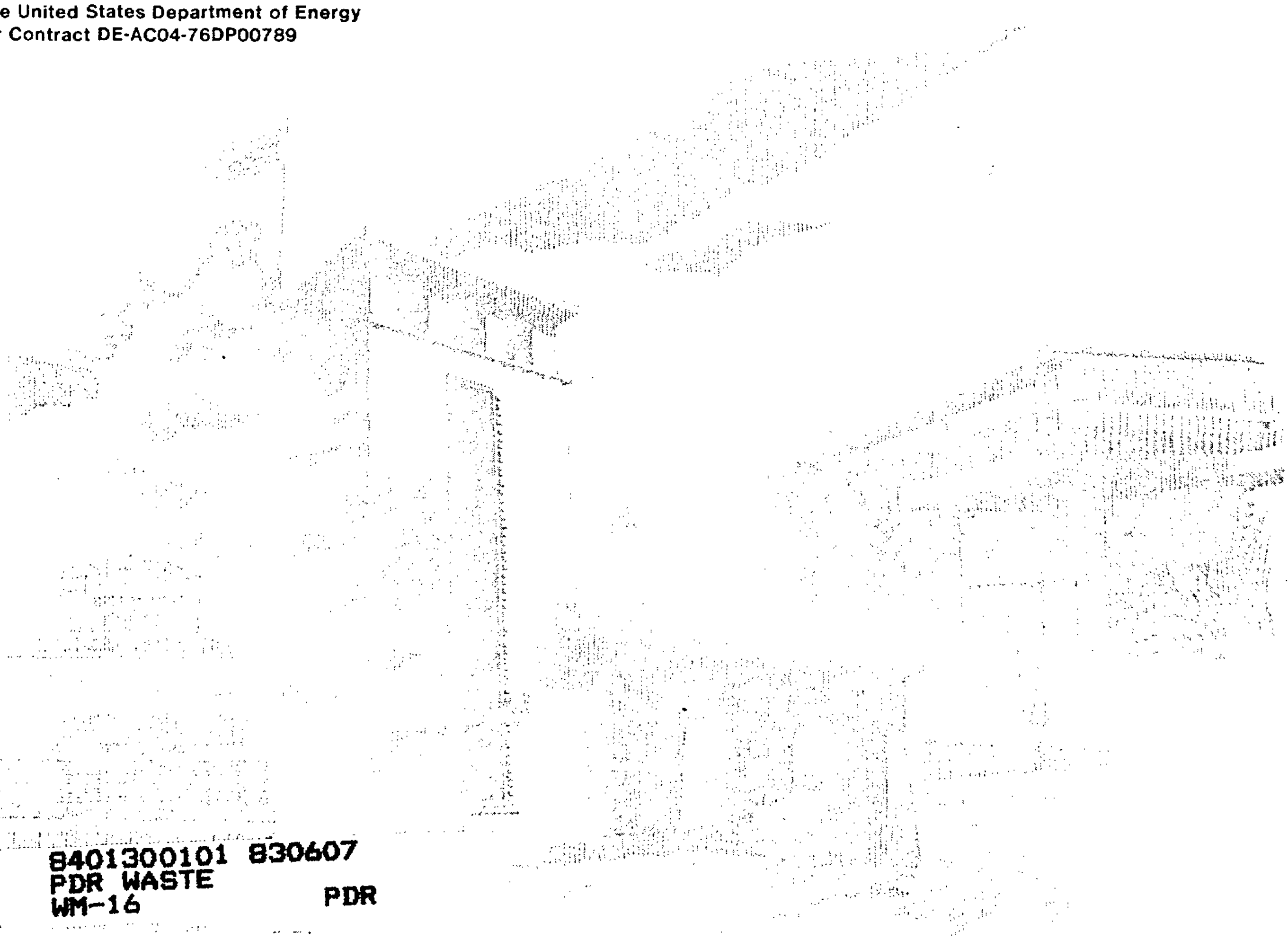
SANDIA REPORT SAND82-1250 • Unlimited Release • UC-71
TTC-0318
Printed May 1982
REPRINTED APRIL 1983

Encl to 6-7-83 ltr to Chase
File 106

Analysis of Recent Council on Economic Priorities Newsletter

Robert M. Jefferson, Robert E. Luna,
James D. McClure, Edwin L. Wilmot

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



SF 2900-Q(6-82)

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes
Printed copy: A03
Microfiche copy: A01

SAND82-1250

TTC-0318

UC-71

Analysis of Recent Council on Economic Priorities Newsletter

June 1982

Robert M. Jefferson
Nuclear Materials Transportation Department 4780

Robert E. Luna
Risk Assessment and Safety Evaluation Division 4781

James D. McClure
Transportation Technology Information Center 4780A

Edwin L. Wilmot
Risk Assessment and Safety Evaluation Division 4781

TRANSPORTATION TECHNOLOGY CENTER
Sandia National Laboratories
Albuquerque, New Mexico 87185

Abstract

Questions relating to the safety of spent fuel shipments were raised by a recent Council on Economic Priorities Newsletter. Specific quotes from the newsletter were grouped into major issue questions and evaluated to determine consistency with available experimental data and analysis.

This page intentionally left blank.

Summary

In January 1982 the Council on Economic Priorities published a newsletter dealing with the "peril" from shipment of "deadly waste products of nuclear fission away from their (sic) overcrowded storage pools at nuclear reactor sites". Since this newsletter capsulized a considerable number of the most frequently heard statements regarding the risks from shipment of spent fuel and other high activity shipments, it was decided to evaluate the statements made in the newsletter against available information in the generally recognized scientific literature.

Parts of the newsletter which seemed to be incorrect or misinterpret available information were identified and grouped under nine main statements. Then each statement was addressed generally and each item specifically as required.

Because a court challenge of HM164 by New York City was in progress when the newsletter was released, there was considerable content in the newsletter on HM164 which is evaluated in this paper. In addition, questions regarding inadequate regulation, accident probabilities, shipping cask response in accidents, accident consequence evaluation, cask design qualification testing, cask quality assurance, emergency response to transport accidents, and cask design and operations standards were addressed. Wherever possible, reference to the reviewed scientific literature was included to provide appropriate supporting data.

This page intentionally left blank.

Contents

This page intentionally left blank.

ANALYSIS OF RECENT COUNCIL ON ECONOMIC PRIORITIES NEWSLETTER*

INTRODUCTION

In January 1982 an analysis questioning the safety of the shipments of radioactive materials was produced by the Council on Economic Priorities (CEP) in their monthly newsletter(1). This commentary addresses incorrect or unprecise assertions in three of the articles that appear in that newsletter, and also covers similar statements contained in a February 9, 1982, article appearing on the opinion/editorial page of the New York Times as well as a number of newspaper articles based on the CEP Newsletter.

The probable driving force for the CEP Newsletter and the sensitivity of this issue revolves around the fact that on February 1, 1982, HM-164(2) was to become an operational rule under the Department of Transportation (DOT) regulations. On January 31, a federal district judge issued a temporary restraining order delaying the enactment of HM-164 until February 10, 1982. That restraining order was extended again on February 10 until the last week in February when a judge's decision was to be rendered. The timing of the New York Times article appeared curiously appropriate considering the legal activities underway. (A decision has been rendered permanently enjoining DOT from enacting the provisions of HM-164 within New York City).

It is the intent of this analysis to address broadly each of the points made in the CEP Newsletter. For the purposes of this analysis, the three articles contained in the Newsletter were broken down into a series of 73 separate items. These 73 items were then re-grouped into nine categories which can be characterized by a single family of concerns which are contained in a single declarative sentence. The CEP Newsletter and these groupings are contained as an appendix to this analysis.

---

*CEP Publication N82-1, January 1982

ANALYSIS

The CEP position can be broken down into nine statements as follows:

1. The DOT rule making (HM-164) requires highway transport.
2. The regulations covering the transportation of radioactive material as contained in the DOT and NRC portions of the Code of Federal Regulations are inadequate to provide the required protection to the public.
3. The probabilities of accidents involving trucks transporting nuclear wastes are inaccurate and generally understated.
4. The behavior of the shipping containers used to transport wastes and spent fuel, when these are involved in accidents, are not well understood.
5. The consequences arising from accidents involving these containers are underestimated.
6. The shipping casks used to transport these materials have not been physically tested.
7. The quality assurance procedures used to manufacture shipping casks are faulty.
8. Emergency procedures and capabilities at the local level are inadequate.
9. The standards for design and operation of these casks are either non-existent or not enforced.

Each of these items will be addressed in order to draw a logical conclusion based on the accusations leveled in the CEP articles.

1. <u>The DOT rule making (HM-164) requires highway transport.</u>

> "The DOT regulations require highway shipments of nuclear waste to take the most direct interstate routes even if these routes traverse densely populated metropolitan areas." 11

> "The federal agency's ill-conceived solution directs that all highly radioactive wastes must be trucked on interstate highways." 1

> "Of all transport options, the NRC considers barge transport the safest, yet the DOT regulations preclude it." 28

The three comments addressing this point appear above. The first comment, Number 11, taken by itself, is true. It is true that HM-164 does require the use of interstate highways, even if these routes traverse densely populated metropolitan areas. However, this is only true if this is the most direct route available and if the state has not defined an alternate route based upon an analysis of the comparative safety the two routes. This approach was taken by DOT on the basis of an examination of all of the risks involved in the shipping of radioactive materials. HM 164 and the methodology for selection of alternate routes are based on a minimization of the overall risk. The largest single component of risk involved is simply that of traffic accidents which kill or injure people in other automobiles or trucks but which do not threaten the integrity of the shipping container in the least. The simplest way to reduce overall impact is to reduce total mileage traveled.

The second and third comments, numbers 1 and 28, are misstatements since the DOT regulations do not preclude the use of other modes for transporting these materials. HM-164 only addresses routing problems in the highway mode.

2. <u>The regulations covering the transportation of radioactive material as contained in the DOT and NRC portions of the Code of Federal Regulations are inadequate to provide the required protection to the public.</u>

"The present generation of shipping casks used to transport irradiated nuclear fuel is unsafe."	7
"Designed in 1961 and unchanged since that time, these testing requirements are according to our findings, inadequate."	42
"Federal regulations require that casks be able to withstand temperatures 400 degrees lower than occur in an average truck fire and crash speeds far lower than occur in the majority of truck accidents."	4&5
"The 30 foot drop test for impact is equivalent to a 30 mph crash into an unyielding barrier such as a bridge abutment."	43
"Impacts at much lower speeds but in more vulnerable areas of the cask could also release radiation."	44
"For example, government documents show that if a shipping cask were to strike a bridge abutment sideways at a mere 12.5 mph, the cask would lose coolant and radioactivity."	45
"The forces can be very large at low velocities."	60
"The shipping cask is designed to withstand a fire of 1/2 hour duration at a temperature of 1475°F. Yet the average temperature of a fire, according to government reports, is 1850°F and many burn considerably hotter and longer, particularly if a tank car is involved."	46
"Our study has identified 21 common industrial materials, routinely shipped in large quantities, that burn at temperatures twice as hot as the test temperature."	57
"In most areas of the country, fires cannot be extinguished within a 1/2 hour."	59
"A torch fire could melt the cask wall itself."	61
"The NRC is presently engaged in a five-year study, due to be completed in 1984, to exactly model the accident environment. It is clear that such a study is	62

> sorely needed because testing requirements developed in 1961 are not equal to present day highway and rail conditions."
>
> "Some are also explosive." 58

A total of 14 comments are grouped under this heading beginning with the statement that the regulations were designed in 1961 and have not changed since that time. In point of fact, the regulations were originally conceived in 1946 by the National Academy of Sciences.[3] Since that time, the regulations which the CEP finds inadequate have been adopted by the International Atomic Energy Agency and updated several times; the latest in 1973.[4] Furthermore, they are currently undergoing additional updating and the revised regulations will probably be published in 1985. Despite serious consideration of possible revisions, the regulations have changed little because in 35 years of actual use, they have proven to be quite effective in minimizing public injury from RAM in transport.

Basically, the CEP addresses two of the test environments (impact and fire) found in the accident-based, engineering test criteria for shipping casks which judged to be inadequate. The regulations[5] call for a 30-foot drop onto an unyielding surface. While the speed attained in such a drop would indeed be equivalent to 30 mph, the key requirement of this test is impact on an unyielding surface. This requirement is included because it is completely reproducible and is not subject to the vagaries of modeling "real" or "typical" structures that a container might impact. In an engineering sense, such a surface requires that all of the energy of the impact be absorbed by the package with none being taken up in the target itself. Thus, impact on an unyielding surface is a very severe condition and is not obtained in any but the most extraordinary accidents, not even by impact onto usual bridge abutments.

Tests conducted by Sandia on a variety of packaging forms and under a variety of conditions indicate that, for comparable damage, considerable differences in velocity can be involved as the target itself changes. The unyielding target, which is reinforced concrete with, nominally, ten times the mass of the cask and surfaced with a minimum of two inches of steel, produces the most damage. To produce damage equivalent to a 30 mph impact on an unyielding target when impacting on an ordinary concrete target (such as an aircraft runway or roadway) has been shown in analysis[6] in tests[7] to require velocities two to two and one-half times as large.

In one test[8] conducted by Sandia, an obsolete shipping cask was dropped from an altitude of 2000 feet onto very hard undisturbed earth (a material called caliche). This cask impacted the ground at 235 mph and penetrated a total of 52 inches. An identical cask was dropped 30 feet onto an unyielding surface in order to compare the damages inflicted. The 30 mph impact onto the unyielding surface produced more visible damage than the 235 mph impact onto very hard earth.

The study referred to by CEP[9], which indicated a shipping cask possibly being damaged by a 12 1/2 mph impact into a "bridge abutment" postulated an absolutely unyielding 1 meter diameter column (a physical impossibility) impacted sideways by a shipping cask exactly upon its center of gravity so that forces were totally taken up in bending the cask (a very highly unlikely situation). Under these highly-theoretical conditions, it was concluded that even the idealized minimum strength cask-model postulated would have to be going at least 12 1/2 mph in order to deform sufficiently to cause internal pressurization and loss of seal integrity sufficient to cause release

of coolant. This scenario in no way was intended by the study's author to represent an achievable event; rather it was conceived as a bounding condition beyond which even the most inventive "what ifs" could not drive the situation.

