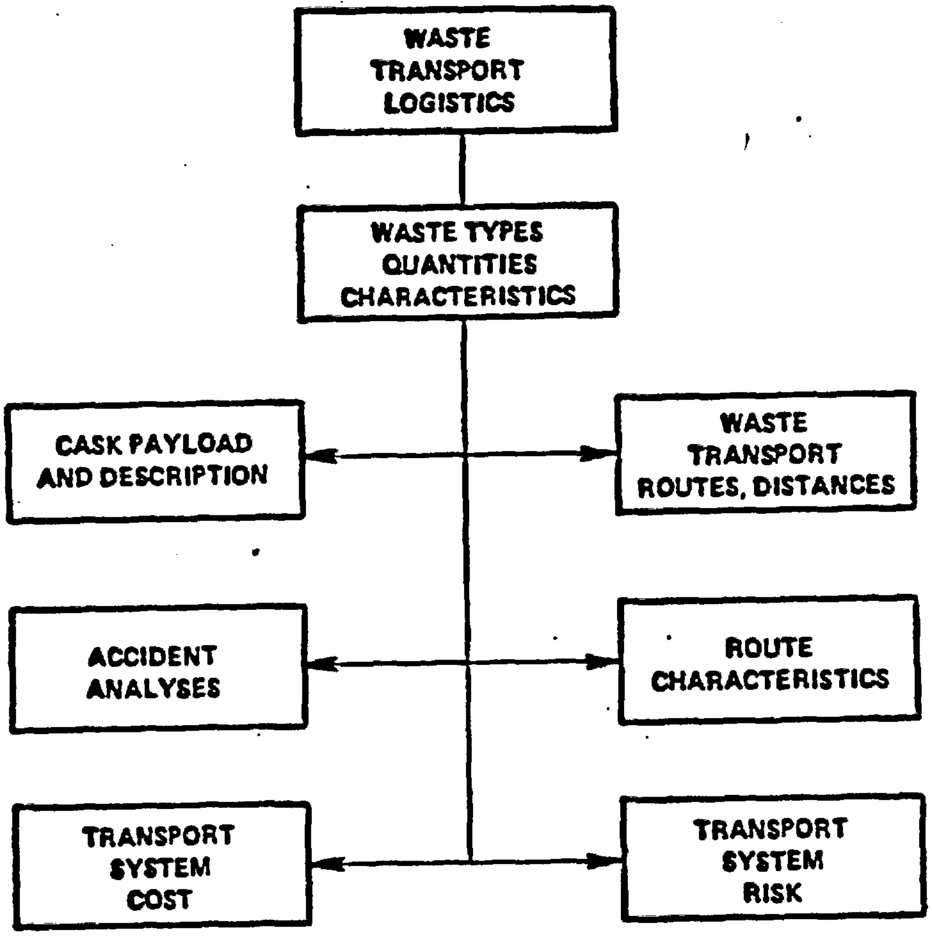

FIGURE 1. TRANSPORT SYSTEM CHARACTERIZATION

The basic form of the data for normal transport is a table of unit risk factors for each waste form, transport mode and population zone. These factors have units such as fatalities/km. The accident risk part of RADTRAN-II requires information on up to eight severity levels of accidents. For each waste form, the probability and the amount of material released (by isotope) must be specified. RADTRAN-II then takes this information and calculates population exposure risk factors should an accident of a given severity occur in a given population zone.

The final step is to calculate the overall cost and risk for a given waste disposal scenario. The cost is calculated based on knowledge of the number of shipments, shipment distance, transit time, shipping charges, fleet size and cask purchase and maintenance costs. The risk is calculated using the unit risk factors obtained from RADTRAN-II and the knowledge of shipment distance and the fraction of the route through each of the three population zones. Health effects resulting from exposure to low levels of radiation are calculated using internationally accepted conversion factors.

The following sections will present the Transport System Characteristics using one specific scenario for transport to each of the five disposal sites currently being considered in the NWTS Program. Because only one scenario is used and because many of the results obtained to characterize the system are presented here for the first time in composite form, the results shown should be considered as preliminary.

3. WASTE TRANSPORT CHARACTERISTICS

In order to assess the costs and risks of waste transport to potential repository sites, it is necessary to completely characterize the system, even parameters such as transport mode and route and cask payloads. These parameters are uncertain since operational decisions have not yet been and will not be made for years to come. The approach taken here is to pick representative values for each of the parameters and incorporate them in what will be called a reference scenario.

The reference scenario considers waste transport to each of five locations within the United States. The locations, shown in Figure 2, are named after the regions in which they are located; the Gulf Interior Region (dome salt) the Permian Basin (bedded salt), the Paradox Basin (bedded salt), Yucca Mountain (tuff) and the Hanford reservation (basalt). For each of the sites, life cycle costs and operational risks for a 26-year operating period are calculated.

