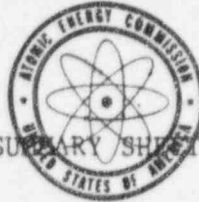


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SECY-R-702

To:

The Commission
POLICY SESSION ITEM

Thru:

The Director of Regulation

Subject:

CONSIDERATION OF FORM FOR SHIPPING PLUTONIUM

Purpose:

To consider publication for public comment of proposed amendments to 10 CFR Part 71 which would require future shipments of plutonium to be made as a solid, encapsulated to meet special form requirements, shipped in packaging meeting normal form requirements of Part 71, except for quantities less than 20 curies.

Discussion:

Previous staff papers by both the General Manager and Regulatory staffs, considered by the Commission in 1970,* on the matter of shipping plutonium nitrate concluded that no regulatory changes should be made at that time to prohibit the shipment of plutonium nitrate, but that the AEC should encourage the development and use of processes which would lead to the transportation of most of the plutonium in the oxide form, preferably in particle sizes above the respirable range. The Commission then requested the staff to evaluate the economic effects of a policy which would require that all plutonium shipments be made in the form of oxide and that the oxide be composed of large particles. An economic study to this effect was considered by the Commission in 1971, and the Commission requested further staff recommendations.** This paper responds to that request. Also, the ACRS considered this matter in 1970 and made a recommendation to "strongly encourage shipment of plutonium in the nonrespirable oxide or other solid form by 1975."

Existing regulations permit the shipment of plutonium in any chemical or physical form, including liquid plutonium nitrate. Using present regulatory criteria, hundreds of plutonium nitrate shipments have been made with no reported instances of plutonium leakage from the containment vessel.

The situation with respect to plutonium transportation in the private sector will change significantly over the next several years. First, increasingly larger quantities of plutonium will be recovered from power reactor

E: * SECY-R-62 - Shipment of Plutonium, & SECY-509 - Plutonium Handling & Storage were considered at Meeting 2439 on October 26, 1970.

** At Information Meeting 1140 on May 24, 1971, during consideration of XA-2 - Economic Impact of Requiring Plutonium Shipments as Oxide.

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fuel. Second, the specific activity of the plutonium will increase with higher reactor fuel burnup resulting in greater pressure generation potential from plutonium nitrate solutions in shipping containers, greater heat generation and higher gamma and neutron radiation levels. These changes will make the present nitrate packages obsolete. Thus, from both safety and economic considerations, the transportation of plutonium as nitrate will soon require substantial redesign of packages to handle larger quantities as well as to deal with the higher levels of gas evolution (pressurization), heat generation, and gamma and neutron radiation.

There is little doubt that larger plutonium nitrate packages could be designed to meet regulatory standards. The increased potential for human error and the consequences of such error in the shipment of plutonium nitrate are not so easily controlled by regulation. Even though such packages may be adequately designed, their loading and closure require high operation performance by personnel on a continuing basis. As the number of packages to be shipped increases, the probability of leakage through improperly assembled and closed packages also increases. Another problem involves pressure buildup in the package through radiolytic decomposition. Pressurization, which will become greater as the quantities of plutonium and its specific activity increase, constitutes a driving force for facilitating leakage in the event of packaging errors. More refined or stringent regulatory requirements, such as double containment, would not sufficiently lessen this concern because of the necessary dependence on people to effect engineered safeguards.

We believe the probability of plutonium leakage through human error would be substantially reduced and safety enhanced if the basic form of plutonium for shipment were modified from liquid to solid, since the solid form is less susceptible to leakage.

Such a change would not be the first time the Commission has acted to restrict the physical form in which radioactive material would be shipped. Concern with potential transportation incidents involving liquids is reflected

in earlier Commission actions to restrict the shipment of particular materials to solid forms rather than specify performance standards. In the first of these actions, the adoption of Appendix F of 10 CFR Part 50, the Commission required, on recommendation of the General Manager and the Regulatory staff (see AEC 180/47)** that shipments of high level waste from reprocessing plants must be made as solids to avoid the potential hazard of radioactivity release. At the same time, the Commission also required that high level waste should be stored in solid form because of the inherent hazards associated with liquids and the dependence on the human element for safety assurance. More recently, the Division of Waste Management and Transportation, in its plan for the management of AEC-generated radioactive wastes (WASH-1202) states as a general policy, "Liquid radioactive wastes shall not be transported offsite."