The second concern involving test conditions for shipping casks as expressed by the CEP articles addresses the fire environment. The regulations(6) require that all surfaces of the cask be exposed to a 1/2 hour duration fire at a radiating temperature of 1475°F. The CEP assertion that some fuels may burn considerably hotter and some fires burn longer is correct. However, it is extremely difficult to identify 21 common industrial materials which are shipped in large enough quantities to fuel a large and long duration fire and which burn at temperatures as high as 2950°F without special burners and/or oxygen supplies. Tests conducted by a number of technical organizations have shown that 1475°F is a realistic radiating temperature, even for fires as hot as 1850°F.(10) In a fire environment, the important parameter is the product of time and radiating temperature. In studying a large number of highway accidents, it was concluded that the likelihood of exceeding the time-temperature conditions given in the regulations was on the order of 3×10^{-9} per truck mile.(11) Beyond that, tests conducted on actual spent fuel shipping casks with time-temperature inputs up to six times as high as that required by the regulations did not cause failure of these casks.(12)

As indicated by one comment, there are persons concerned about the effect of a torch fire that might impinge upon the wall of a cask. Tests conducted for the DOT using torches designed to simulate the environments found in severe accidents involving LPG railroad tank cars showed that this environment is considerably less severe than the 30 minute totally engulfing fire at 1475°F.(13)

Because the cask is not totally engulfed and because it is constructed of metal, the heat introduced by the torch is simply conducted away to a surface removed from the heat input area where the heat is radiated to the atmosphere.

Finally, there is one comment which indicates that the NRC is presently engaged in a study to be completed in 1984 to exactly model the accident environment. There is no possible way to exactly model randomly occurring accident environments. The NRC understands this fact and is, in fact, re-evaluating each of the hypothetical accident tests in light of actual accident experience to determine IF the time-temperature test parameters should be changed.[14]

3. The probabilities of accidents involving trucks transporting nuclear wastes are inaccurate and generally understated.

"Based on reasonable mileage projections, we expect
trucks transporting nuclear wastes to have four accidents 9
per year by 1990. That figure rises to 17 accidents per
year by 2000."

"According to DOT, a severe nuclear transport accident
leading to radiation release and just one cancer fatality
could occur only once every 25 million years. Is the 12
probability of an accident which leads to a single cancer
casualty this remote? The assumptions underlying these
estimates are not realistic."

"A fire associated with a truck or rail accident in-
creases the probability that radioactivity will be 19
released. Fires occur in 1.6 % of all truck and 1% of
all rail accidents."

"Yet statistics for truck accident speeds are crude." 21

"Speed of impact was judged crudely by accident 22
damage."

"Not surprisingly, 76% of all truck accidents occur in 23
urban areas."

"The urban accident rate (the number of accidents per
mile) is about 30 times the national average for all 24
truck accidents."

"Assuming reasonable growth in the number of operating
reactors (from 72 to 150 large power reactors) and extra-
polating from actual truck accident data, we project four 26
nuclear transport accidents per year in the 1990's, and
17 accidents per year by the turn of the century.
Three a year will occur in cities during the 1990's and
the rate will rise to 13 annually by the year 2000."

"Rail transport is not safer." 27

"Routing shipments along interstates through urban areas
will obviously increase the probability and consequences 25
of an accident."

The probability numbers in at least some of the identifiable sources of information (most of the information sources are not referenced) in the CEP article involve accident rates that deal with general commercial transportation (truck, rail, etc.) in the United States. The CEP generally characterizes the data as "not realistic", "crude" and refers to a yet to be published study by the Council on Economic Priorities which is claimed to use "reasonable mileage projections". General commerce transportation data has been collected by Sandia since 1954 and now makes up a file of about 28,000 pages.[15] This and similar data bases form the most comprehensive statistical collection available anywhere in the world. This comprehensive data base on general commerce transportation is used for analytical purposes because it provides a conservative estimate upon which analyses of radioactive material (RAM) transport accidents can be evaluated. The reason for stating that such RAM transport analysis estimates are conservative is that sufficient extra care is taken in RAM packaging and procedures that actual accident experience in RAM transportation is better than that for commercial transport accidents.

Detailed analyses of RAM transport accident/incident experience have been available since November 1980 and such analyses are continually being updated[16] The existing records on RAM transportation accidents and incidents date back to 1971 when the USDOT began compiling such information. The current file holdings on RAM transportation accident/incidents represent the collective experience of the USDOT and the USNRC. It must be emphasized that these data files do not represent "hypothetical" cases of what "might" happen but represent true experience of what "has" happened. To assert, as is done indirectly in the CEP article,

that the mere occurrence of an accident leads directly to release of radioactive material and dangerous public exposures is not borne out by the facts.

Since there have been transportation accidents and incidents involving radioactive materials, what does this experience show? First of all, the actual accident/incident experience of the USDOT shows that of the approximately 105,000 hazardous material incident reports that have been filed with the USDOT since 1971, 585 of these reports, (approximately 0.6 percent) have involved radioactive material. Only 101 of these events have involved RAM transport accidents (where the vehicle was involved in an accident). The remainder were not accidents but are better characterized as incidents in which some event (not a transport accident) occurred which may have resulted in public exposure (most did not). To carry the level of analysis further, it must be understood that the existing RAM transport packaging systems involve essentially two categories, Type A and Type B. Type A packagings are designed to meet normal transport environment conditions only. This does not preclude the possibility of a Type A packaging failing in an accident. Instead the primary protection provided by Type A packaging comes from the limitation on the radioactive contents in the package. In contrast, Type B packages and large quantity packagings (of which spent fuel casks are one type) involve designs which must be capable of surviving severe engineering tests and still meet stringent release, shielding and leak rate criteria before they can be certificated for actual use. To summarize the RAM transport accident experience to date, (i.e., 101 accidents since 1971), all of those accidents where some portion of the radioactive contents

were released, (5 Type A and 53 industrial packagings in 9 release events) have involved packagings which were not designed to be accident resistant. In that same time period, there have been 48 Type B packagings exposed to transport accident conditions with no release of contents. Perhaps more revealing is the fact that there have been 237 Type A packagings and 761 strong-tight industrial packagings exposed to transport accident conditions with no release of contents.

4. The behavior of the shipping containers used to transport wastes and spent fuel, when these are involved in accidents, is not well understood.

"they assume that the pressure cooker-like shipping casks used to transport the deadly waste will remain intact even following a serious traffic accident." 2

"A shipping cask is a pressure cooker on wheels." 14

"A low speed accident, likely in an urban area, could unseat a valve or damage a seal, releasing radioactive steam to the environment." 15

"The same event could crack the brittle metal cladding about the fuel, exposing the radioactivity to the coolant." 16

"Once unseated, a pressure relief valve may fail to reseat - like the pressurizer valve at the Three Mile Island reactor, thereby vaporizing all coolant." 17

"The fuel would then heat up further, releasing the more volatile radionuclides such as cesium." 18

"Government reports show that a fire of 1/2 hour duration at a temperature of 1850°F, the average temperature of an accident fire, could cause the seal and pressure relief valve to fail, thus causing a release of coolant and radioactive material." 20

"In case of loss of coolant, the gaseous radionuclides are likely to be released, but the extent of release of the volatiles depends on the temperature of the fuel." 29

"It is quite possible that irradiated fuel will reach temperatures greater than 670°F, causing more cesium to be released with the steam and hot air." 30

"A recent Japanese paper, for example, predicts higher internal cask temperatures than do American programs." 64

"Other programs do not properly model the external cooling fins on a shipping cask: the geometry is complex and simplifying assumptions are made." 65

The Department of Energy and its predecessor organizations (ERDA, AEC) have sponsored elaborate test programs to address the response of large spent

fuel casks under accident conditions.[17] The fact that the capability exists to perform full scale tests of accident conditions for massive spent fuel casks and that this capability has been exercised represents a recognition on the part of the United States government and the U.S. nuclear industry in general that safe packaging and transportation can and must be provided. Since such a program basically represents a sophisticated engineering development effort one must view in perspective the engineering motivation for such tests. The most obvious ingredient of full scale accident testing is the sensational aspect of, for example, a tractor-trailer rig, with a spent fuel cask aboard, colliding with a massive earth-backed concrete abutment. Such tests are perhaps even more spectacular when witnessed by slow-motion film than they are in real time. Behind the sensational elements of such testing is the sound engineering motive of understanding the behavior of the system from basic scientific principles. As a result, such testing is preceded by less sensational scale model testing and detailed structural and thermal analyses of systems, subsystems and individual components. In fact, the prime objective of a full scale testing program, such as was conducted at Sandia, is to link analytical methods, scale model test response, and full scale prototype response. Accurate determinations of full scale accident response can be made without expensive and time consuming full scale tests of cask structures. These are not new problems in the engineering sense because similar questions must be grappled with, for example, in the response of high rise buildings and dam structures to earthquake forces and other similar public safety type questions.

The behavior of shipping containers, specifically the casks used to transport wastes and spent fuel, are well understood under conditions up to, and exceeding

those involved in the accidents that such casks might see during operation. For example, concerns have been expressed about pressure relief valves which might unseat as a result of accidents involving either impact or fire. While it is inconceivable that a low speed accident could unseat a valve or damage a seal, it is possible in a water filled cask to heat the cask in a fire to the point where the relief valve would open up and release steam generated on the inside of the cask. It should be noted that this steam might contain small amounts of radioactivity which, as the result of the fire, would be lofted to great heights and (because of the size of the fire needed to achieve such total heating of the cask) thus present very minor, if any, public threat. Further, it should be noted that all of the casks in current use in this country are being shipped dry thus making it impossible to boil the internal coolant and raise the pressure to a point where the pressure relief valve might unseat (most dry shipments are in casks where relief valves are removed or plugged because they are unnecessary). This does not say that future casks will not be shipped wet but simply that the statements concerning today's casks are inconsistent with reality.

While experiments and analysis provide significant insights about the behavior of the casks in addicent environments, much work has also been done to characterize the behavior of the spent fuel and mechanisms for release of radionuclides to the cask interior. The finding of such studies (see for example reference 18) indicates serious inconsistency between the CEP's postulated dangers and what might be expected in any real event. Such inconsistency on this important point should cast considerable doubt upon the validity of the consequences projected in this article.

5. <u>The consequences arising from accidents involving these containers are underestimated</u>.

The point is made that the consequences of accidents are underestimated by a substantial margin:

> "The assumptions underlying these estimates are not
> realistic. Even so, an NRC study put the maximum 38
> economic consequences on the order of $2 billion,
> a gross underestimate."

Indeed, comments of this type are often offered as a result of questions relating to most aspects of consequence analysis: i.e., (1) corrections of methodologies, (2) assumptions used in the methodologies, (3) results, and (4) lack of application of available data. In the CEP article it is claimed that each of these components is in some way intentionally biased so that the consequences are underestimated. It is instructive to examine each aspect individually to establish the facts in each case.

The articles first claim to be examining the consequence of accidents:

> "Two recent NRC studies greatly underestimate the
> number of early deaths following an irradiated 47
> fuel accident."

The information drawn from one of these studies (NUREG-0194)[19] does not relate to accidents, but rather to criminal, intentionally destructive acts of sabotage. The consequences from accidents cannot be compared to consequences from sabotage. By using consequences calculated for sabotage and applying them to accidents, the articles in the CEP Journal intentionally overstate the accident case by several orders of magnitude. The following five items refer to NUREG-0194 and thus do not apply to the consequences of accidents and will not be discussed further.

"The computer program was designed for use at nuclear reactors where all persons, except reactor personnel, are located outside a 1/4 mile radius." 48

"NUREG-194 does not calculate economic consequences at all." 50

"Assuming that 100,000 people per square mile did stay approximately 50,000 latent cancers would develop." 34

"In a rail accident, NUREG-194 projects up to 4,100 early deaths and 680,000 latent cancer fatalities." 51

"The 1977 study, called NUREG-194 also makes unrealistic assumptions about evacuation times: 90% of persons within ten miles could be evacuated in four hours. 49

The claim is made that the methodologies employed are inadequate and, as a result, do not predict severe enough consequences.

"Another limitation of the TRUE computer program is that no matter how much radioactivity is released in a nuclear transport accident, the area contaminated remains the same." 56

It is true that the methodologies used do have limitations. One of the two consequence assessment models used in the TRUE program[20] was limited to a calculational grid which covered New York City. As the amount of material released increases, the affected area grows in length but not very much in width. When calculations are truncated at a given distance from the accident (at the end of the grid), the appearance of no increase in affected area is achieved. It was for this reason that a second model without these limitations was used to complete the calculations in this TRUE study and remove this limitation. This fact is not acknowledged by the CEP article. The CEP critique continues by questioning model results and postulated releases.

"The NRC's TRUE study employs a more realistic computer code for an urban setting, estimating health effects and economic consequences as well. However, in this case, the estimates for radiation release are unrealistically low." 52

"Incredibly, it predicts no early deaths in a city as large as New York City. But it does predict up to 4,000 delayed cancer fatalities and as much as $2 billion worth of damages." 54

"More realistic release assumptions would make the number of health effects and the economic consequences rise dramatically." 55

"The TRUE study assumes that only radioactive corrosion (cobalt-60) will be released in an accident, along with gaseous radionuclides: it assumes no cesium is released." 53

The fact remains that the codes used were developed for this special problem; ... have undergone extensive validation. The model used for the TRUE study ... developed specifically for New York City and is an extremely complex code ... requiring detailed data. The criticism yields the point that the code is more realistic, but seems to question the validity of a "more realistic" assessment ... the answer is not high enough.

The consequences of a more realistic model can only change with the input ... One of the most important assumptions is the release fraction selected ... an accident scenario. Since type B packagings are designed to withstand the vast majority of transportation accidents, not even one accident involving packagings for spent fuel or high level radioactive materials has ever resulted in a loss of material. As a result, data describing release fractions are [illegible]available from experience gained in general commerce. Release fractions for [illegible] ...ents then must be estimates made from analyses and informed engineering judgments. In NUREG-0170[6] written between 1974 and 1977) it was assumed that ... [illegible]tile and inert gas nuclides might be relesed in very severe accidents. ... [illegible]nt analysis of cesium escape fractions and tests of spent fuel casks ... [illegible]ed these release assumptions because of the confinement capability ... [illegible]. In 1977 to 1980, the authors of the TRUE analysis evaluated

all available data and decided that the only feasible release was "crud" contaminated cooling water, if any, contained in the cask. But even this release is conservative because full release of highly contaminated fluids is assumed together with a mechanism for complete aerosolization. The claim that release fractions are underestimated is entirely false.

In addition to concerns about methodologies and assumptions, a third question is the alleged underestimate of results for health effects and decontamination costs.

> "However we assume that an area of 1/2 square mile would have to be off limits to people for several hundred years." 35

> "Under calm meteorological conditions, a 10% release of cesium would deposit itself in a wedge-shaped pattern up to 7.5 miles from the point of release." 32

> "It would settle as fine particulates that cling to cement and pavement." 31

> "At Hiroshima the bomb exploded with enough force to blow most of its cesium into the atmosphere; but in an on-the-ground urban traffic accident, cesium would remain fixed to buildings and pavement. 36

> "We do know that hundreds to thousands of early deaths are possible." 33

Results of consequence analyses are a reflection of input values. If the analyses use overestimated values (as in release fractions above) for input, they should produce overestimated results. Thus, the TRUE analysis and others by the DOE, NRC, and DOT should represent the worst possible situation ever to be achieved. The CEP apparently finds the results insufficiently frightening and provides their own estimates of consequences. These estimates ignore the technical results discussed here and are not (apparently) subject to the same peer review to which DOT, DOE, and NRC, et.al. are subjected. For example, under calm meteorological conditions a

release of airborne radioactive materials would not produce a wedge shaped pattern but a circular pattern with its center at the release point. The claim of producing a "1/2 square mile" area that is uninhabitable for several hundred years must be viewed with skepticism: not even Hiroshima or Nagasaki, which would represent extremes in release quantity, remained uninhabitable. Other claims made are completely unsubstantiated.