The reference scenario describing the quantity of waste to be transported to each site is shown schematically in Figure 3. 72 000 tonnes of uranium discharged from commercial nuclear power plants, 6720 high level waste (HLW) glass logs in metal canisters from Savannah River defence waste processing and 300 HLW logs from West Valley processing are transported to the repository sites. Half of the 72 000 tonnes is transported directly to the repository, the other half is shipped to Barnwell, South

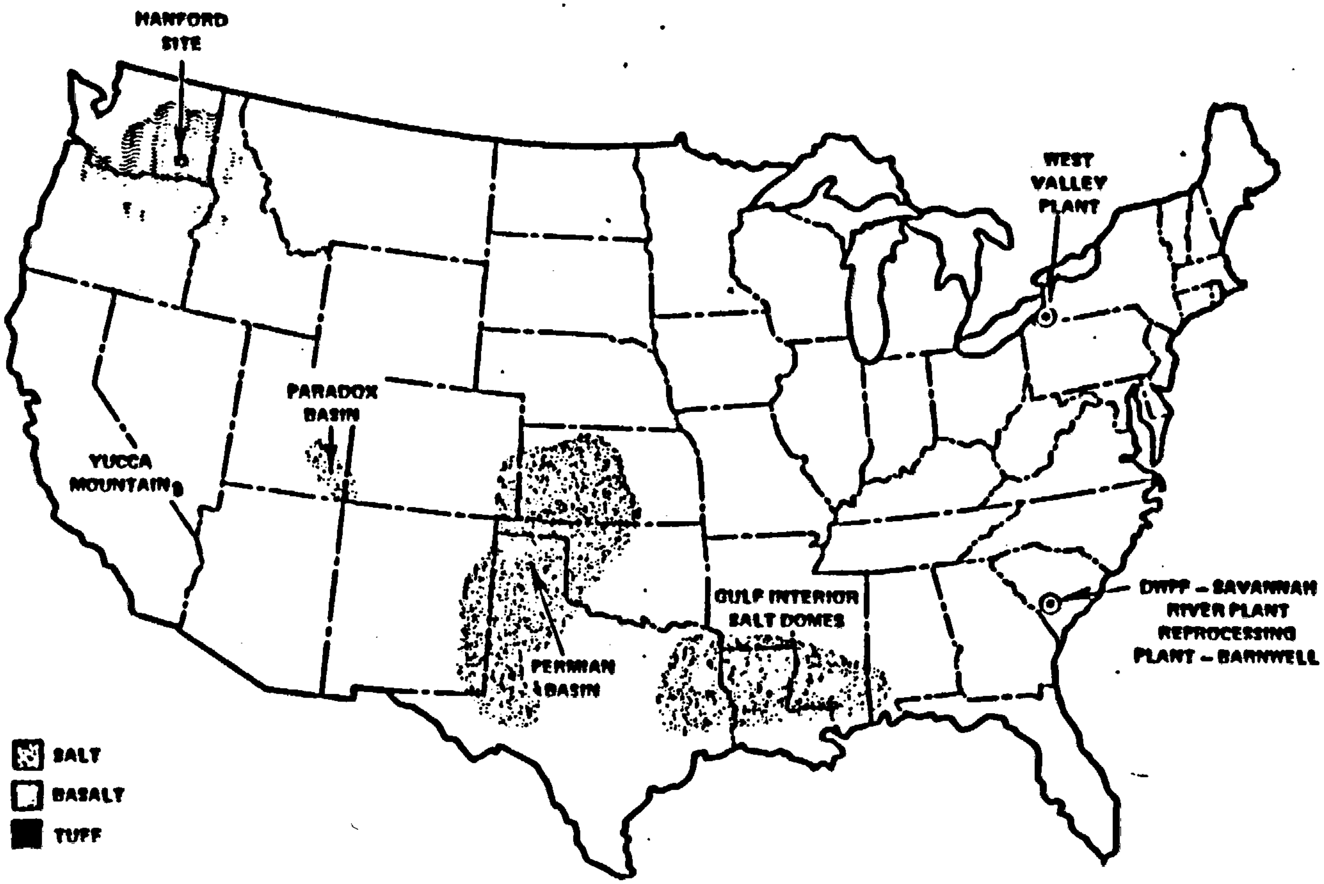

FIGURE 2. KEY LOCATIONS IN REPOSITORY TRANSPORTATION ASSESSMENT

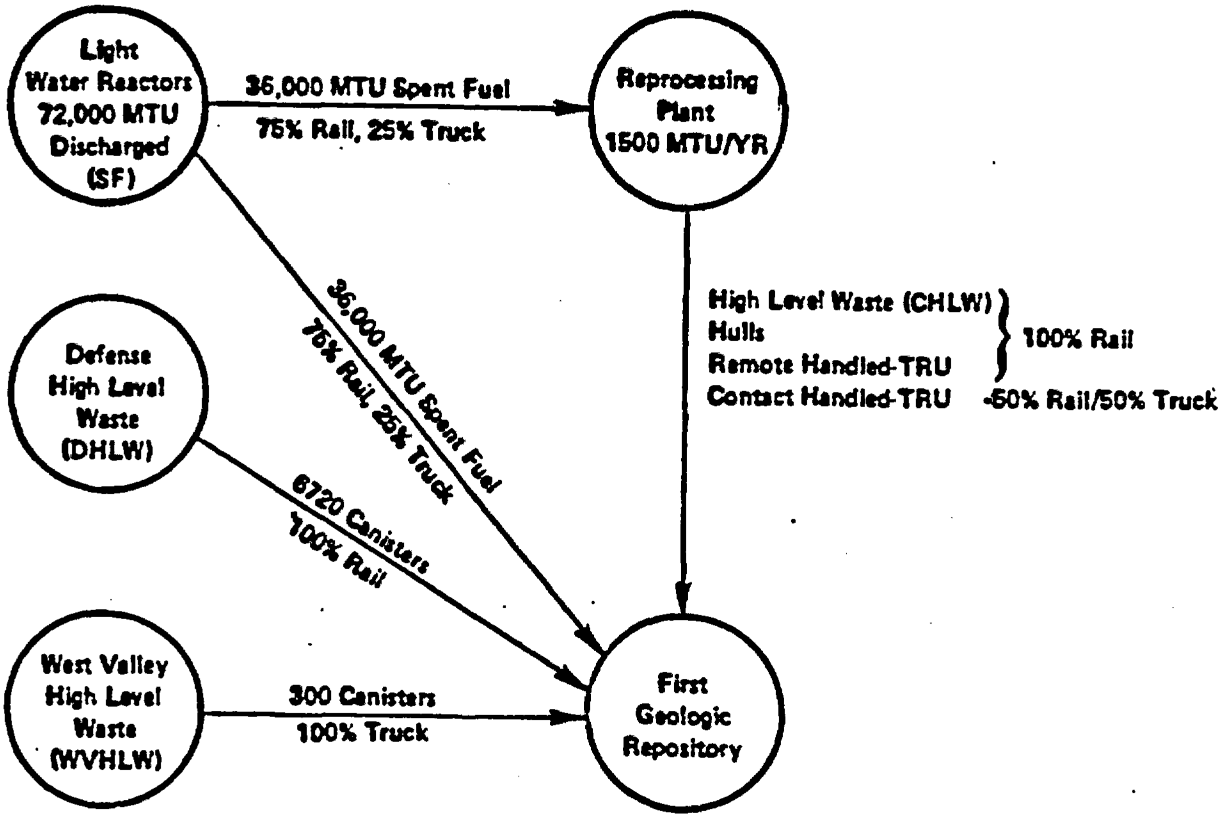

FIGURE 3. SCENARIO FOR REPOSITORY TRANSPORTATION ASSESSMENT

Carolina for reprocessing. Reprocessing wastes are then shipped to the repository sites. For each waste type, the fraction to be shipped by truck and rail is selected. For spent fuel, 75% is shipped by rail and 25% by truck. Wastes from reprocessing requiring heavy shielding are shipped by rail. Contact-handleable transuranics (CH-TRU) are shipped 50% rail, 50% truck. All wastes from Savannah River are shipped by rail; West Valley wastes are shipped by truck in this reference scenario.

For each of the model options, reference transportation systems were specified based upon waste form data from ORIGEN2 and canister configurations being used in the NWTS Program in 1982. Payload estimates for each of the transportation systems were based on shielding calculations using DOT allowable radiation levels and vehicle size and weight requirements for unrestricted shipment by both truck and rail. Data and results of these preliminary calculations are given in Table I. Transportation distances and transit times for wastes from nuclear reactors were based upon twenty-one reactor centroids to establish routes from all parts of the country to the Barnwell, South Carolina reprocessing plant and each candidate repository location. The transport distances and cask payloads were then used to estimate cask fleet size. To make these estimates, current experience was reduced to empirical formulas for distance versus speed for truck and rail transport, cask turnaround time and cask availability. The total shipment distance and fleet size for each type of waste, destination, and mode is shown in Table II.