Experience shows that those transportation incidents which have resulted in widespread contamination have involved liquid radioactive materials and have been caused by packaging error. As a result of the most recent such incident, involving leakage of a short half-life medical isotope shipped on a Delta Airlines passenger plane, the National Transportation Safety Board, following an investigation, made recommendations which have resulted in rule changes by both the AEC and Department of Transportation concerning package preparation, pickup, monitoring and notification requirements. We are not aware of evidence that widespread contamination resulted from incidents involving solid forms of radioactive material.

Under present circumstances plutonium which is generated at reprocessing plants as a nitrate is shipped to fuel fabrication plants for conversion to the oxide form and subsequent processing. A change to solid form for shipment would result in the conversion to oxide being centralized at the reprocessing plant, unless the fuel fabrication plant were located on the same site. Plutonium oxide can be produced which is directly usable for fuel fabrication for commercial LWR's and for LMFBR's so that additional processing to redissolve the oxide would not be necessary. Such an oxide has already been produced at Hanford for the prequalification phase of the FFTF program (entered into by several fabricators).*

* One fabricator of mixed oxide fuel (for FFTF) would have to redissolve because of process incompatibility.

** AEC 180/47 - Siting of Commercial Reprocessing Plants & Related Waste Management Facilities, dated October 9, 1968.

At an industry meeting in November 1972 on plutonium recycle, sponsored by Nuclear Assurance Corporation, it was proposed by several of those present, including fuel fabrication representatives, that plutonium should be shipped and stored as the oxide because of anticipated problems both in shipping and storage of the nitrate. Further, it was decided that standards committees should be encouraged to prepare standards for shippable oxide, acceptable to all fabricators for direct incorporation into their fuel manufacturing processes, to avoid any need for dissolution or other major pretreatment prior to use. This appears to be a readily achievable goal using existing technology. Requiring solid plutonium to be transported in a nonrespirable particle size range would reduce risk of exposure through inhalation if the plutonium were to be released from its container; however, production and use of nonrespirable oxide is not a commercially viable alternative at this time.

The costs of processing and shipping plutonium in solid rather than liquid form could be lower because:

- a. Conversion to oxide would probably be carried out in a few reprocessing plants rather than a larger number of fabrication plants, resulting in lower processing and health and safety associated costs;
- b. Standardization of the oxide characteristics for direct use in fabrication will be favored, and will probably come about rapidly, particularly since such a move is technologically possible now;
- c. Less complex shipping container designs (oxide vs nitrate) would result and quicker and less costly AEC container evaluation would be expected;
- d. Fewer technical problems would be associated with storage; and
- e. Availability of scrap reprocessing and waste management systems at central sites, particularly if associated with reprocessing plants, should result in lower handling costs.

We believe that requiring packages for solid forms of plutonium to provide at least double containment of the

material would more than compensate for not specifying a nonrespirable form for shipment. The double containment provision would require that the material be contained in a "special form" capsule (as defined in Part 10 CFR 71) which in turn is within a package which meets the requirements for radioactive material not in "special form."

Even though our assessment indicates that there will not be a significant increase in the quantities of plutonium available for recovery in the next few years, we believe that any change in the requirements regarding the form of plutonium for shipment should be announced promptly so that those firms that are currently designing and building reprocessing and fuel fabrication plants can make plans to accommodate this change. Near term industry decisions that could be affected include those bearing on conversion of plutonium to oxide for storage and shipment at reprocessing plants, process design of plutonium fuel fabrication plants, and packaging design and procurement. Also, adequate time should be allowed for implementation of the change in existing facilities. Based on our assessment of the process and equipment changes needed to permit shipment of plutonium in solid form, and the time when increased plutonium shipments will occur, three (3) years from the effective date of any rule change would represent a satisfactory time period.