> "Decontaminating the area is not feasible, according to government report." 37

> "Even so, an NRC study put the maximum economic consequences on the order of $2 billion, a gross underestimate." 38

Decontamination may or may not be feasible; it is certainly possible. In some cases the value of the contaminated buildings may not justify clean-up efforts; razing and rebuilding may occur. In those cases where economics dictate decontamination it is possible even if expensive.

The fourth aspect of the criticism is that the Government is not using available data to support consequence analyses. The articles use Three Mile Island as an example.

> "The NRC questions whether a 10% release of cesium is realistic. In the Three Mile Island accident, however, irradiated fuel was exposed to a severe steam environment and 50% of the cesium in the irradiated fuel was released to the coolant water. In light of that figure and other evidence, a 10% release of cesium in a highway accident is conservative." 39

The claim stated is that the release fractions for release of cesium from a shipping cask accident should be based on cesium releases resulting during the accident at Three Mile Island. The environment created in an accident

involving an operating reactor cannot be compared to transportation accident environments. At Three Mile Island, events in the core during the accident produced Peak fuel temperatures in the range of 1350°C to 2200°C. At these temperatures cesium was able to migrate from the fuel quite readily. In contrast, the maximum credible temperature expected during a transporter accident might reach 1000°C (assuming no coolant in the cask and short decay time fuel). At this lower temperature the rate of release of cesium from the spent fuel would only be about 0.0005 of the rate at 1350°C. Further, cesium released from the fuel to the inside of the cask must escape from the cask before it becomes a part of the 10% figure referred to. Since cesium is very active chemically and since the temperature of the cask will be much lower than that of the fuel, the cesium is unlikely to be released from the cask. For these reasons, the Three Mile Island accident data are not applicable to a spent fuel transport accident.

6. <u>The shipping casks used to transport these materials have not been physically tested.</u>

> "Our most disturbing finding is that none of the types of shipping casks presently in use have been physically tested against possible highway and rail accident conditions." 6

> "But no casks presently moving on the highways or rails have actually been physically tested." 63

The implication of these comments is that the Department of Energy and the Nuclear Regulatory Commission together with the Department of Transportation have in some way been culpably negligent by providing unsafe transportation packagings for nuclear wastes and for irradiated spent nuclear fuel because they have allowed these casks to be certified by analysis rather than by physical testing. These comments strike at the very base of the engineering profession since many of the structures utilized in modern society are designed on the basis of analysis and not full scale physical testing. Such things as high-rise buildings, dams and bridges are routinely designed to specified engineering levels including margins of safety to assure that the end product has been designed with public safety in mind. Likewise, the specifications for shipping casks also must meet engineering standards factored into the analytical review of the design. While in the very early stages of the engineering profession in this country, the design rules had not been firmly established and some failures in these "civil engineering" structures were experienced, the design process is now very well developed and capable of quite refined design on the basis of analysis only.

In an effort to resolve this question concerning the adequacy of design and analytical tools, the Department of Energy through the Sandia National

Laboratories conducted a series of tests in 1977 and 1978 in which severe vehiclular accidents involving spent fuel shipping casks were staged.[17] In addition to validating the analytical tools available, these tests were intended to evaluate whether or not the damage incurred in an actual accident was of similar magnitude to that experienced in the engineering tests specified in the regulations. These tests did indeed show that the damage incurred by the engineering conditions specified in the regulations exceeded that experienced by packages involved in actual accidents of considerable severity. Secondly, the tests did show through a variety of means that the analytical tools or calculational approaches used to design and evaluate these casks were quite accurate. Thus, it is incorrect to say that because the actual unit being transported on the highway or railway has not been subjected to a physical insult of the kind that might be experienced in an accident, it is "untested" or "unsafe." If this argument is pursued, it would be necessary to build high-rise buildings and destroy them in order to build a second high-rise building to put into actual use. This is neither realistic, economical, nor necessary.

7. <u>The quality assurance procedures used to manufacture shipping casks are faulty.</u>

> "As an example, the highway shipping casks NAC-1 and NFS-4 have had design and construction defects." 66

> "There is reason to believe that the number of faulty welds is high because the wrong metals - for example copper - were used." 67

> "The welds were never examined for flaws when the casks were constructed: radioactive contamination precludes their examinaton at this stage." 68

> "Shipping casks have also bowed or slumped in the middle and have had to be reinforced with copper plates which were installed without NRC review and permission." 69

Since the article attacks the quality of a specific cask owned by the Nuclear Assurance Corporation, they were asked to comment. The following is their statement concerning these accusations:

> NFS-4 and NAC-1 spent fuel shipping casks were constructed under Quality Assurance Programs that met the requirements of 10CFR71 Appendix E or 10CFR50 Appendix B. All structural welds of NFS-4 and NAC-1 casks were radiographed to verify integrity and soundness.
>
> These radiographs are part of the permanent manufacturing records of these casks. No copper plates have been used to reinforce the NAC spent fuel shipping cask. Copper is not used as a weld material. Copper fins are used to assist in heat transfer between the cask cavity and the external surface. These fins are attached to the inside of the outer stainless steel shell and to the outside of the inner stainless steel shell and are embedded in the lead between the shells.

In addition to challenging the capability of this specific cask the inference is that quality assurance in shipping casks is uniformly poor. Quality assurance requirements are carefully spelled out in both the NRC regulations and in the Safety Analysis Report for packaging submitted to the

NRC for certification. A complete "pedigree" is required for the construction of each cask. Furthermore, during the life of the cask, there are repeated quality checks to assure that the cask remains in good condition.

8. Emergency procedures and capabilities at the local level are inadequate.

"Urban communities are not prepared to handle a potentially catastrophic accident." 8

"The release of even a relatively small amount of such irradiated material could leave blocks of a large city like New York uninhabitable for hundreds of years." 3

"An accident while trucking such wastes through a city, for instance, could cost thousands of lives and tens of billions of dollars." 10

"Local Departments of Health, emergency personnel and fire and police departments are neither trained nor equipped to cope with emergencies of this magnitude." 40

"It is often unclear who has the authority and responsibility for cleanup and protecting the public health and safety in an emergency, a confusion which compounds the hazard." 41

Perhaps the answer to these comments can begin by the posing of another question ... are large urban communities prepared to cope with any large and potentially catastrophic accident such as earthquake, flood, fire or armed attack? Most large urban communities in this country do not have adequate resources and/or trained manpower to provide totally error-free response to major disasters. Thus, the statement about specific preparedness for nuclear related events are also true. However, experience with non nuclear events does reveal a capability to respond to emergencies in a sound manner. Most sound planning for a radioactive material transportation accident should be embedded in the existing first response capabilities such as are found in fire departments, police departments, state or local agencies that have radiological expertise and, finally, in the civil defense and/or National Guard.

The need for emergency response planning and training has been recognized in several ways. First, the U. S. Department of Transportation has developed and distributed to each state a self-contained, pre-packaged training course on Handling Radioactive Materials Transportation Emergencies.[21] This training material was placed, free-of-charge, into a state/local office (as designated by the governor of each state) in the summer of 1981. Secondly, the Federal Emergency Management Agency (FEMA) in conjunction with the USDOT has recently completed the development of a guidance document on emergency response planning for state/local governments for radioactive material transport accidents. This guidance document is in its final stages of review and notice of its availability for public comment will be made shortly in the Federal Register.

9. <u>The standards for design and operation of these casks are either non-existent or not enforced.</u>

"For lack of specific cask standards, ASME boiler standards are used." 71

"Regarding the trucks and drivers themselves, the DOT has no special requirements and there is no specific oversight." 72

"Further, neither the NRC nor DOT inspect the vehicles and tiedowns holding these shipping casks." 73

"In addition to poor quality control and inadequate NRC inspection, the standards for cask construction have not yet been set down by ASME (American Society for Mechanical Engineers). 70

There is currently no lack of special cask standards as a result of activities under the auspices of both the American Society of Mechanical Engineers (ASME) and the American National Standards Institute (ANSI). The ASME activity has been underway for a little over two years and has centered in the Committee on Containment Systems for Nuclear Spent Fuel and High-Level Waste Transport Packagings (NUPACK). The purpose of NUPACK is to develop, maintain, and coordinate codes and standards for the construction and in-service requirements for containment systems for nuclear spent fuel and high-level waste transport packaging. The development process for an ASME code is long and involved. It is anticipated that a first draft of the code will be completed by December 1982. The ANSI standards transportation activity has been underway since 1968 and has been centered in the ANSI N14 Committee "Transportation of Fissile and Radioactive Materials." A brief description of each of these standards organizations is outlined in the following sections.

ASME NUPACK

Although ASME codes exist which provide guidance to reactor fabricators, similar codes do not exist for shipping container fabricators. As a result, reactor pressure vessel codes are used in the design of shipping casks. Since casks do not see such severe conditions of service as reactor pressure vessel and since casks designed according to reactor codes are overly conservative, an effort was initiated to develop an ASME code for transport containers. Chartered in September 1979, the NUPACK Committee is chartered to develop, maintain, and coordinate codes and standards for the construction and in-service requirements for containment systems for nuclear spent fuel and high-level waste transport packaging. Construction includes general requirements, examination, testing, inspection, modifications, repairs and replacements. Those items required as pressure barriers limiting the release of radioactive material to acceptable levels during transport are included in the containment systems. The codes and standards developed by NUPACK are supervised by the ASME Nuclear Codes and Standards Committee.

At the present time, the estimated completion date of the first draft of the ASME containment code is December 1982. The ultimate outcome should be a code or standard for shipping cask containment design, fabrication, and inspection.

ANSI N14

The scope of ANSI N14 established in 1966 is to develop standards for the packaging and transportation of fissile and radioactive materials but not including movement or handling during processing and manufacturing operations. Within this scope, twenty-five standards writing groups either

write new proposed standards or revise previously approved standards. The currently approved and currently active writing efforts within ANSI N14 is as follows:

ANSI N14 STANDARDS WRITING GROUPS

November 1981

N14.1	Packaging of Uranium Hexafloride for Transport.
N14.2	Tiedowns for Transport of Fissile and Radioactive Material Containers Greater than One-Ton Truck Transport.
N14.3	Packaging and Transportation of Radioactively Contaminated Biological Materials.
N14.4	Quality Assurance in the Fabrication, Use, and Maintenance of Shipping Containers for Radioactive Materials.
N14.5	Leakage Tests on Packages for Shipment of Radioactive Materials.
N14.6	Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500kg) or More for Nuclear Materials.
N14.7	Guide to the Design and Use of Shipping Packages for Type A Quantities of Radioactive Materials.
N14.8	Fabricating, Testing, and Inspection of Shielded Shipping Casks for Irradiated Reactor Fuel Elements.
N14.9.2	Packaging of Nuclear Power Plant Radioactive Processed Wastes Plants for Transport to Ultimate Disposal.
N14.10.1	Administrative Guide for Packaging and Transporting Radioactive Materials.
N14.19	Ancillary Features of Irradiated Fuel Shipping Casks.
N14.20	Control of Contamination of Transport Vehicles.
N14.23	Design Basis for Resistance to Shock and Vibration of Radioactive Material Packages Greater than One Ton in Truck Transport.
N14.24	Marine Transportation of Radioactive Material.
N14.25	Tiedowns for Rail Transport of Fissile and Radioactive Material.

N14.26 Inspection and Preventative Maintenance of Packaging for Radioactive Materials.

N14.27 Carrier and Shipper Responsibilities and Emergency Response Procedures for Highway Transportation Accidents Involving Truckload Quantities of Radioactive Materials.

N14.28 Emergency Response for Less Than Truckload Lots.

In addition, there are numerous NRC Regulatory Guidelines which relate to the requirements placed on cask designers and manufacturers to assure competent designs.

Regulatory Guides

Number	Title	Rev.	Issued Year/Month
7.1	Administrative Guide for Packaging and Transporting Radioactive Material	--	74/06
7.2	Packaging and Transportation of Radioactively Contaminated Biological Materials	--	74/06
7.3	Procedures for Picking Up and Receiving Packages of Radioactive Material	--	75/05
7.4	Leakage Tests on Packages for Shipment of Radioactive Materials	--	75/06
7.5	Administrative Guide for Obtaining Exemptions From Certain NRC Requirements Over Radioactive Material Shipments	-- 0-R	75/06 77/05
7.6	Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels	-- 1	77/02 78/03
7.7	Administrative Guide for Verifying Compliance with Packaging Requirements for Shipments of Radioactive Materials	--	77/08
7.8	Load Combinations for the Structural Analysis of Shipping Casks	--	77/05

7.9	Standard Format and Content of Part 71 Applications for Approval of Packaging of Type B, Large Quantity, and Fissile Radioactive Material	-- 1	79/03 80/01

On this basis, it is difficult to conclude that standards are non-existent. Further, it is incredible to claim that the NRC who has such responsibility has defaulted in the enforcement of these standards and regulations. On the contrary, NRC is making it more and more difficult to obtain a certificate of compliance by progressively more conservative interpretation of its own regulations and the consensus standards in existence.

Conclusion

This analysis has addressed specific sections and passages of the CEP Newsletter and predicated publications which are incorrect or misleading in an attempt to provide factual and contrasting information. However, the publication of a paper such as this, no matter how correct, factual and well reasoned, cannot undo the damage done by these publications to the public's confidence that the transport risk is low and that regulatory agencies responsible for RAM transportation safety are doing their jobs properly. Equal coverage of the "facts" presented here would be useful, but such an occurrence is both unlikely and inadequate. It is unlikely because to disclose that hazards are small and regulators are doing their jobs is simply not news. It is inadequate because, in analogy with Gresham's law, bad news drives out (gets more notice than) the good. As a result, the net effect of a perfect and well-publicized rebuttal is still likely to be negative or at least not very positive.

This page intentionally left blank

Appendix

Highlighted and Annotated Text of the

January 1982

Council on Economic Priorities Newletter

1. The Latest Nuclear Dilemma, Waste Shipment Peril Explored, Newsletter Council on Economic Priorities, CEP Publication N-82-1, January 1982.

2. Federal Register, Vol. 45, No. 22, Proposed Rules, U.S. Department of Transportation, Highway Routing of Radioactive Materials, Docket No. HM-164, Notice No. 80-1, Jan. 31, 1980.