4. WASTE TRANSPORT COSTS

Transport costs for the reference scenario were calculated by combining fleet capital, fleet servicing and maintenance, and shipping charges. These costs are summarized in Table III. Fleet capital costs were based on transportation system characteristics and comparison with costs of existing transport systems. Servicing and maintenance costs were estimated by taking a fraction of the unit capital cost per year multiplied by the operating fleet size. It was also assumed in the capital cost that the fleet would be completely replaced once during the repository operating lifetime for all waste types except for DHLW and WV-HLW. These two waste types are shipped to the repository during only a portion of the operating period. Freight charges were based upon published tariffs, where available, and estimates based on spent fuel where no tariffs were published. Charges for physical security while in transit were based on current spent fuel escorting experience. These costs were applied to all waste forms. This is believed to be conservative in that current regulations do not include such requirements on reprocessing waste types. Additional charges for administrative functions and traffic management were not included. Such functions and related costs would be covered by the staffs at origin and destination facilities. Also, cost for construction of truck and rail access to repository receiving facilities was not included; this is assumed to be included in the repository cost.

TABLE 1. PACKAGING DATA FOR TRANSPORTATION ASSESSMENT

Waste Type	Conversion[1] Factor	Waste[2] Quantities	Waste Configuration	Transport Index[5]	Truck[3] Payload[6]	Truck[3] No. of Shipments	Rail[4] Payload[6]	Rail[4] No. of Shipments
Spent Fuel[7]	–	72,000	PWR/BWR Assy's	20	2/5	20,817	12/32	10,061
CHLW	0.438	15,789	13" dia x 10' lg	20	1	0	12	1,316
Hulls	0.15	5,413	30" dia x 10' lg	20	1	0	4	1,354
RHTRU	0.75	27,070	30" dia x 10' lg	4	1	0	4	6,768
CHTRU	5.25	189,470	55 gal drums	2	16	5,921	52	1,822
DHLW	–	6,720	24" dia x 118" lg	20	1	0	5	1,344
WV-HLW	–	300	24" dia x 118" lg	20	1	300	7	0

(1) Canister or drum per MTU reprocessed.
(2) Reprocessing wastes quantities given in number of canisters or drums; spent fuel given in MTU.
(3) Loaded shipping weight for all waste types – 80,000 lb. max.
(4) Loaded shipping weight for all waste types – 200,000 lb. max except CHTRU is 140,000 lb.
(5) Dose at one meter from the cask in mrem/hr.
(6) Payload refers to number of fuel assemblies, canisters, or drums per transport package.
(7) All spent fuel treated as PWR in radiological analyses.

TABLE II. WASTE TRANSPORT FLEET REQUIREMENTS

	Shipment Destinations											
	Reprocessing Site		GIR		Permian		Paradox		Yucca Mt.		Hanford	
Transport Mode/Waste Type	Total Distance, 10^6 km	Fleet Size, No.	Total Distance, 10^6 km	Fleet Size, No.	Total Distance, 10^6 km	Fleet Size, No.	Total Distance, 10^6 km	Fleet Size, No.	Total Distance, 10^6 km	Fleet Size, No.	Total Distance, 10^6 km	Fleet Size, No.
Truck												
Spent Fuel	19	7	21	7	28	8	35	9	41	10	46	11
CH-TRU	–	–	7	4	16	5	24	7	27	7	32	8
West Valley-HLW	–	–	1	2	1	2	1	2	1	2	2	2
Rail												
Spent Fuel	11	14	12	14	15	16	18	17	22	19	24	19
Commercial-HLW	–	–	2	4	4	5	6	6	8	7	8	7
Hulls	–	–	2	5	4	5	6	6	8	7	8	7
RH-TRU	–	–	11	21	21	25	31	30	38	31	40	32
CH-TRU	–	–	3	6	6	7	8	8	10	9	11	9
Defense-HLW	–	–	2	8	4	9	6	11	8	11	8	12

TABLE III - TRANSPORT DISTANCE, FLEET AND COST SUMMARY

	GIR	PERMIAN	PARADOX	YUCCA MTN.	HANFORD
VEHICLE MILES TRAVELED (millions of miles)	89	129	166	194	207
FLEET SIZE (No. of Units)	92	103	117	124	128
FLEET CAPITAL (millions of 1982 dollars)	325	362	404	430	439
FLEET SERVICING AND MAINTENANCE (millions of 1982 dollars)	227	254	286	305	312
FREIGHT AND IN TRANSIT SECURITY (millions of 1982 dollars)	742	1003	1182	1371	1418
TOTAL COST (millions of 1982 dollars)	1294	1619	1872	2106	2169

TABLE IV - TYPICAL TRANSPORT COST BREAKDOWN (PERMIAN)

WASTE TYPE	MILLIONS of 1982 $US	% OF TOTAL
Spent Fuel to Repository	447	28
Spent Fuel to Reprocessing	355	22
CHLW	78	5
HULLS	83	5
RHTRU	418	26
CHTRU	147	9
DHLW	84	5
WV-HLW	5	0.3
		100%

The relative costs for each waste type for a typical location (Permian Basin) are given in Table IV. It is readily evident that transport of transuranium wastes from reprocessing makes up a significant portion of the costs. These higher costs are due in part to the conservatism in assumptions related to transuranium waste volumes generated in reprocessing and in the potential for volume reduction in waste treatment. More detailed future analyses in this area will probably result in reduced costs for these waste types.