Based on a reconsideration of the overall question of plutonium shipment and taking into account the points summarized above, the staff concludes that the Commission should adopt a policy of shipping plutonium (except for specified small quantities) in solid form in packages which provide double containment of the material. The staff believes that such a policy would offer a significant enhancement of safety over shipping plutonium in liquid form, and is capable of being implemented by the industry, both from a technical and economic standpoint.

If the Commission approves the policy recommended in this paper, the proposed revisions to 10 CFR Part 71, as shown in Enclosure "A" to this paper, will be published in the Federal Register for public comment.

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- Recommendation: a. Approve publication of proposed amendments to 10 CFR Part 71, as shown in Enclosure "A", that would require that all plutonium in quantities greater than 20 curies shall be packaged for shipment as a solid in capsules which meet the requirements for special form and shall be shipped inside packaging that meets the requirements of Part 71 for radioactive material in normal form, these requirements to become effective three years after the effective date of the amendment;
- b. Note that the proposed amendments to 10 CFR Part 71 as set forth in Enclosure "A" will be published in the Federal Register, allowing 60 days for public comment;
- c. Note that if, after expiration of the public comment period, no significant adverse comments or significant questions have been received and no substantial changes in the text of the rule are indicated, the Director of Regulation will arrange for publication of the amendment in final form. If adverse comments or significant questions have been received or substantial changes in the text of the rule are indicated, the revised amendments will be submitted to the Commission for approval;
- d. Note that the Joint Committee on Atomic Energy will be informed by letter such as Enclosure "B";
- e. Note that a public announcement such as Enclosure "C" will be issued when the proposed amendments are filed with the Office of the Federal Register; and
- f. Note that the Regulatory staff plans to prepare an environmental statement in connection with this rule making action.

- Alternatives: The following alternatives are discussed in the Background Report, Enclosure "D":
- a. Make no change in requirements;
 - b. Revise package performance requirements to achieve higher integrity against liquid leakage; and
 - c. Ship as dry nonrespirable oxide.

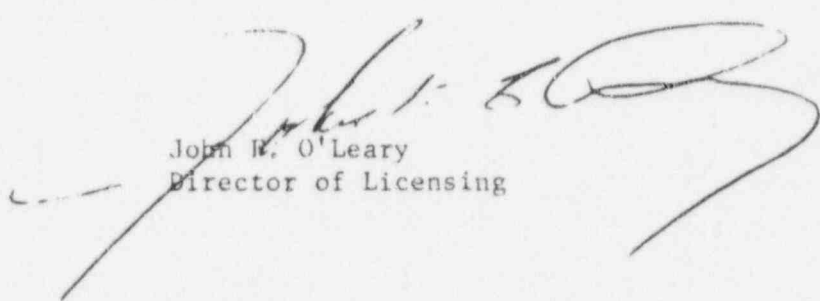
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Coordination: The Directorate of Regulatory Standards and the Directorate of Regulatory Operations concur in the recommendations of this paper. The Office of General Counsel has no legal objections. Certain of the General Manager's Divisions do not concur in the recommendations of this paper. A summary evaluation of the comments by the Regulatory staff is presented in Enclosure "E". The full text of the General Manager's comments is presented in Enclosure "F". The Office of Congressional Relations concurs in the draft letter to the Joint Committee on Atomic Energy, attached as Enclosure "B". The Office of Information Services has prepared the draft public announcement, attached as Enclosure "C".

Scheduling: For discussion at Policy Session on June 14, 1973.