3. Problems Associated with the Transportation of Radioactive Substances, National Academy of Sciences, National Research Council, Publication 205, R. D. Evans, 1951.

4. Regulations for the Safe Transport of Radioactive Materials, 1973 Revised Edition, International Atomic Energy Agency, Safety Series No. 6, Vienna, Austria.

5. 10CFR71, U.S. Nuclear Regulatory Commission, Rules and Regulations, Title 10, Chapter 1, Code of Federal Regulations, Part 71, Appendix A.

6. NUREG-0170, Final Environmental Statement on the Transportation of Radioactive Materials by Air and Other Means, Office of Standards Development, U.S. Nuclear Regulatory Commission, December 1977.

7. Relative Response of Type B Packagings of Regulatory and Other Impact Test Environments, J. D. McClure, et al, Proceedings of PATRAM 80, Sixth International Symposium Packaging and Transportation of Radioactive Materials, Berlin, FRG, Nov. 1980.

8. Air Drop Test of Shielded Radioactive Material Containers, SAND75-0276, I. G. Waddoups, Sandia National Laboratories, Albuquerque, NM, Sept. 1975.

9. An Assessment of the Risk of Transporting Spent Nuclear Fuel by Truck, PNL-2588, Battelle, Pacific Northwest Laboratories, Nov. 1978.

10. An Assessment of Accident Thermal Testing and Analysis Procedures for Radioactive Materials Shipping Packages, R. B. Pope, et al, ASME Paper 80-HT-38, American Society of Mechanical Engineers, April 1981.

11. Severities of Transportation Accidents, R. K. Clarke, et al, SLA-74-0001, Sandia National Laboratories, July 1976.

12. Full Scale Simulations of Accidents on Spent-Nuclear-Fuel Shipping Systems, H. R. Yoshimura, Porceedings Fifth International Symposium Packaging and Transportation of Radioactive Materials, Las Vegas, Nevada, May 1978.

13. HNPF Spent Fueld Cask Temperature Response; Torch Impinging on Water Filled Neutron Shield, M. G. Vigil, et al, SAND82-0704, TTC-0297, Sandia National Laboratories, March 1982.

14. A Model Study of Transportation Safety, W. R. Lahs, Proceedings of PATRAM 80, Sixth International Symposium Packaging and Transportation of Radioactive Materials, Berlin, FRG, Nov. 1980.

15. Transportation Technical Environmental Information Center Index SAND80-1885, C. A. Davidson, J. T. Foley, Sandia National Laboratories, Albuquerque, New Mexico, Oct. 1980.

16. The Nature of Transportation Accidents Involving Radioactive Material Packaging, SAND81-1330C, TTC-0220, E. L. Emerson, J. D. McClure, Sandia National Laboratories, March 1982.

17. Crash Testing Of Nuclear Fuel Shipping Containers, SAND77-1462, R. M. Jefferson, H. R. Yoshimura, Sandia National Laboratories, Feb. 1978.

18. Transportation Accident Scenarios for Commercial Spent Fuel, SAND80-2124, TTC-0156, E. L. Wilmot, Sandia National Laboratories, Feb. 1981.

19. NUREG-0194, Calculations of Radiological Consequences from Sabotage of Shipping Casks for Spent Fuel and High Level Wastes, C. V. Hodge and J. E. Campbell, U.S. Nuclear Regulatory Commission, Feb. 1977.

20. Transportation of Radionuclides in Urban Environs: Draft Environmental Assessment, N. C. Finley, et al, NUREG/CR-0743, SAND79-0369, prepared for U.S. Nuclear Regulatory Commission, July 1980.

21. Handling Radioactive Material Transportation Emergencies, U.S. Department of Transportation, Research and Special Programs Administration, Materials Transportation Bureau, DOT/RSPA/MTB-7917, July 1979.

Council on Economic Priorities
NEWSLETTER
January 1982 CEP Publication N 82-1

The Latest Nuclear Dilemma

Waste Shipment Peril Explored

By Marvin Resnikoff, Leslie Birnbaum and Lindsay Audin

NEWSLETTER SUMMARY

The Department of Transportation (DOT) is on the verge of instituting new regulations that may well threaten the lives of hundreds of thousands of people, and the value of property worth tens of billions of dollars.

The regulations, which go into effect this February, deal with the urgent problem of how to transport deadly waste products of nuclear fission away from their overcrowded storage pools at nuclear reactor sites. The federal agency's ill-conceived solution directs that all
(1) highly radioactive wastes must be trucked on Interstate highways.

Study to Appear in Spring

The extreme dangers and the urgency involved has prompted the Council on Economic Priorities to examine alternate solutions. CEP's full study of the near term options for handling irradiated fuel will be released this Spring.

The new federal guidelines embrace a number of flawed assumptions that tempt disaster. Most prominent among them: they assume that the
(2) pressure cooker-like shipping casks used to transport the deadly waste will remain intact even following a serious traffic accident. Should that logic prove wrong, the penalty to human life and property will be grave. The release of even a
(3) relatively small amount of such irradiated material could leave blocks of a large city like New York uninhabitable for hundreds of years.

Alternate Transport Considered

But, how else can we deal with these growing stockpiles of nuclear waste? CEP will evaluate alternate transportation of nuclear waste to dump sites by barge, rail and highway. The Council will also consider storage at reactors using the most up-to-date dry storage techniques.

Present System Unsafe

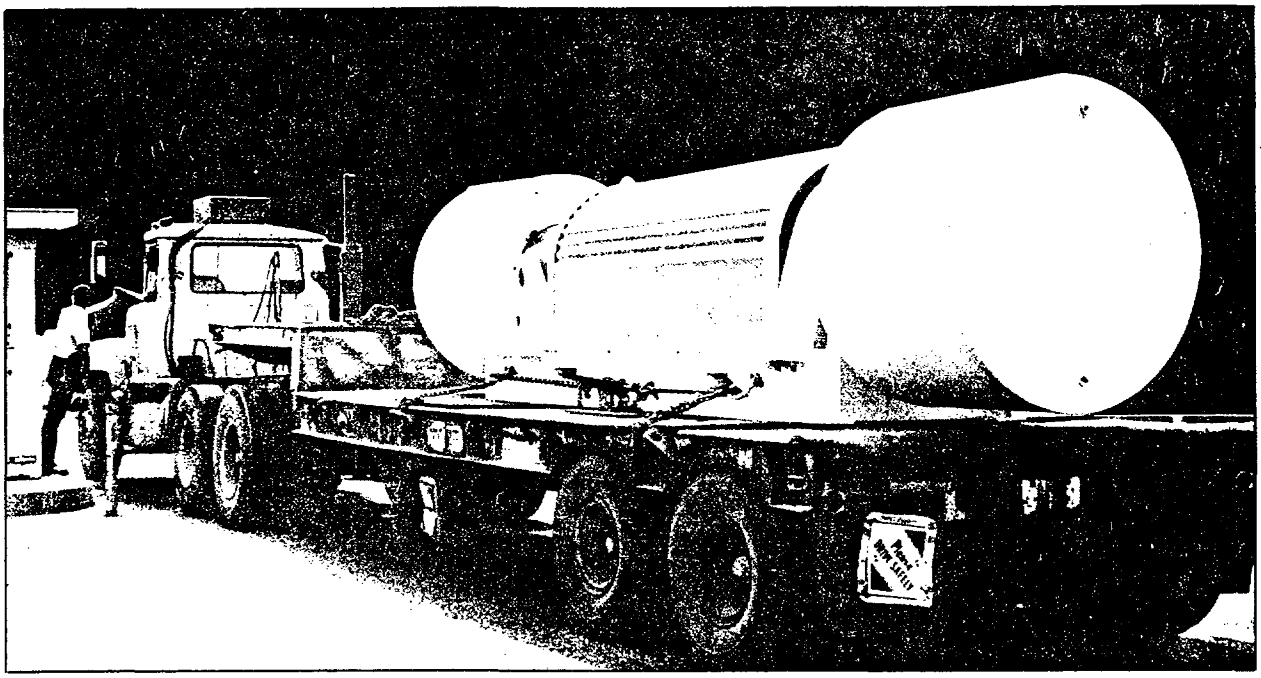
Among CEP's findings:

- Federal regulations require that casks be able to withstand temperatures 400 degrees lower
(4) than occur in an average truck fire and crash
(5) speeds far lower than occur in the majority of truck accidents.
- Our most disturbing finding is that none of the types of shipping casks presently in use have
(6) been physically tested against possible highway and rail accident conditions.
- The present generation of shipping casks
(7) used to transport irradiated nuclear fuel is unsafe.
(8) Urban communities are not prepared to handle a potentially catastrophic accident.
- Based on reasonable mileage projections, we
(9) expect trucks transporting nuclear wastes to have four accidents per year by 1990. That figure rises to 17 accidents per year by 2000.

Upgrading Requirements Recommended

CEP recommends that:

- the present generation of shipping casks be removed from service;
- new shipping cask testing requirements be made more realistic for today's driving conditions;
- casks be physically tested. Present tests rely on computer accident simulations;
- alternate routes and modes of transportation be investigated;
- the Federal government perform a comprehensive study of truck accident probabilities;
- communities be better notified, trained, and equipped to deal with a nuclear transport accident. ■



Nuclear fuel is shipped in massive steel containers. About 120 such trucks will travel America's highways daily by the 1990's.

Transport Solutions Unsafe

Back-logs of irradiated nuclear fuel, the highly radioactive end-product of the fission process, are building at 72 power reactors across the country. If the problem is not dealt with soon, the consequences will be dire. But the consequences of moving these wastes to AwayFrom Reactor Storage Sites (AFR) threaten to be just as severe: An accident while trucking such wastes
(10) through a city, for instance, could cost thousands of lives and tens of billions of dollars. In the aftermath of new Department of Transportation (DOT) regulations directing that this material be transported by truck on Interstate highways, CEP has undertaken a study to examine the problem. We ask: must this material be shipped? And if it must: what is the safest way to transport it?

Issue Highly Charged

Nuclear waste is a highly charged issue to a wary public who feels that this toxic material cannot be moved and stored safely. That view was only reinforced following the notable failures at West Valley, New York and Lyons, Kansas. With no permanent solution in sight, the public may fear that a temporary centralized storage facility would eventually become a *defacto* permanent facility. The net result: continuing nuclear waste build-up at the reactors.

Council on Economic Priorities
NEWSLETTER

Editor-in-chief: Alice Tepper Marlin
Managing Editor: Geoffrey Quinn

The Council on Economic Priorities is a non-profit organization established to disseminate unbiased and detailed information on the practices of U.S. corporations. These practices have a profound impact on the quality of American life. CEP was established so that the American public could become aware of this impact and work to ensure corporate social responsibility. CEP publishes 3-6 CEP **Studies** and or **Reports** and 8-12. **Newsletters**. per year. Memberships and contributions are tax-deductible. Indexed in Public Affairs Information Service Bulletin. 84 Fifth Avenue, New York, New York 10011 ISSN 0193-4066

The Federal Department of Transportation (DOT), in order to standardize a patchwork regulatory system, has issued regulations which, this February, will pre-empt current local and state ordinances. The DOT regulations re-
quire highway shipments of nuclear (11)
waste to take the most direct Interstate routes even if these routes traverse densely populated metropolitan areas. The law was passed even though over 220 state and local governments, including New York City, had passed ordinances regulating or banning these shipments.

Whether irradiated nuclear fuel remains at the reactor for its full operating life, or is stored at a government Away From Reactor (AFR) site, it will have to be taken somewhere eventually. Implementation of the DOT regulations, together with pending Congressional AFR legislation, will relieve the nuclear garbage pile-up. The number of nuclear shipments will then dramatically increase.

According to DOT, a severe nuclear (12)

(12) transport accident leading to radiation
release and just *one* cancer fatality
could occur only once every 25 million
years. Is the probability of an accident
which leads to a single cancer casualty
this remote? The assumptions under-
(13) lying these estimates are not realistic.

Probable Accidents Ignored

(14) A shipping cask is a pressure cooker
on wheels. A low speed accident, likely
in an urban area, could unseat a valve
(15) or damage a seal, releasing radioactive
steam to the environment. The same
event could crack the brittle metal clad-
(16) ding about the fuel, exposing the radio-
activity to the coolant. Once unseated,
a pressure relief valve may fail to re-
(17) seat—like the pressurizer valve at the
Three Mile Island reactor, thereby
vaporizing all coolant. The fuel would
(18) then heat up further, releasing the more
volatile radionuclides such as cesium.
Because of a faulty valve, four GE rail
shipping casks were voluntarily removed from service, June, 1981.

A fire associated with a truck or rail accident increases the probability that radioactivity will be released. Fires occur
in 1.6% of all truck and 1% of all train
(19) accidents. Government reports show
that a fire of 1/2 hour duration at a tem-
perature of 1850°F, the average
(20) temperature of an accident fire, could
cause the seal and pressure relief valve
to fail, thus causing a release of coolant
and radioactive material.

Neither of these possible events were considered by DOT. Rather than investigate and quantify valve unseating, the Nuclear Regulatory Commission studied the less likely possibility of actually breaching the shipping cask. The cask itself is massive, weighing 21 to 75 tons, with 1/2 inch steel walls surrounding 6 or more inches of lead. Clearly the speed of impact, or the heat input must be great to breach the containment..

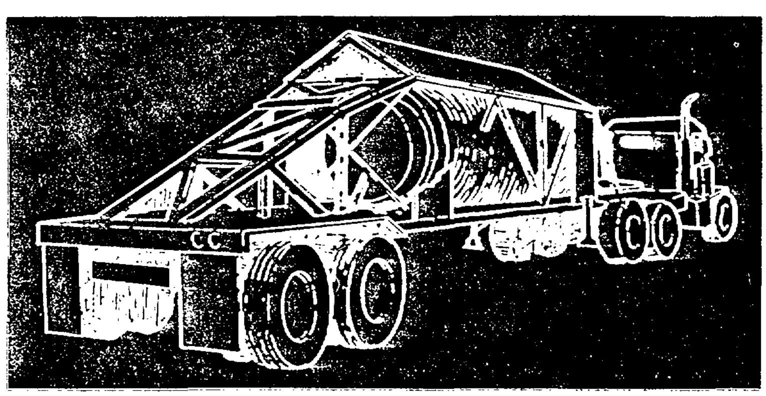
(continued on page 4)

Six Steps Insure Safe Transport

- We recommend that the present generation of shipping casks be removed from service until their safety can be assured.
- We recommend that no additional shipping casks be certified until new testing requirements are available. While only eleven 1960 state-of-the-art shipping casks remain, now is the time to phase them out. New at-reactor storage options can accommodate the irradiated fuel produced until these new casks are available.
- One copy of each model shipping cask should be physically tested, not tested by computer simulation. The cask cavity should be pressurized, contain a heat source to simulate radioactive fuel, and be subjected to realistic accident tests.
- We recommend that alternate routes or modes of transport such as barge or rail be investigated particularly since the probability of a truck accident per mile travelled in urban areas is 30 times greater than the national average. We recognize that this will transfer the accident risk to rural and suburban areas, potentially affecting food and water supplies for urban areas as well.
- We strongly advise the Federal agencies to perform a comprehensive study on truck accident probabilities. The DOT regulations ought not to be put into effect until this study is completed and then only if the results support the DOT regulations.
- Without radiation detectors and personnel trained in their use, communities are defenseless against a shipping accident. We strongly recommend that Congress fund a program, preferably paid for by shippers, to train and equip local emergency personnel. We further recommend that emergency personnel of local communities be notified in advance of irradiated fuel shipments. ■

More About Nuclear Casks

Each truck shipping cask contains 25 tons worth of lead and stainless steel. Were it not for that shielding a person standing three feet from a fuel assembly would receive a lethal dose of radiation in less than ten seconds. Inside the cask, the fuel is stored within a grouping of rods called an assembly. Each rod is a hollow tube filled with ceramic fuel pellets stacked like poker chips. Despite the claimed efficiency of nuclear power, substantial amounts of fuel must be disposed of. A typical pressurized water reactor uses 60 fuel assemblies, or 30 tons of fuel, each year. ■



(21) Yet statistics for truck accident speeds are crude. Estimates of accident speeds are derived from damage, skid marks, and the statements of drivers. In fact the accepted NRC study based its data on phone calls to three city police departments. (22) Speed of impact was judged crudely by accident damage.