5. WASTE TRANSPORT RISKS

Risk estimates have been made in terms of health effects—injuries, deaths, latent cancer fatalities (LCFs)—to both occupational and public groups, which may result from transportation operations. Both normal operations and possible accidents were considered. Calculations of non-radiological impacts were based on References 7 and 8 and radiological impacts on References 6 and 9. Results of the risk assessment are summarized in Table V. Radiological impacts under normal conditions included consideration of radiation levels from the waste transport loadings shown in Table I, typical truck and rail operational speeds, stops during transit, population density distributions in regions traversed and proximity of shipments to the population. The LCF's shown in Table V consider population exposure resulting from transport. The maximum individual exposure was also calculated. It was found that the maximum individual received less than 1.4 mrem/yr, about 1 percent of background.

TABLE V - TRANSPORT RISK SUMMARY

	GIR	PERMIAN	PARADOX	YUCCA MTN.	HANFORD
Non-Radiological					
Injuries[1]	46	65	85	99	105
Deaths[1]	5	8	10	12	12
Pollution Health Effects	0.2	0.2	0.3	0.3	0.3
Radiological - LCFs[2]					
Normal Operations	13	19	22	26	27
Accidents	0.01	0.02	0.02	0.02	0.02

(1) Based on Current Accident Statistics

(2) Estimtaes Include Present and Future Generations

Both the non-radiological and radiological estimates of accidents were based on accident rate experience recorded in national transportation statics. Accident predictions over the life cycle of repository operations are summarized in Table VI. Of the total number of accidents, it is expected that less than 2% would be of such severity that a radiological release is conceivable. Even though very unlikely, accidents of such severity and related conceivable releases have been included in the risk estimates. Injuries and deaths indicated in Table V were those which may result from ordinary traffic accidents, both truck and rail, and were independent of the radioactive material present in loaded shipments. Radiological impact calculations (LCFs)included additional factors such as accident probability, severity, conceivable isotopic releases, meteorological conditions, and population distribution. Because of the complexity of the problem and the number of scenarios and related waste types considered, the analysis was simplified by calculating unit risk factors that represent the impact for a unit distance of travel. These unit risk factors were calculated for each waste type, and urban, suburban, and rural population densities and then combined with distances traveled to determine total impact. The results of the risk assessments indicate that the only significant radiological risk is from normal transport, not from accidents. No immediate radiological injuries or deaths are expected from accidents.

TABLE VI - PREDICTED TRANSPORT ACCIDENT SUMMARY (PERMIAN)

Waste Type	Number of Accidents - Life Cycle Truck	 Rail
SF to Repository	48	26
SF to Reprocessing	31	19
CHLW	0	7
HULLS	0	7
RHTRU	0	37
CHTRU	27	10
DHLW	0	7
WVHLW	2	0
TOTALS	108	115

The magnitude of cost and risk results should be placed in some perspective to be meaningful. The values in Tables V and VI are for 26 years of repository operation. In that same period and using the same models and data as used in this analysis, 117 000 latent cancer fatalities would be predicted for the nation from background radiation. About 65 000 people would be predicted to die from truck accidents and 32 000 from train accidents in the course of moving the nation's freight. With respect to cost, nearly 1 x 10^{12} US dollars would have been spent by the consumer of the electricity produced from which these wastes resulted. Some additional comparisons are summarized in Table VII.

TABLE VII - TRANSPORT COST AND RISK PERSPECTIVES

- Waste transport costs are 0.2% of cost to consumers using the generated nuclear power
- Waste transport vehicle miles traveled are 0.02% of commercial freight over a comparable period of time
- Deaths predicted are 0.02% of the current annual total for commercial freight
- LCFs are only 0.03% of those attributable to natural background radiation.

6. SENSITIVITY ASSESSMENT

Narrowing the uncertainties present in the risk results is dependent upon refinement of basic inputs such as the quantities of waste, waste form and the packagings used. Sensitivity analyses, coupled with estimates of the uncertainty in parameters play an important role in prioritizing a list of refinements. Comparison with previous results is a form of sensitivity analysis. Both will be used here.

By varying the split of rail and truck, large shifts in the risk numbers are observed. Going fully to truck transport would increase the fatalities by a factor of 5 but would decrease the LCFs by a factor of 2. Such swings are greater than the differences observed among sites and points out the results shown should be considered relative to other risks and to a lesser extent as absolute values which will occur should a decision be made to emplace waste at one of the sites.

Changing the duration of stops by trains has a large impact on cost and risk. In the risk model, trains were estimated to stop 8.6 h/100km versus 1.1 h/100km for trucks. Reducing the train stops to 4.3 h/100km reduces the LCFs by 45%. The values for stop time and the population exposure while stopped are very uncertain parameters. Additional studies have been initiated to refine the stop model and the input parameters to the model.