(23) Not surprisingly, 76% of all truck accidents occur in urban areas. The urban accident rate (the number of accidents per mile) is about 30 times (24) the national average for all truck accidents. Routing shipments along Interstates through urban areas will obviously (25) increase the probability and consequences of an accident. Yet this factor is not taken into account in DOT calculations.

CEP Predicts More Accidents

Assuming reasonable growth in the number of operating reactors (from 72 to 150 large power reactors) and extrapolating from actual truck accident (26) data, we project four nuclear transport accidents per year in the 1990's, and 17 accidents per year by the turn of the century. Three a year will occur in cities during the 1990's and the rate will rise to 13 annually by the year 2000.

(27) Rail transport is not safer. Deteriorating track beds have led to a rising rail accident rate, due in major part to broken rails and consequent derailments (80% of rail accidents). (28) Of all transport options, the NRC considers barge transport the safest, yet the DOT regulations preclude it.

Complete Study Available Spring

This newsletter is based on preliminary research findings by Dr. Marvin Resnikoff, Leslie Birnbaum and Lindsay Audin. Together the team has had over 15 years experience researching nuclear transportation issues. For information about how to order the full study, please contact Stuart Baldwin, Director of Marketing at CEP. ■

Releases Serious

Though irradiated nuclear fuel is primarily solid, its temperature following a collision and/or fire will determine the amount of radioactivity released. Some of the radionuclides are in gaseous form (krypton, iodine), others are volatile (cesium, tellurium) and still others are non-volatile (strontium, plutonium) and are not likely to escape the cask. (29) In case of loss of coolant, the gaseous radionuclides are likely to be released, but the extent of release of the volatiles depends on the temperature of the fuel. We focus on the release of cesium into the atmosphere because it would produce a high incidence of cancer and a number of genetic effects. (30) It is quite possible that irradiated fuel will reach temperatures greater than 670°F, causing more cesium to be released with the steam and hot air. It would settle as fine particulates that cling to cement and pavement. (31) The economic consequences would be almost unimaginable.

Urban Accidents Severe

Under calm meteorological conditions, a 10% release of cesium would (32) deposit itself in a wedge-shaped pattern up to 7.5 miles from the point of release. Early deaths due to pulmonary edema (lung burnout) would occur within ¼ mile of the accident. The number of early deaths is difficult to predict because it would depend on the location of the accident and on the height of apartment buildings, the number of residents and their location, whether windows are opened or closed, and whether a fire and/or explosion occurs lifting radioactivity into the air. (33) We do know that hundreds to thousands of early deaths are possible. Outside the immediate ¼ mile area, radioactive deposits would cause delayed cancer fatalities if anyone remained in the area. (34) Assuming that 100,000 people per square mile did stay, approximately 50,000 latent cancers would develop. (35) However we assume that an area of ½ square mile would have to be off limits to people for several hundred years.

(36) At Hiroshima the bomb exploded with enough force to blow most of its cesium into the atmosphere; but in an on-the-ground urban traffic accident, cesium would remain fixed to buildings and pavement. Removal of the radio-

". . . A shipping cask is a pressure cooker on wheels. Even a low speed accident could release deadly radioactive steam into the environment. . ."

activity, probably by razing the structures and pavement, would be a massive and costly urban renewal project in a densely populated city. (37) Decontaminating the area is not feasible, according to government report. After waterhosing concrete and asphalt, the residual dose will still be too high to allow residents to remain.

Based on the assessed value of Manhattan property, damages would reach the tens of billions of dollars. No private property is insured against this loss. (38) Even so, an NRC study put the maximum economic consequences on the order of \$2 billion, a gross underestimate. The NRC questions whether a 10% release of cesium is realistic. In the Three Mile Island accident, however, irradiated fuel was exposed to a severe steam environment and 50% of the cesium in the irradiated fuel was released to the coolant water. (39) In light of that figure and other evidence, a 10% release of cesium in a highway accident is conservative.

Localities Unprepared

(40) Local Departments of Health, emergency personnel and fire and police departments are neither trained nor equipped to cope with emergencies of this magnitude. It is vitally important that fire departments be able to extinguish a fire at a nuclear transport accident within a half hour or the cask pressure relief valve and seals can rupture. To do this, local communities must be prenotified. Yet, the NRC argues that the prior notice would alert terrorists. We do not agree because irradiated fuel shipments are easily

(continued on page 5)

identified by their massive size and markings. Citizens groups, the news media and, we assume, persons intent on malevolent acts, are now aware of shipments.

It is often unclear who has the authority and responsibility for cleanup
(41) and protecting the public health and safety in an emergency, a confusion which compounds the hazard. For example, in a 102-car train derailment which took place near Rockingham, North Carolina, March 21, 1977, four 14-ton cylinders containing uranium were involved in the wreckage. Seventeen agencies responded to the emergency call since the dispatcher called every agency he thought appropriate. Radioactivity could have been tracked throughout the area, as a result. Other accidents involving uranium concentrate spills in Kansas and Colorado required 2 weeks or more to decontaminate the area, due in part to the initial confusion and unclear lines of authority and financial responsibility.

Because shipping casks contain prodigious amounts of radioactivity, they should be constructed to withstand all likely highway, rail or barge accidents.

"...An accident in a city could cost thousands of lives and tens of billions of dollars in damages..."

The nuclear industry has claimed that these massive shipping casks are "virtually indestructible." But are they?

The four NRC testing requirements are: 1) impact—that the cask withstand a 30 foot drop into an unyielding surface, 2) puncture: a 40 inch drop onto a cylindrical spike, 3) followed by fire at 1475°F for ½ hour, and 4) immersion under three feet of water for eight hours. Designed in 1961 and unchanged since that time, these testing
(42) requirements are according to our findings, inadequate.

Impact Test Velocities too Low

The 30 foot drop test for impact is equivalent to a 30mph crash into an
(43) unyielding barrier such as a bridge abutment. A higher velocity collision with a "softer" structure would cause the same damage as a 30mph crash into an unyielding barrier. However, according to NRC's own statistics, fewer than ¼ of truck accidents occur at less than 32mph.

Impacts at much lower speeds but in
(44) more vulnerable areas of the cask could also release radiation. For example, government documents show
(45) that if a shipping cask were to strike a bridge abutment *sideways at a mere 12.5mph*, the cask would lose coolant and radioactivity. A nuclear transport truck jackknifing on a slick road could produce this result. Other accidents at 40mph could cause a rupture disk to vent or cask cavity seal to fail.

The shipping cask is designed to withstand a fire of ½ hour duration at a temperature of 1475°F. Yet the average temperature of a fire, according to government reports, is 1850°F
(46) and many burn considerably hotter and longer, particularly if a tank car is involved. Our study has identified 21

(continued on page 6)

Studies Overlook True Threat of Accidents

Two recent NRC studies greatly
(47) underestimate the number of early deaths following an irradiated fuel accident. The reason for this amazing omission: the computer program was designed for use at nuclear reactors
(48) where all persons, except reactor personnel, are located outside a ¼ mile radius. The 1977 study, called NUREG-194 also makes unrealistic as-
(49) sumptions about evacuation times: 90% of persons within ten miles could be evacuated in four hours. NUREG-
(50) 194 does not calculate economic consequences at all.

Even granting these unrealistic assumptions, the number of latent cancer fatalities and projected early deaths for a city as densely populated as New York City would still be high.
(51) In a rail accident, NUREG-194 projects up to 4,100 early deaths and 680,000 latent cancer fatalities (assuming a population density of
(52) 100,000 persons per square mile).

The NRC's TRUE study employs a more realistic computer code for an urban setting, estimating health effects and economic consequences as well. However, in this case, the estimates for radiation release are unrealistically
(53) low. The TRUE study assumes that only radioactive corrosion (cobalt-60) will be released in an accident, along with gaseous radionuclides; it assumes no cesium is released. Incredibly, it
(54) predicts no early deaths in a city as large as New York City. But it does predict up to 4,000 delayed cancer fatalities and as much as $2 billion worth of damages. More realistic
(55) release assumptions would make the number of health effects and the economic consequences rise dramatically. Another limitation of the TRUE computer program is that no matter how much radioactivity is re-
(56) leased in a nuclear transport accident, the area contaminated remains the same. ■

What You Can Do

Tell your elected officials that you want shipping casks built to withstand highway and rail accidents. Say you also want local emergency personnel trained and equipped to handle accidents. Ask your municipal government to take action against the DOT regulations. Get in touch with public interest groups in your state that are concerned about this issue. Write CEP and we will send you a list. ■

(57) common industrial materials, routinely shipped in large quantities, that burn at temperatures twice as hot as the test (58) temperature. Some are also explosive. The production of these flammables has greatly increased since 1960. The duration of a fire is also at issue. In (59) most areas of the country, fires cannot be extinguished within a ½ hour. Nearly 90% of firefighters are volunteers who cannot respond as rapidly as full-time professionals.

Not all Accidents Modelled

Besides not being sufficiently rigorous to model highway and rail impact and fire scenarios, there are some glaring omissions in these studies. Some accidents involve crushing of casks by heavy objects. A cask can be pinned between two rail cars. (60) The forces can be very large at low velocities.

Other accidents might involve a localized high temperature flame, a fire torch, such as occurred in a Port of Newark fire last July 27. A torch fire (61) could melt the cask wall itself. But cask regulations ignore this and other such obvious dangers.

The NRC is presently engaged in a five-year study, due to be completed in 1984, to exactly model the accident (62) environment. It is clear that such a study is sorely needed because testing requirements developed in 1961 are not equal to present day highway and rail conditions.

Physical Testing Not Performed

Not only are the standards inadequate, but there is little assurance that approved casks meet these standards. Physical tests were made on obsolete highway and rail casks. But no (63) *casks presently moving on the highways or rails have actually been physically tested.* The tests actually made have been computer simulations or hand calculations. In the case of certain rail casks, scale models have been tested. Economic considerations are to blame. Each cask costs between $1.5 and $3 million and is not reusable following a test.

Reliance on computer rather than physical testing presents problems because of the numerous simplifying assumptions which must enter into these programs. A recent Japanese (64) paper, for example, predicts higher internal cask temperatures than do American programs. The disagreement appears to be partly in modelling the steam environment in a loss of coolant accident. Other programs do not properly model the external (65) cooling fins on a shipping cask; the geometry is complex and simplifying assumptions are made. In order to model this accident scenario accurately, a fire test with an internal heating element in a pressurized cask would be needed.

The industry quality control and NRC inspection programs have been entirely inadequate. As an example, the highway shipping casks NAC-1 (66) and NFS-4 have had design and construction defects. There is reason to believe that the number of faulty welds (67) is high because the wrong metals—for example copper—were used. *The welds were never examined for flaws when the casks were constructed;* (68) radioactive contamination precludes their examination at this stage. Shipping casks have also bowed or slumped in the middle and have had to (69) be reinforced with copper plates which were installed without NRC review and permission.

In addition to poor quality control and inadequate NRC inspection, the (70) standards for cask construction have not yet been set down by ASME (American Society for Mechanical Engineers). For lack of specific cask (71) standards, ASME *boiler* standards are used.

Regarding the trucks and drivers (72) themselves, the DOT has no special requirements and there is no specific oversight. Further, neither the NRC (73) nor DOT inspect the vehicles and tie-downs holding these shipping casks. ■

Coming Up:
A newsletter report on the new B-1b bomber. CEP examines the plane and finds that it is unneeded for US strategic defense.

JOIN THE COUNCIL ON ECONOMIC PRIORITIES AND BE A PART OF THE CORPORATE RESPONSIBILITY MOVEMENT.

☐ **Please enroll me as a Sustaining Member of CEP**, and send me a copy of all CEP **Reports** and **Newsletters** as they are released. Membership is a tax-deductible $35.

☐ **Please enroll me as a Regular Member of CEP**, and send me a copy of all CEP **Newsletters**. Membership is a tax-deductible $15. Students, Unemployed and retired persons may join for $7.50.

Please bill me (over ten dollars please).

name ______________________________

street ______________________________ apt. ________

city ______________________________ state ________ zip ______

all contributions are tax-deductible.

Annual tax-deductible membership for individuals: $35 (sustaining members receive CEP **Reports** and **Newsletters**), or $15 (regular members receive CEP **Newsletters**); student membership: $7.50. Full service corporate/institutional/governmental subscription: $1000/year (10 copies of publications and CEP staff testimony mailed first class; invitations to and tapes of briefing sessions; copies of press coverage). Regular institutional subscription: $500/year (four copies of publications and invitations to briefing sessions). Public library subscription: $150/year (three copies of publications).

This page intentionally left blank.