6.1 Comparison with Previous Work

The results shown here are quite different from the results presented in previous assessments [10,11] done within the NWTS Program . In the past assessments, the frequency of non-radiological fatalities per unit of travel for truck and rail were about equal. Recent statistics show that the accident fatality rate for rail is about a factor of two lower than indicated in previous estimates [3]. When this new data is incorporated into the risk calculation and is coupled with the assumption that the rail cargo payload is approximately five times greater than the truck payload, the number of fatalities for rail becomes about an order of magnitude lower than truck results for transport of the same quantity of waste. Previous estimates showed only the effect of the difference in payload between truck and rail.

The radiological risk calculations also show some major differences. Previous estimates have considered exposure from accidents which are severe enough to release material as well as exposure to the population from passing casks. The estimates here are quite similar to previous estimates for these exposures. In the present calculation, a new model for exposure to the general population from stops was considered. The stops model incorporated in RADTRAN-II was developed following observation of both truck and rail shipments. Incorporating the results of these observations into the model shows that the dominant exposure to the general population occurs at stops. The results show that the risk of release, which has been the focus of many past transport studies, poses a lesser risk than stops. This last statement is not meant to imply that additional modeling of releases is not important.

Rather, it points out that other components of the risk equation need to be studied with equal thoroughness.

For perspective, the current modeling of the stops can be compared with the exposure received by the populace around the reactors that generated the waste being transported. Based on an assessment of population doses from operating plants in 1975[12], the population dose was 1300 person-rem for the generation of 170 x 10^{12} watt-h of electricity or 7.6 person rem/10^{12} watt-h of electricity generated. A repository with a capacity of 72 000 MTU contains waste from fuel that has generated an estimated 526 x $10x^{12}$ watt-h/a of electricity. The associated population exposure from reactor operation would be 4000 person-rem/a or 0.8 LCFs/a. Multiplying by the 26 year operating period results in 20 LCFs which is approximately equal to the LCFs estimated for transportation. Thus the transport LCFs shown are very comparable to the LCF of operating plants generating the waste. An additional perspective, if the same person-rem/LCF conversion factor were used for background radiation, 117 000 LCF would be projected to occur during the 26 year operating period.

The comparison among the five candidate sites shown here considered only the first repository. Siting of the second and subsequent repositories can have a significant effect on both costs and risks. Previous assessments[13] of the regional concept indicated that transportation cost and risk may decrease by as much as a factor of two by optimal regional siting of 2 or 3 repositories. Such differences are comparable to the differences in costs and risks between repository sites reported here. Accordingly, additional transportation analyses of the regional siting concept are needed.

The results shown here are the initial attempt to estimate the cost and risks of transporting waste materials to the 5 potential repository sites. The basis for many of the values shown is taken from work being performed by Sandia Laboratories for the NWTS Program, soon to be published in reference[14]. The results should be considered preliminary and will be refined substantially before the site of the first repository is chosen in 1987. The values shown can be used to estimate transport impacts relative to other risks encountered daily by society. Such perspective is important in informed decision making.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
Office of Public Affairs
Washington, D.C. 20555

NUREG/BR-0032
Vol. 4 **, No.** 13 **WEEK ENDING** April 3, 1984

NEWS RELEASES

No. 84-42
Tel. 301/492-7715

FOR IMMEDIATE RELEASE
(Thursday, March 29, 1984)

NOTE TO EDITORS:

Attached is a Nuclear Regulatory Commission "General Statement of Policy" defining the agency's role in responding to accidents and incidents involving the transportation of nuclear materials.

NUCLEAR REGULATORY COMMISSION
NRC Response to Accidents Occurring
During the Transportation of Radioactive Material;
General Statement of Policy

AGENCY: Nuclear Regulatory Commission.

ACTION: General Statement of Policy.

SUMMARY: The Nuclear Regulatory Commission (NRC) has defined in a general policy statement its role in responding to accidents and incidents related to the transportation of nuclear materials. The purpose of the policy statement is to state clearly the extent of the NRC's participation and involvement in responding to such a transportation accident or incident.

EFFECTIVE DATE: MAR 29 1984

FOR FURTHER INFORMATION CONTACT: Dr. Justin T. Long, Office of Nuclear Material Safety and Safeguards, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, telephone (301) 427-41[illegible].

SUPPLEMENTARY INFORMATION:

<u>Background</u>

The Nuclear Regulatory Commission (NRC), under the Atomic Energy Act of 1954, as amended (42 U.S.C. Chapter 23) and Section 201 of the Energy Reorganization Act of 1974, as amended (42 U.S.C. 5841), is authorized to license and regulate the receipt, possession, use, and transfer of "byproduct material," "source material," and "special nuclear material" (as defined in 42 U.S.C. 2014). The NRC authority to license air shipment of plutonium is further governed by Pub. L. 94-79. Pertinent NRC regulations are contained in 10 CFR Parts 30, 40, 70, 71, and 73.

The U.S. Department of Transportation (DOT), under the Dangerous Cargo Act (R. S. 4472, as amended, 46 U.S.C. 170), Title VI and 902(h) of the Federal Aviation Act of 1958 (49 U.S.C. 1421-1430 and 1472(h)), the Department of Transportation Act (49 U.S.C. 101, et seq.) and the Hazardous Materials Transportation Act (49 U.S.C. 1801-1812), is required to regulate safety in the transportation of hazardous materials, including radioactive materials. Pertinent DOT regulations are contained in 49 CFR Parts 100 to 178.

The roles in regulatory responsibility of NRC and DOT have been delineated in a Memorandum of Understanding (MOU) between the two agencies dated June 8, 1979 (44 FR 38690). The MOU does not define the specific responsibilities of each agency in responding to transportation accidents or incidents. However, in all accidents, incidents, and instances of actual or suspected leakage involving packages of radioactive material regulated by the NRC, the MOU assigns to NRC the responsibility to act as lead agency for investigating the cause of the leakage and preparing a report of the investigation.

The Federal Emergency Management Agency (FEMA) is responsible for preparing a Federal Radiological Emergency Response Plan (FRERP). On December 23, 1980, FEMA published a "Master Plan" for commercial nuclear power plant accidents (45 FR 84910). Development of the FRERP, which is scheduled for completion in 1984, entails revision of the "Master Plan," including its expansion to incorporate provisions for responding to all types of peacetime radiological emergencies including transportation accidents. Availability of planning guidance for developing the FRERP was noticed in the Federal Register on April 28, 1983 (48 FR 19229). The FRERP will be based on the planning guidance and on the results of a Full Field Exercise conducted in the vicinity of the St. Lucie nuclear power plant in March 1984.

The response to transportation accidents is less structured than the radiological emergency response to accidents at licensed sites because of the uncertainties surrounding (1) the location where the accident occurs, (2) the diversity of authority of those who will be responding, and (3) the likely limited radiation knowledge of the first-on-scene responders (who are usually local officials). The states have the primary responsibility for protecting the health and safety of the citizens from public hazards. Recognition of the responsibilities for radiation hazards is reflected by the existence of an appropriately designated state agency chartered with the responsibility of responding to radiological emergencies.

The existing Memorandum of Understanding between the DOT and the NRC (mentioned above) assigns NRC the responsibility for the regulation and certification of shipping containers for fissile materials and for other radioactive materials (other than low specific activity materials) in quantities exceeding Type A limits as defined in 10 CFR Part 71. The MOU assigns DOT the responsibility for regulation of most other aspects of nuclear transportation activities. DOT operates a National Response Center which serves to relay information concerning transportation incidents involving hazardous materials. DOT regulations require a carrier, at the earliest practicable moment, to give notice to the National Response Center after an incident occurs during the course of transportation in which, among other things, fire, breakage, spillage, or suspected radioactive contamination occurs involving shipment of radioactive material. Each notification of a transportation incident of any kind is relayed by the National Response Center to the Regional Office of the Environmental Protection Agency (EPA) for incidents on land or to the U. S. Coast Guard Captain of the Port for incidents in navigable waters. When a reported incident is known to involve radioactive material, notification is also made to the Regional Coordinating Office for Radiological Assistance of the U. S. Department of Energy (DOE) and to the Regional Office of the Nuclear Regulatory Commission. NRC may also become aware of a transportation incident through other channels, such as the shipper, the carrier, or the police or highway patrol.

DOE has stated that DOE's involvement is the maintenance, at about 30 sites, of teams of technically trained nuclear and transportation specialists available to assist states, upon request, by providing desired advice and counsel in areas where states may need assistance. Such teams are highly professional and are equipped to provide analytical and diagnostic support, but not to become involved in cleanup activities. Such teams operate under the DOE Radiological Assistance Program or the Federal Radiological Monitoring and Assessment Plan (DOE coordinated).

The Commission invites all interested persons who desire to submit written comments or suggestions on this general statement of policy to send them to the Secretary of the Commission, United States Nuclear Regulatory Commission, Washington, D. C. 20555, Attention: Docketing and Service Branch by JUL 27 1984 Consideration will be given to such submissions in connection with possible future revision of the stated policy. Copies of comments received may be examined at the Commission's Public Document Room, 1717 H Street, N. W., Washington, D. C.

Statement of NRC Policy:

In any accident or incident occurring in connection with the transportation of radioactive material in which a report is required to be sent to the National Response Center by DOT regulations in 49 CFR 171.15, NRC radiation safety assessment actions will consist of the following.