DISTRIBUTION:

DOE/TIC-4500-R67 UC 71 (235)

U. S. Department of Energy
Technical Information Center (235)
Oak Ridge, TN 37830
Attn: DOE/TIC-4500-R67 UC 71

U. S. Department of Energy
Routing DP 123
Washington, DC 20545
Attn: G. Oertel
J. Jicha
F. P. Falci

U. S. Department of Energy
Albuquerque Operations Office
Albuquerque, NM 87115
Attn: K. A. Carlson
E. C. Hardin

American Nuclear Energy Council
410 1st Street SE
Washington, DC 20003
Attn: Ed Davis
Thom Miranda

Ken Gablin
Consultant
6749 Towne Lane Road
McLean, VA 22101

Science Concepts
1750 Pine Valley Drive
Vienna, VA 22180
Attn: Mark Mills

American Nuclear Society
555 North Kensington Avenue
La Grange Park, IL 60525
Attn: Octane J. DuTemple
V. Gay Easly

LeBoeuf, Lamb, Leiby & MacRae
1333 New Hampshire Avenue NW
Suite 1100
Washington, DC 20036
Attn: Leonard M. Trosten

Southern States Energy Board
One Exchange Place, Suite 1230
Atlanta, GA 30338
Attn: Kenneth J. Nemeth

Tom Brown
Deputy Director
Jefferson County Office of Civil Defense
175 Arsenal Street
Watertown, NY 13601

Maria E. Lopez-Otin
Special Assistant to Commissioner Roberts
U. S. Nuclear Regulatory Commission
1717 H Street N.W.
Washington, DC 20555

Edward L. Helminsky
The Radioactive Exchange
2550 M Street NW
Suite 275
Washington, DC 20037

George Dix
X Corp.
26619 Haney Avenue
Damascus, MD 20872

GE Morris Operations
7555 E. Collins Road
Morris, IL 60450
Attn: Gene Voiland

Nuclear Services Co., Inc.
P. O. Box 191
West Valley, NY 14171
Attn: Philip G. Woods
James P. Duckworth

Eugene Cramer
Southern California Edison Co.
P. O. Box 800
Rosemead, CA 91770

Lawrence W. Bierlein
910 17th Street NW
Washington, DC 20006

Omer Brown
U. S. Department of Energy
Office of General Council
1000 Independence Avenue SW
Washington, DC 20585

Steven P. Kraft
Edison Electric Institute
1111 19th Street NW
Washington, DC 20036

9000 G. A. Fowler
9700 E. H. Beckner
9780 R. M. Jefferson (50)
Attn: TTC Master File
9781 TTC Library (10)
9781 R. E. Luna
9782 R. B. Pope
9783 G. C. Allen
3141 L. J. Erickson (5)
3151 W. L. Garner (3)
8214 M. A. Pound

Second Distribution:
9780 R. M. Jefferson (100)

Org.	Bldg.	Name	Rec'd by	Org.	Bldg.	Name	Rec'd by

Sandia National Laboratories

COPY OF U.S. NUCLEAR REGULATORY
COMMISSION STAFF COMMENTS
ON CEP NEWSLETTER

February 10, 1982

MEMORANDUM FOR: Chairman Palladino
Commissioner Gilinsky
Commissioner Bradford
Commissioner Ahearne
Commissioner Roberts

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: TRANSPORTATION ARTICLE IN THE NEWSLETTER OF THE COUNCIL ON ECONOMIC PRIORITIES

This is in reply to a request from Commissioner Ahearne for staff comments on the recent newsletter of the Council on Economic Priorities dealing with spent fuel shipments.

Both NRC and DOT exercise control over the transport of spent fuel. Basically, NRC regulates the design, construction and use of the shipping casks, including proper loading of the casks for shipment. DOE regulates the actual transport of the material. This includes tie-downs, routing, vehicle and driver requirements, etc. DOT also prescribes the procedures to be followed in the event of a transportation accident involving radioactive materials. FEMA is the federal agency responsible for overall emergency planning and coordination.

The adequacy of NRC regulations for safe transport of radioactive material is reviewed and evaluated on a continuing basis. Most recently, in 1981, the NRC completed a comprehensive evaluation of its transportation regulations and concluded that "the present regulations provide a reasonable degree of safety and that no immediate changes in the regulations are needed to improve safety." The staff continues to believe the present regulations provide adequate protection for material moved in spent fuel casks. As part of its continuing review, the NRC has initiated several studies to consider the adequacy of the regulations and to identify possible improvements where appropriate. Enclosed is a list of various NRC studies currently underway which pertain to the safety of spent fuel shipments.

The article in the newsletter of the Council on Economic Priorities was apparently prompted by the new DOT regulations for routing of radioactive material shipments made by truck. Among other things, the article questions the safety conclusions in NRC studies and the standards to which spent fuel casks are licensed.

The staff reviewed the newsletter to identify the issues which were being raised. Those issues, together with the staff's comments are enclosed.

(signed) William J. Dircks

William J. Dircks
Executive Director for Operations

~~8204220579~~

CONTACT: C. E. MacDonald

Staff Comments on
Council on Economic Priorities
Transportation Article

1. An accident while trucking through a city could cost thousands of lives and tens of billions of dollars.

The basis for the statement that an accident involving irradiated nuclear fuel which could cost "thousands of lives and tens of billions of dollars," is not known. The NRC environmental statement, "Transportation of Radioactive Material by Air and Other Modes," NUREG-0170, December 1977, characterizes a very severe urban accident involving an irradiated nuclear fuel truck cask as having the potential for less than 1/2 latent cancer fatality and costs of 200 million dollars. The assumed population density for the analysis was the average urban density of New York City, 15,444 people per square kilometer. The probability of such an event is listed as 2×10^{-8} per year for the spent fuel traffic expected in 1985.

The NRC/Sandia urban study, "Transportation of Radionuclides in Urban Environs: Draft Environmental Assessment," NUREG/CR-0743, July 1980, estimates one latent cancer fatality and a $2 billion dollar cost for a worst case accident involving spent fuel in New York City with an associated annual probability of about 1.4×10^{-10}.

Enclosure 2

Transport of Radionuclides in Urban Environs

This effort was undertaken to assist the NPC in preparing a generic environmental impact statement on the transportation of radioactive material near, in, and through a large densely populated area. The generic environmental impact statement will consider such unique facets of the urban setting as:

(1) High population density: Heavy pedestrian traffic; diurnal variations in population; and horizontal vertical distribution.

(2) Unique transportation environment: Convergence of transportation routes; heavy traffic; many users and holders of radioactive materials; and different safeguards environment.

(3) Special effects: Effects of local and micrometeorology, and shielding effects of buildings.

Emphasis will be placed on radiological health effects, but all environmental impacts, both radiological and nonradiological, will be assessed.

Development of Regulatory Guides

The staff has a continuing program to develop regulatory guides in the area of transportation. At present, three guides for spent fuel casks are in various stages of development; these are: (1) fracture toughness criteria for cask materials, (2) acceptable procedures for fabrication and construction, and (3) development of a design and construction code for spent fuel casks. The latter project is being conducted in conjunction with the ASME Boiler and Pressure Vessel Code Committee.

2. New DOT regulations direct material to be transported by truck on the most direct interstate routes, even if these routes traverse metropolitan areas.

DOT regulations do not preclude shipment by modes other than truck. When shipments are made by highway, the regulations require the shipment to be routed by the most direct interstate routes. The rule also provides that large quantity shipments, including spent fuel, must be routed around a city whenever an interstate bypass or beltway is available. In addition, DOT permits states to designate alternate routes when those routes are demonstrably as safe as the routes specified in the DOT rule.

3. DOT regulations will preempt current local and state ordinances.

DOT has listed as an appendix to its routing rule those type of state and local ordinances which it considers to be inconsistent with federal regulations. This finding of inconsistency is expected to provide a basis for preemption if the state or local ordinances are challanged.

4. According to DOT, a transportation accident leading to radiation release and just one cancer fatality could occur only once every 25 million years. Is the probability this remote?

NRC studies indicate that the probability of a latent cancer fatality from accidents involving shipments of spent fuel is remote. NUREG-0170 specifies an annual probability of 4.2×10^{-4}, based on 1,500 shipments per year. This is comparable to a frequency of one latent cancer fatality in 2,400 years.

We have not been able to identify where, or if, the one in 25 million year estimate has been used by DOT.

5. A low speed accident in an urban area could unseat a valve, releasing radioactive steam and vaporizing the coolant. This would cause the fuel to heat up further and release more volatile radionuclides such as cesium.

It is possible that a relief valve could fail to reseat as a result of a low speed accident. However, the effects of such an event have been evaluated. An analysis for the potential for release of cesium from a rail cask shipment of 7 PWR fuel assemblies has been performed for an accident that exceeds the design basis accident (NUREG-0069, "Potential Releases of Cesium from Irradiated Fuel in a Transportation Accident," July 1976). The evaluation, in which the relief valve was assumed to remain open so that the cask is vented to the atmosphere, showed that potential releases of volatile fission products were consistent with estimates in the environmental survey (WASH-1238, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," December 1972). It was concluded that no more than 3 curies of cesium could be released, and that the potential cesium release from this postulated accident did not significantly increase the risk to public health and safety above that already estimated (14 rem from inhalation to the maximum exposed individual) in WASH-1238. It should be noted that due to weight limitations, highway casks would be limited to 3 PWR fuel assemblies. The estimate of release of cesium is also supported by a more recent study (NUREG/CR-0722) discussed in Item 16.

6. Because of a faulty valve, four GE rail shipping casks were voluntarily removed from service, June 1981.

In June 1981, the General Electric Company notified the NRC that it was voluntarily limiting the use of its four Model No. IF-300 shipping casks. Future shipments would only be made with a dry cask cavity; no coolant (water) would be present in the cavity during shipment. This was because of a problem with a relief valve.

The valve is designed to open in the event of an accident and, after relieving internal pressure within the cask, to reseat and reseal. The problem with the valve centered upon whether it would meet specified leakage limits after reseating.

When liquid coolant is excluded from the cavity (i.e., dry shipment), the internal pressures would not be sufficient to cause the relief valve to open and thus its reseating performance is not important to safety. Liquid coolants will not be used in the cask until NRC agrees the problem has been satisfactorily resolved.

This potential problem is not generic to other spent fuel casks because no other cask is equipped with a valve which is intended to reseat.

7. Government reports show that a 1/2-hour, 1850°F fire could cause the seal and pressure relief valve to fail, causing release of coolant and radioactive material.

Casks are permitted to release water coolant under accident conditions if the activity of the coolant is within federally allowed limits. The case in which the cask is vented to the atmosphere is discussed in Item 5, above. Fire temperatures are discussed in Item 22.

8. Failure of relief valves was not considered by DOT. NRC studied the less likely possibility of actually breaking the cask.

The DOT did not specifically consider failure of relief valves in the routing rule but it did consider packaging standards. The NRC considers possible failure of relief valves in licensing evaluations of specific casks. The NRC has also considered loss of coolant, as would occur in the event of valve failure or malfunction, in generic environmental studies (NUREG/CR-0743, WASH-1238 and its supplement NUREG-0069, see Item 5).

9. The study accepted by NRC for truck accident speeds based its data on phone calls to three city police departments.

The study referred to, NUREG/CR-0743, July 1980, is a contractor's draft report prepared to assist the NRC staff in formulating a draft environmental impact statement on the transport of radionuclides in urban environs. This report is now under staff review and has not yet been accepted by NRC. The contractor's draft report uses an accident severity categorization scheme developed in NUREG-0170, which is based upon a detailed statistical study of accident severities and probabilities (SLA-74-0001, September 1976). The accident severity categorization scheme was supplemented by additional data including information obtained by phone calls to three city police departments in high density urban areas. The collection and statistical treatment of accident data upon which the report is based represents the state-of-the-art for estimating accident speeds and conditions and is not based solely or principally on the phone calls as noted in the CEP Report.

10. Routing shipments along interstates through urban areas will increase the probability and consequences of an accident. 76% of all truck accidents occur in urban areas and the urban accident rate is about 30 times the national average for all truck accidents.

The staff agrees that about 76% of all truck accidents occur in cities. Further, our figures seem to show that the urban accident rate is about 15 times higher than the overall accident rate. Nevertheless, the statement "routing shipments along interstates through urban areas will increase the probability and consequences of an accident" does not follow from available facts. The probabilities of some accidents may increase, but others will decrease. Also in those accidents for which consequences increase, probabilities decrease. The severities of the accidents in cities is generally less than elsewhere. Although about 3/4 of the truck accidents occur in cities, one study (Heavy Trucks, Fatal Accident Reporting System, NHTSA, USGPO, 1977) shows that only 1/4 of fatal truck accidents occur in cities. The frequency of accidents on interstate highways is less than on other types of roads. Only 5% of fatal accidents occurred on urban portions of interstate roads, while 19% occurred on urban portions of other road types. Because of differences in population density and property values, the consequences of a given accident will usually be higher in an urban area than in a rural area, but the likelihood of a severe accident in an urban area is much less than in rural areas.

11. CEP predicts four nuclear transport accidents per year in the 1990's and 17 accidents per year by the turn of the century. Three a year will occur in cities in the 1900's and rise to 13 annually by the year 2000.

Based upon a projected 1.43 x 10^6 shipment-miles of spent fuel in 1990 and 6.68 x 10^6 shipment-miles in 2000, the estimate of 17 traffic accidents per year appears plausible. The large majority of these will be relatively minor traffic accidents which would not challenge the integrity of spent fuel casks (see Item 19). NUREG/CR-0743 estimates 94% of urban truck accidents involving spent fuel cause no release of radioactive material. The risk from severe accidents having a potential to cause release is estimated to be small.

12. Of all transport options, NRC considers barge transport to be the safest, yet this is precluded by DOT regulations.

The NRC has not established barge transport as the safest mode. DOT regulations, including the new routing rule, do not preclude the use of barge transport. Both NRC and DOT consider barge, as well as other modes of transport, to be adequately safe for radioactive material.

13. Following an accident, the temperature of irradiated fuel will determine the extent to which volatiles would be released. "It is quite possible that irradiated fuel will reach temperatures greater than 670°F causing more cesium to be released with the steam and hot air."

Following an accident, fuel temperatures could exceed 670°F; however, this does not mean that significant amounts of cesium would be released. It is possible that the fuel cladding could potentially fail as a result of an accident. However, clad failure alone does not lead to cesium release. As indicated in Item 16, the fractional release for cesium is 0.3%. Because the cask interior is at a much lower temperature than the central fuel pins, most of the cesium released from the fuel pins is expected to plate-out and be contained within the spent fuel cask. The possible release for a breached containment vessel has been considered for a rail shipment of 7 PWR fuel assemblies, and the maximum release was estimated to be less than 3 curies of cesium (NUREG-0069, see Item 5).

14. Under calm meteorlogical conditions, with a 10% release of cesium, hundreds to thousands of early deaths could occur within 1/4 mile of the accident. Outside the 1/4 mile area, delayed cancer fatalities would result if anyone remained in the area. Assuming 100,000 people per square mile did stay, 50,000 latent cancers would develop. An area of 1/2 square mile would be off limits to people for several hundred years.

In NUREG/CR-0743, a sabotage event in a city considered a 0.28% respirable release from a 15KCi cesium source (a respirable release of 0.042KCi). This compares well with a 10% release (0.052KCi) from a typical truck cask, as assumed in the CEP analysis. This study found no early fatalities or injuries and 5 to 9 latent cancer fatalities; this estimate is consistent with NRC staff estimates. Without more detail on how an estimate of "hundreds to thousands of early deaths" was obtained, we cannot explain this CEP estimate. However, the NRC staff believes the CEP estimate to be excessively high. Furthermore the NRC staff believes, as documented in a May 2, 1980 letter* to Dr. Resnikoff, that a 10% release of cesium from the cask inventory is excessively high. The basis for the CEP assumption that a 1/2 square mile area would be off limits for several hundred years is not given. Even if a release of this magnitude were to occur it is not clear why decontamination procedures could not be performed.