- Call the agency designated by the affected State to respond to transportation accidents involving radioactive materials as soon as practicable to ensure that agency has been informed of the incident. (The State government is responsible for assuming control of the accident scene to protect the health and safety of the public.)
- Offer NRC technical assistance in the form of information, advice, and evaluations to the State at the time the initial notification is made to the appropriate State agency.
- Assure awareness of the incident by the DOE and other affected agencies, including any agencies specifically designated by the Federal Emergency Management Agency.
- Maintain awareness of the situation until normal conditions are restored at the scene of the accident.
- Provide information on packaging characteristics in response to any query regarding NRC-approved packages.
- Respond to requests for information on NRC activities in connection with the event. Requests for specific information on an accident normally will be referred to the appropriate State agency, or to the DOE if the situation relates to DOE activities.
- If the shipper is an NRC licensee, ensure that the shipper provides complete and accurate information concerning the radioactive material and details of the shipment to emergency response personnel.
- In accordance with the NRC-DOT Memorandum of Understanding, act as lead agency for investigating all accidents, incidents, and instances of actual or suspected leakage involving packages of radioactive material regulated by the NRC. Any NRC personnel at the scene of a transportation accident will notify the on-scene coordinator of his or her presence and make clear that, unless NRC assistance is requested by the on-scene coordinator, NRC activities will be primarily limited to information collection.
- Provide recommendations to emergency response personnel on radiological issues if NRC assistance should be requested by the on-scene coordinator or if a need is recognized by NRC personnel.

The policy here set forth relates solely to radiological concerns. Responding to any attempt to steal or sabotage a shipment of nuclear material is a responsibility of the Federal Bureau of Investigation (FBI) as delineated in the NRC/FBI Memorandum of Understanding dated April 27, 1979, and published December 20, 1979, at 44 FR 75535.

Dated at Washington, D. C., this
23rd day of March, 1984.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,
Secretary of the Commission.

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No. 84-43
Tel. 301/492-7715

FOR IMMEDIATE RELEASE
(Monday, April 2, 1984)

NRC PROPOSES REVISED FINANCIAL QUALIFICATIONS REQUIREMENTS

The Nuclear Regulatory Commission is proposing to amend its regulations governing the financial qualifications of applicants to build and operate nuclear power plants.

The Commission eliminated its previously existing financial review requirements governing both applicants for operating licenses and construction permits for nuclear power plants in amendments to its regulations published in March 1982. The action was challenged by the New England Coalition of Nuclear Pollution and others in a suit filed in the U.S. Court of Appeals for the District of Columbia Circuit.

In a February ruling this year, the court remanded the rule back to the Commission--finding it inconsistent because the reasons advanced for eliminating the requirements for electric utilities would, if supported by the facts, apply to all license applicants. The court also found that, in promulgating the final rule, the Commission had abandoned the premise on which the proposed rule was based--that regulated utilities were presumed to be financially qualified because of their regulated status.

In effect, the proposed amendments would reinstate the previous requirement that applicants for a construction permit be financially qualified to conduct the activities authorized by the permit. However, there currently are no applications to build nuclear power plants pending and this approach will give the Commission an opportunity to study the matter further without delaying a response to the court's remand.

At the operating license stage, however, the Commission continues to believe that the regulated status of electric utilities continues to provide a reliable basis for determining financial qualification and that a case-by-case review is unnecessary. This view is supported by several court decisions which have established the principle that, once a facility is substantially completed, public utility commissions are to set rates which permit utilities to recover all reasonable costs of serving the public.

Accordingly, the proposed amendments would not require a financial qualifications review for applicants for operating licenses who are regulated public utilities or are authorized to set their own rates. All other applicants for operating licenses and construction permits would, under the proposeds amendments, continue to be subject to case-by-case financial qualifications reviews.

The Commission also does not intend to waive or relinquish its authority to require financial qualifications information as necessary in other circumstances or to preclude an exception to or waiver of the proposed rule if special circumstances were demonstrated.

The Commission also is seeking public comment on an alternative approach which would eliminate completely financial qualifications review requirements for all license or permit applicants. Experience to date indicates that these reviews probably do not provide any significant additional assurance of safety beyond that provided by pre-licensing reviews of facility structures, systems and components; operating and material handling procedures; and technical qualifications.

Written comments on the proposed amendments to Parts 2 and 50 of the NRC's regulations should be recieved by June 1, 1984. They should be addressed to the Secretary of the Commission, Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch.

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CONF-830528--Vol. 1

PATRAM '83

Seventh International Symposium on

PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS

Proceedings

MAY 15-20, 1983

New Orleans, Louisiana, U.S.A.

Transportation Technology Center
Sandia National Laboratories
and
Oak Ridge National Laboratory

Date Published: December 1983

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by Union Carbide Corporation for the U.S. Department of Energy
under Contract No. W-7405-eng-26

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