*A copy of the May 2, 1980 letter from the staff to Dr. Resnikoff is attached.

15. Based on the assessed value of Manhattan property, damages could reach billions of dollars. No private property is insured against this loss. An NRC study put the maximum economic consequences on the order of $2 billion, a gross underestimate.

NUREG/CR-0743, the draft environmental assessment on urban transport prepared by an NRC contractor does estimate $2 billion costs from a severe spent fuel accident in Manhattan. The NRC staff has been evaluating this cost estimate and has found instances of great overestimation as well as large uncertainties. Although large uncertainties do surround this NRC contractor cost estimate, the NRC staff has no reason to believe that it is a gross underestimate.

16. The NRC questions whether a 10% release of cesium is realistic. However, in light of observations at TMI, a 10% release of cesium in a highway accident is conservative.

As detailed in the letter of May 2, 1980 from the NRC staff to Dr. Resnikoff, the observations at TMI, specifically the occurrence of a clad-steam chemical reaction, do not appear to be relevant to the far lower temperatures, smaller masses, and different configuration involved in a spent fuel transportation accident. A February 1980 study by ORNL "Fission Product Release from Highly Irradiated Fuel," (NUREG/CR-0722) based on a series of experiments on irradiated fuel, simulating a cask loss of coolant accident, finds a fractional release of 0.3% for cesium. This is the release from the fuel elements, not from the cask. The amount released from the cask is expected to be much less, because of plate-out on the interior of the cask. In summary, the NRC staff, for the reasons cited in the staff letter to Dr. Resnikoff and on the basis of the new, experimental data in NUREG/CR-0722, believes a 10% release fraction for cesium is excessively high.

17. Local departments of health and fire and police departments are not trained or equipped to cope with emergencies of this magnitude. Also, local communities are not prenotified of shipments.

The federal agencies responsible for developing guidance and planning for transportation accidents involving radioactive material are DOT and FEMA. Both agencies have ongoing programs directed towards improving emergency response capabilities. This includes training of state and local emergency response personnel. In addition, DOE maintains a radiological assistance team which is available to advise and assist local authorities at the scene of an accident.

With regard to prenotification, NRC regulations were recently amended to require licensees to provide advance notification of spent fuel and nuclear waste shipments to state governors or their designees. This requirement becomes effective in July 1982.

18. It is often unclear who has the authority and responsibility for cleanup and protecting public health and safety in an emergency, a confusion which compounds the hazard.

In the event of a transportation accident involving radioactive material, those aspects of the accident which do not involve radioactivity (e.g., traffic control, fire fighting, etc.) are the responsibility of the state or local agency normally responsible for those occurrences. The radiological aspects to protect the health and safety of the public are the responsibility of state government.

19. Shipping casks should be designed to withstand all likely accidents. The present standards are unchanged since 1961 and are inadequate.

Shipping casks are designed to criteria which make the casks resistant to all likely accidents and most unlikely accidents as well. A Sandia Laboratories Study, SAND 77-0001, "Severities of Transportation Accidents Involving Large Packages," dated May 1978 supports the view that the present test standards provide protection for large, heavy, spent fuel casks against a high percentage of road and rail accidents. An ongoing Commission study, referred to as the Modal Study, is identifying the characteristics of transportation accidents at the upper end of the severity scale to determine whether NRC standards should require protection against very severe accidents on a cost-effective basis.

20. The 30-foot drop test is equivalent to a 30-mph crash into an unyielding barrier. According to NRC's own statistics, fewer than 1/4 of truck accidents occur at less than 32 mph.

It is not valid to compare a 30 mph impact of a spent fuel cask into an unyielding surface with the crash of a vehicle carrying that cask at the same speed. The crushing of the truck cab, and the energy absorbed in the trailer, in breaking the tiedown devices, in rotary motion, and in demolishing most of the objects in the path of the cask, all serve to reduce the amount of energy available to damage the cask. With the very few objects available which would represent an unyielding surface to a spent fuel cask, the impacting surface in most accidents will yield considerably. While these considerations do not provide absolute assurance of cask survival in all accidents, they serve to make cask failure in an accident unlikely.

21. Government documents show that if a shipping cask were to strike a bridge abutment sideways at 12.5 mph, the cask would lose coolant and radioactivity.

This apparently refers to a 1978 report, PNL-2588, prepared for the Department of Energy by Pacific Northwest Laboratory. In that report, various failure thresholds were estimated for a generic "reference" cask. One case considered in the report was side-on impact of the reference cask into a column, such as a bridge support. The report estimated the failure threshold could be as low as 12.5 mph for the worst case of geometric alignment between the cask and the column.

The estimate, made as part of a risk analysis, was based upon several conservative assumptions. Principal among these was assuming the column to be perfectly rigid and capable of developing the very high forces required to fail a cask without the column itself being subject to failure or deformation. The report also neglected other possible sources of energy dissipation such as crushing of the tractor-trailer equipment.

The report notes the estimates are less than the actual strength of the cask if tests to failure had been performed. The report also notes the failure threshold estimate should not be used as an assessment of cask integrity for purposes other than performing a risk analysis.

This type of impact is not directly covered in the present cask test standards. The extent (if any) to which the standards should reflect this type load will be considered in the Modal Study of Transport Safety currently being conducted by the NRC. (The Modal Study is described in the staff comments in Item 19.)

22. Shipping casks are designed to withstand a fire of 1/2 hour at 1475°F, yet the average temperature of a fire, according to government reports is 1850°F and many burn considerably hotter and longer.

The regulatory design test is a 1/2-hour exposure to a thermal radiation source of 1475°F, having an emissivity of 0.9. The effect of this test is equivalent to a seemingly hotter 1/2-hour hydrocarbon fuel fire (e.g., gasoline, kerosene). A real fire would not be uniformly at 1850°F, it would exhibit a temperature distribution with a peak temperature averaging around 1850°F. The local temperatures depend on ventilation (i.e., available oxygen) and the presence of massive cooling surfaces (i.e., heat sinks). Ventilation would tend to increase flame temperatures; massive cooling surfaces would absorb heat and tend to decrease flame temperatures. A large fire surrounding a cask would have a peak temperature some distance away from the massive cask. The fire would have to be large to engulf the cask, making ventilation poor. It has been shown that packages respond to the regulatory 1475°F fire about the same as they do to real hydrocarbon fires (Bader, B.E., "Heat Transfer in Liquid Hydrocarbon Fuel Fires," Proceedings International Symposium for Packaging and Transportation of Radioactive Materials, January 12-15, 1965).

The remaining question is the fire duration. The probability of exceeding the 1/2-hour fire in an accident has been studied and found to be small (WASH-1238, December 1972). In addition, casks are massive and generally insensitive to a fire's total heat.

23. Not all accidents are modeled in NRC standards (e.g., crush loads and torch fires).

It is not necessary to model all accidents in the regulatory package standards, as long as the standards result in packages which will survive most transportation accidents. Accident crush forces are a good example since there is no specific regulatory accident crush test. An NRC sponsored study of accidental crush forces "Potential Crush Loading of Radioactive Material Packages in Highway, Rail, and Marine Accidents," NUREG/CR-1588, dated October 1980, concludes that for packages such as spent fuel casks the regulatory impact test assures a level of protection against accidental crush forces at least as high as the level of protection provided against accident impact and puncture forces. Adequate crush resistance is therefore provided without the need for a specific crush test.

The potential for torching fires and fires involving materials other than hydrocarbons are well known. Because of the relative infrequency of heat sources with temperatures higher than large hydrocarbon fires, the small probability of such localized heat sources interacting with a spent fuel cask, and the relative ineffectiveness of a local heat source on a massive spent fuel cask, local torching fires are not directly represented in NRC standards, but will be considered by the ongoing NRC Modal Study for inclusion in the standards on a cost-effective basis.

24. No casks moving on the highways or rails have actually been physically tested. Reliance on computer analysis rather than physical testing presents problems because of the simplifying assumptions which must be made.

The report is accurate in that full-scale physical tests have not been conducted on casks that are presently being used. However, the NPC does require applicants to demonstrate that proposed cask designs meet NRC safety standards. This demonstration may be by means of full-scale testing, scale model testing, engineering analysis, or a combination of these methods.

The use of engineering analysis techniques, including computer modeling, is a well established and verified engineering practice. A number of computer programs are available and have been used by engineers to accurately model a variety of different systems and to successfully predict their performance under specified conditions. Simplifying assumptions of a conservative or bounding nature are routinely used to reduce the amount of analysis required to obtain necessary results.

Although casks in current use have not been subjected to full-scale physical tests, a number of obsolete casks have been tested by DOE. In one test, a truck carrying a cask was deliberately placed in the path of a speeding locomotive. The 120-ton locomotive struck the cask at a

speed of 80 miles per hour. In another test, a cask aboard a truck moving at about 80 miles per hour was deliberately crashed into an immovable concrete structure. Subsequent examination in both tests indicated that no radioactive material would have been released if the casks had been loaded with spent fuel. In addition, the observed test results were in good agreement with the engineering evaluations made before the tests were conducted.

25. The industry quality control and NRC inspection programs have been highly inadequate.

Since 1979, the NRC has required its licensees to apply quality assurance (QA) programs to the design, fabrication and use of shipping containers. Design and fabrication of shipping containers after the effective date of the rule must be in accordance with an NRC approved QA program. NRC licensees are required to maintain and use radioactive material containers in accordance with an NRC approved QA program. This has resulted in increased inspections by both the NRC and users of the packages. Several deficiencies in package construction have been found and corrected.

26. There is reason to believe that the Model No. NFS-4 casks have faulty welds and wrong metals (copper) and have bowed or slumped in the middle and had to be reinforced with copper plates which were installed without NRC review and permission.

In 1979, Nuclear Assurance Corporation informed the NRC that one of its casks deviated from the design approved by the NRC. The deviations consisted of a small region of reduced lead shielding and the inner shell being bowed along its length so that it was outside the straightness limit specified on the drawings. Copper plates had been welded to the outer shell of the cask to provide additional shielding to compensate for the region of reduced lead shielding, not to provide additional strength.

Upon receiving this information, the NRC ordered all casks of this design withdrawn from service until it could be determined that the casks were fabricated properly and met NRC requirements. Subsequently, the inner shells of three other Model No. NFS-4 casks were found to be outside the straightness limit specified on the drawings.

The casks whose shells did conform to the drawing specifications were returned to service with restrictions placed upon their contents and operating conditions. Those casks whose shells do not conform to the drawings remain out of service pending a demonstration of adequacy by the licensee.

Based on inspections performed by IE, there are no indications that structural materials other than those approved by the NRC were used to fabricate the casks. The copper plates are a shielding material and are not used for a structural purpose. Also, the cask welds were inspected following accepted procedures and there are no indications that the welds are faulty.

27. Standards for cask construction have not yet been set down by ASME. For lack of specific standards, ASME boiler standards are used.

ASME standards for pressure vessels, including nuclear reactor vessels, are contained in the "ASME Boiler and Pressure Vessel Code." Design criteria for spent fuel casks are given in Regulatory Guide 7.6. The criteria in this document were adapted from Section III of the ASME Code for Class I nuclear vessels. Section III is being used by a newly formed ASME Committee to develop specific standards for spent fuel casks.

28. DOT has no special requirements for trucks and drivers. Neither NRC nor DOT inspect the vehicles and tie-downs holding shipping casks.

DOT has extensive safety requirements applicable to vehicles and drivers of hazardous material shipments, including shipments of spent fuel. Specific requirements for emergency response training of drivers of vehicles carrying large quantities of radioactive materials were included in the DOT routing rule. DOT has a nationwide field inspection force charged, among other things, with inspection of drivers and vehicles.

29. NRC studies (NUREG-0194) underestimate the number of early fatalities because people within 1/4 mile are not considered and 90% of persons within 10 miles are assumed to be evacuated within 4 hours. Granting these assumptions, a rail accident in New York City still projects up to 4,100 early deaths and 680,000 latent cancer fatalities.

The source term used in the CEP evaluation is unrealistically large for a transportation accident, since it assumes 100% release of cesium (see response to Item 16, above). The CEP evaluation is also based upon an improper extrapolation of consequence estimates to the high population densities in a city.

The model used to estimate public health consequence in NUREG-0194, which is essentially the same as that used in the Reactor Safety Study, does make the assumptions described by CEP. However, these assumptions do not substantially effect the consequence estimate in that report and do not invalidate its conclusions. For extrapolation to urban areas, however, the cautionary language in the Addenda to NUREG-0194 is important: "The population environment is modeled by a uniform population density. The value of 100 people/mi^2 chosen for these calculations slightly overestimates the average density in the conterminous United States; radiological consequences for different values of population density may be estimated by linear scaling provided that caution is applied for urban densities. These calculations do not include considerations of release kinetics, buildings, evacuation, or decontamination, all of which are important for urban situations and which presumably tend to decrease the calculated consequences."

In NUREG/CR-0743, near field effects not treated in NUREG-0194 were considered. But even in the case of a sabotage event involving a sizeable cesium source term (see response to Item 14), no early fatalities were estimated.

30. Another NRC study, the TRUE study, uses unrealistically low estimates for radiation release and assumes only corrosion products will be released along with gaseous radionuclides, but no cesium.

The release estimates made in NUREG/CR-0743 (i.e., the "TRUE" Study), attempt to be realistic but are probably conservative, based upon physical test data and engineering analysis. Several sources of evidence, including an explicit analysis in NUREG/CR-0743, indicate that the addition of an appropriately small amount of cesium (such as 0.3% - see response to Item 16) would not effect consequences in a detectable manner.

References Cited in Staff Comments

WASH-1238	"Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants," December 1972
NUREG-0069	"Potential Releases of Cesium from Irradiated Fuel in a Transportation Accident," July 1976
NUREG-0170	"Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes," December 1977
NUREG-0194	"Calculations of Radiological Consequences From Sabotage of Shipping Casks for Spent Fuel and High-Level Waste," February 1977
NUREG/CR-0743	"Transportation of Radionuclides in Urban Environs: Draft Environmental Assessment," July 1980
NUREG/CR-1588	"Potential Crush Loading of Radioactive Material Packages in Highway, Rail, and Marine Accidents," October 1980
NUREG/CR-0722	"Fission Product Release From Highly Irradiated LWR Fuel," February 1980
NRC Regulatory Guide 7.6, Rev.1	"Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels," March 1978
SLA-74-0001	"Severities of Transportation Accidents," Change 1, September 1976.
SAND 77-0001	"Severities of Transportation Accidents Involving Large Packages," May 1978
PNL-2588	"An Assessment of the Risk of Transporting Spent Nuclear Fuel by Truck," November 1978
Bader, B.E.	"Heat Transfer in Liquid Hydrocarbon Fuel Fires," Proceedings, International Symposium for Packaging and Transportation of Radioactive Materials, January 12-15, 1965
National Highway Traffic Administration	"Heavy Trucks Fatal Accident Reporting System," 1977

MAY 0 2 1980

Marvin Resnikoff
Sierra Club Radioactive Waste Campaign
P. O. Box 64, Station G
Buffalo, New York 14213

Dear Marvin:

Thanks for sending me the Aug/Sept. issue of The Waste Paper and your detailed technical paper which was the basis of the popular article on a spent fuel shipping accident in The Waste Paper. First I will respond to the items listed in your letter. Then I will comment on your spent fuel accident analysis, drawing on information provided by the NRC staff and the Sandia Labs staff working on the urban transport study. Finally I will respond to your recommendation for a research program.

1. NUREG-0194 does cite COMO as the computer code used for consequence estimate. To the best of my knowledge COMO is essentially the same as the CRAC computer code. CRAC is the code currently in use to obtain consequence estimates for reactor accidents and, to a limited extent (cf. Ch.5, SAND77-1927), transportation incidents. Therefore I have enclosed for your information a copy of the CRAC computer code user's manual (Enclosure A). I understand that the code itself may be obtained from the National Energy Software Center (NESC), 9700 S. Cass Avenue, Argonne, Ill., 60439 (telephone 312-972-7250; Julia Pietrzak should be able to help you). The CRAC code (access code No. 722) is available at the NESC on the IBM 370 and a cost of around $180 would be involved unless you have a contract with DOE or one of its prime contractors. Although some details of the modeling can only be found by examining the user's manual or computer code itself, much information on the modeling is contained in Appendix VI of the Reactor Safety Study (Enclosure B).

I don't entirely understand your statement, "we find it incredible that 100% of the cesium could be released, in one case, as a respirable aerosol, yet only two persons would suffer early fatalities." The statement at the end of page 6 in NUREG-0194 appears to refer to high level waste (reprocessing waste), not spent fuel; thus, I don't understand its relevance to the problem you address. Table II on page 10 of NUREG-0194 seems to confirm this view. A spent fuel release involving 100% of the volatiles (essentially cesium) produces mean values for early mortality of 0.5 to 0.6, depending on the solids release fraction. On the other hand high level waste produces mean values for early mortality ranging from 0 to 1.7 (I believe the 1.7 value in Table II is the basis for the value of 2 cited on page 6). By comparing results for spent fuel with a minimal solids release fraction (0.001) the effect of the cesium release can be deduced. For a 1% cesium release values for early mortalities are 0.0 mean and 0.0 peak; for a 100% cesium release values for early mortalities are 0.5 mean and 3.0 peak. In evaluating the reasonableness of these estimates you should bear in mind the following factors: (1) early death is modeled as a threshold effect (unlike the latent death estimate)

OFFICE ▶						
SURNAME ▶					Attachment	
DATE ▶						

~~8005190518~~

MAY 0 2 1980

and it should not be expected to behave as a continuous function of release fraction, population density, or other parameters; (2) the consequence estimate does r . normally include regions very close .o the point of release (for the Reactor Safety Study it appears from Table VI 4-1 that the closest calculation point is normally 1/4 of a mile from the release point), because the gaussian air dispersion models are not valid or validated close in; (3) The number of people in a 22 1/2 degree sector (the angle evaluated by CRAC) one mile from the release point is only about 20 for a population density of 100 people per square mile. Figure 3 in NUREG-0194 shows the conditional probability of early fatality is around 0.01 near the release and plummets to around 0.0001 at one mile. Considering these facts together it does not seem surprising to me that under these conditions, less than one early fatality is estimated for a spent fuel release involving all the available cesium.

2. A copy of NUREG-0069, concerned primarily with releases of cesium in a spent f el accident, is enclosed (Enclosure C), as you requested.

3. A report by S. R. Fields, "Spent Fuel Shipping Cask Accident Evaluation" (HEDL-TME 75-138, VC-71), issued in December 1975 for ERDA, models a loss of coolant accident for the IF-300. I don't have an extra copy to send you, but it is available from NTIS. In this report Fields presents a good deal of modeling and lists various computer codes. His thermal calculations however, appear to rely on a standard generalized thermal analysis code called "TAP", which you may be able to acquire. Apparently Fields' approach is typical or standard practice in the analysis of shipping cask accidents. Rather than developing specific computer codes for the thermal analysis of loss of coolant accidents, general heat transfer codes are adapted for this purpose by specifying input parameters. The NRC licensing staff uses a variety of codes for verifying the calculations of applicants. I have enclosed for your information an article by W. A. Shuker (Enclosure D) that surveys eleven general heat transfer codes. This can assist you in selecting and using such codes for shipping cask analysis.

4. Sandia has modified their analysis and although cleanup is still assumed, groundshine dose is explicitly calculated. Preliminary indications are that groundshine dose can be very significant in some circumstances. Sandia has also modified their economic cost model, although the details of decontaminating major structures in cities are not addressed. Thus, the Draft Environmental Assessment, which we hope to issue soon (June), will, I believe adequately address your concerns about groundshine dose.

OFFICE ►						
SURNAME ►						
DATE ►						

MAY 2 1980

In addition to myself and my coworkers in the Transportation and Product and Standards Branch, Office of Standards Development, your technical paper and The Waste Paper article were reviewed by the Transportation Certification Branch, Office Nuclear Material Safety and Safeguards, and by staff members at Sandia Labs. Detailed comments of these groups are Enclosures E and F, respectively. These enclosures state the case explicitly and in some detail. Nevertheless let me summarize what I consider to be their salient points and add a few of my own thoughts. Because humans have so often demonstrated their inability to predict the future, I believe it imprudent to brand any hazards analysis scenario as "impossible" or "incredible," except in cases where blatant, egregious violation of natural laws is apparent. Nevertheless your scenario for a spent fuel accident contains sufficient logical inconsistencies that more detailed consideration by the NRC regulatory staff, as conservative as we tend to be, appears unwarranted. There seem to be three crucial problems in the proposed secenario:

1. Technical judgement supported by related technical documentation indicates that the minimum temperature required to initiate the zircaloy - steam reaction cannot be achieved while the water required for the steam atmosphere is present in the cask; your technical paper presents no convincing contrary evidence.

2. Given a hydrogen generating reaction (neglecting the strong reservations stated above), it does not appear that a flammable (i.e explosive) concentration would be formed in the cask.

3. Given a hydrogen explosion (neglecting both of the strong reservations stated above), it is not clear that a significant aerosolized, respirable release of spent fuel solids would occur and that the large estimated public health consequences would occur.

Regarding attainment of high temperature by the fuel clad consider the following:

(a) the steam-zircalloy reaction requires some water to be present in the cask, but the ORNL formula used to calculate peak cladding temperature assumes complete loss of coolant. As long as some water remains in the cask, its heat of vaporization will provide a significant heat sink.

(b) PNL-2588 (An Assessment of the Risk of Transporting Spent Nuclear Fuel by Truck, by H. K. Elder, et al. November 1978, Pacific Northwest Lab.) does describe the thermal response of a spent fuel cask (containing one PWR element emitting 12.4 Kw) to six accident scenarios. Three of these scenarios (1/2 hour fire with initial loss of coolant, 2 hour fire with initial loss of coolant, minimum duration fire causing a loss of coolant) are of interest here. The fuel pin temperature (obtained in the 2 hour fire case) was 1600 deg. F, which is still below the 1688 deg. F zircalloy-water reaction activation temperature.

OFFICE ►						
SURNAME ►						

(c) The implication in your paper that uncovering fuel rods will cause their temperature to rapidly reach excessive temperatures does not seem consistent with the experience with casks currently licensed, of which twothirds (four out of six) use only gas as the coolant fluid. Table 2-12 of the interim report, "Scoping Study Spent Fuel Transport Accidents" by Rhyne et al (Enclosure G) States the characteristics of those casks. (I have also enclosed, Enclosure H, NUREG/CR 0081 the final report on the same subject.

(d) In the same report Table 2-13 summarizes the analyses of the response of the currently licensed casks to the design basis (30 minute) fire; peak cladding temperature achieved was 594 deg. C (1100 deg. F) for the NLI 1/2 cask

Regarding the formation of an explosive mixture inside the cask, (assuming that a temperature high enough for the zircalloy-water reaction to occur is reached, contrary to the above discussion) your scenario assumes an unseated pressure relief valve. High internal temperatures cause steam generation, high internal pressure, and resulting continous outflow through the open relief valve. On pages 9-10 of your paper you indicate the highly exothermic nature of the zircalloy-water reaction which should raise the internal cask pressure and cause further outflow through the relief valve. Under these circumstances it is difficult to visualize how air will enter the cask to form an explosive mixture, as stated on page 11 of your paper. If the initial cask atmosphere is steam at elevated pressure, I do not understand how an explosive mixture will form if hydrogen is evolved in an exothermic reaction.

Regarding the effects of a hydrogen explosion (assuming that sufficiently high temperatures are reached to initiate the zircalloy steam reaction and that an explosive mixture is formed and detonates, contrary to the above discussion) consider the fluid filled volume of the cask. You estimate .343 cubic meters (12.13 cubic feet), although table 2-12 of Enclosure E indicates that a value of .189 cubic meters might be more accurate. The heat of combustion of hydrogen is 68.32 K cal/g-mole. A stoichiometric mixture of oxygen and hydrogen is 2/3 hydrogen by volume; a stoichiometric mixture of air and hydrogen is 2/7 hydrogen by volume. Assuming a cask gas volume of .343 cubic meters, an oxygen-hydrogen reaction would involve .229 cubic meters of hydrogen and an air-hydrogen reaction would involve 0.098 cubic meters of hydrogen. At STP these are 10.2 and 4.38 g-mole respectively. Thus the corresponding thermal yields are 697 and 299 K cal. A Kg of TNT has an explosive energy yield of about 1.12 x 10^6 calories. Thus conservatively assuming that all the thermal yield is available as explosive energy, the oxygen and air mixtures are estimated to have explosive yields equivalent to 0.62 Kg (1.37 lb.) and 0.27 Kg (0.59 lb.) of TNT. These are rather small yields. At initial higher pressures the yield would be proportionately increased. The weight of contents in the cask is about 840 Kg (1 PWR fuel element in the NLI 1/2). Dividing this mass

OFFICE ➤						
SURNAME ➤						

into the explosive yield gives less than 1 calorie per gram; a rather low energy density for fuel disruption. In other words even assuming that a hydrogen explosion were to occur, it is not clear that the effect on the cask and fuel would be the release in respirable form of the phase 2 release fraction stated in your Table 3.

The preceding discussion, expanded on and augmented by Enclosures D and E, indicates why the NRC staff plans no immediate, specific response to the accident scenario you have presented. In regard to your recommendations for a safety research program, a point-by-point response follows:

1. On pages 30-31 of NUREG/CR 0811 the thermal analysis computer codes, used to analyze the thermal response of casks under normal and accident conditions for licensing purposes, are listed. In at least one case confirmatory tests were performed. The NRC staff is beginning an effort, the modal study, to determine severe accident environments and the thermal/mechanical response of casks to these environments. This should add considerably to the knowledge of cask behavior in extreme environments and the ability of computer models to predict that behavior. This work will augment information accumulated over the years by NRC licensees, the NRC staff, DOE, the Transportation Technology Center (Sandia Labs), and other domestic and foreign investigators of this subject. I believe a thorough review of the relevent literature (NUREG/CR-0811 contains a rather complete review of information in print) would convince you that further model development is unnecessary. Since thermal analysis theory was been extant for at least 100 years and since thermal analysis codes have yielded good results for several years, the recommendation for verification tests does not seem appropriate.

2. As stated above, it is not considered cost-effective to perform expensive experimental validation tests, when the analysis of these phenomena appears to be so well in hand. Can you give any reason for performing experiments for the rather simple physical system you describe, when the theortical and calculational knowledge needed to model it are so well established? As you know the NRC staff licenses casks to experience a set of hypothetical accident conditions (10 CFR 71, Appendix B), without allowing more than certain quantities of radioactive contents to be released (§71.36(a)(2). The staff believes its current licensing practice gives a sufficient assurance of safety, so that the changes you propose to both accident conditions and acceptance criteria are not justified.

3. I believe the modal study will investigate the response of contemporary casks to severe environments, so that your concerns stated here will be satisfied.

OFFICE ►						
SURNAME ►						
DATE ►						

I hope you find the above discussion and the enclosed material informative a: thought prc··ckinc. You may wish to reconsider certain aspects of your accident analysis, after evaluatin. these comments and documents. In the meanti . if I can provide ·y other information to improve this dialogue, don't :..it·:e to write or c.ll (301-443-5946). I will be interested to rec·ive your comments on the Sandia Draft Assessment on transport in cities to · issued soon and the NRC Dra: EIS, which we hope will be issued a short ti.. later.

Sincerely,

Norm n A. Eisenberg
Transportatio· & Product Standards Branch
Office o: Standards Developm..t

Enclosures:
A. CRAC Computer Code User's Manual
B. Appendi· VI of the Reactor Safety Study
C. NUREG-C. ?
D. Survey of Heat Tran.fer Codes
E. Comments from Transportation Certification Branch, NMSS
F. Comments from Sandia Labs
G. "Scoping Study-Spent Fuel Transportation Accidents," Interim Report
H. NUREG/CR-0881

SD TASK NO. TP-610-2

Ongoing NRC Studies Related To Transportation of Spent Fuel

The Transportation of Radioactive Material
to and from United States Nuclear Power
Plants: Draft Environmental Assessment

The objective of this study is to assess the radiological impacts of transporting fresh fuel to, and spent fuel from, U.S. nuclear power plants. The assessment is for both normal and accident impacts. The report is presently in draft final form.

Modal Study of Radioactive Material Transport Safety

The purpose of this study is to develop possible package test standards representative of high severity accidents and to evaluate a range of post-test safety standards. The study will consider the types of environments that could be produced by severe accidents in each mode of transport. Various shipping containers will be physically tested to determine what level of safety standards would be feasible and practicable under these conditions. The study will also consider the risk from potential high consequence accidents, the cost-benefit of possible test standards and the effectiveness of various operational and administrative controls.

Emergency Response Guidance to the States

The objective of this program is to provide guidance to the states for developing emergency response programs for transportation accidents involving radioactive material. The project includes surveying existing emergency response capabilities, developing a model emergency response plan and providing a cost-effective guidance program to the states. The project is expected to be completed early in 1983.

Collection and Evaluation of Data on Radioactive
Material Accidents and Incidents

The purpose of this program is to collect all available data on radioactive material accidents and incidents; and to prepare annual reports showing the number of incidents, to assess the radiological and economic consequences, and to provide data to states in support of their emergency response programs. The first annual report is expected in Spring 1982.

Enclosure 1