John W. O'Leary
Director of Licensing

Contact: S. H. Smiley
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ENCLOSURE "A"

ATOMIC ENERGY COMMISSION

(10 CFR Part 71)

PACKAGING OF RADIOACTIVE MATERIAL FOR TRANSPORT AND TRANSPORTATION
OF RADIOACTIVE MATERIALS UNDER CERTAIN CONDITIONS

Consideration of Form for Shipping Plutonium

The Atomic Energy Commission is considering the amendment of its regulations in 10 CFR Part 71, "Packaging of Radioactive Material for Transport and Transportation of Radioactive Materials under Certain Conditions" to require that all plutonium in quantities greater than 20 curies shall be packaged for shipment as a solid in capsules which meet the requirements for special form and shall be shipped inside packaging that meets the requirements of Part 71 for radioactive material in normal form. The proposed requirements would become effective three years after the effective date of the amendment.

In light of anticipated significant changes in the characteristics and quantity of plutonium to be transported in the future, the Commission has considered the matter of form for shipping plutonium from the standpoint of public health and safety. Existing regulations permit the shipment of plutonium in any chemical or ^{physical} ~~liquid~~ form, including liquid plutonium nitrate. Using the present criteria and requirements of Part 71, hundreds of plutonium nitrate shipments have been made with no reported instances of plutonium leakage from the containment vessel.

Enclosure "A"

However, the present situation with respect to plutonium transportation in the private sector is expected to change drastically over the next several years. Increasingly larger quantities of plutonium will be recovered from power reactor fuel. Consequently, increases in quantities of plutonium shipped and number of shipments made are expected. For example, the amount of plutonium available for recovery is estimated to be 500 kg in 1973 as compared to 21,000 kg in 1980. In addition, the specific activity of the plutonium will increase with higher reactor fuel burnup, resulting in higher gamma and neutron radiation levels, greater heat generation, and greater pressure generation potential from plutonium nitrate solutions in shipping containers.

Because of these expected changes in plutonium transport and the inherent susceptibility of liquids to leakage, the Commission believes that safety would be significantly enhanced if the basic form ~~permitted~~ for shipments of plutonium were changed from liquid to solid and if the solid form of plutonium were required to be shipped in a package providing at least double containment of the contents. Such a change is considered to be feasible from an economic and technological standpoint.

The Commission's assessment indicates that there will not be a significant increase in the quantities of plutonium available for recovery in the next few years. However, the Commission believes that any change

in the requirements regarding the form of plutonium for shipment should be announced promptly so that firms that design and build fuel reprocessing and fuel fabrication plants can make timely plans to accommodate this change. It is anticipated that if a solid form for shipment is required, plutonium recovered at fuel reprocessing plants would be converted to the oxide form for shipment to fuel fabricators. Based on the Commission's assessment of process and equipment changes necessary to permit shipment of plutonium as oxide, and the time when increased plutonium shipments will occur, about three years appears to be a sufficient time period. Accordingly, if the proposed amendments are adopted, the effective date would be specified as three years from the effective date of such adoption.

Pursuant to the Atomic Energy Act of 1954, as amended, and section 553 of Title 5 of the United States Code, notice is hereby given that adoption of the following amendments of 10 CFR Part 71 is contemplated. All interested persons who desire to submit written comments or suggestions should send them to the Secretary of the Commission, U. S. Atomic Energy Commission, Washington, D. C. 20545, Attention: Chief, Public Proceedings Staff, by * . Copies of comments on the proposed amendments may be examined at the Commission's Public Document Room at 1717 H Street, N. W., Washington, D. C.

* A date will be inserted to allow 60 days for public comments.

1. A new section 71.42 is added to read as follows:

§ 71.42 Special requirements for plutonium shipments

(a) Notwithstanding the exemptions in § 71.9, plutonium in excess of 20 curies per package shall be shipped as a solid encapsulated to meet the requirements of special form as defined in § 71.4(o)(2) of this part, and shall be shipped inside an outer packaging which meets the requirements of this part for packaging of material in normal form.

(b) Authority provided in AEC licenses issued pursuant to this part for the delivery to a carrier for transport of plutonium in a liquid form in quantities exceeding 20 curies per package, shall expire on (three years from the date of adoption of this amendment).

(Secs. 53, 161, 68 Stat. 930, 948: 42 U.S.C. 2073, 2201)

Dated at _____ this _____ day
of _____, 1973.

For the Atomic Energy Commission

Paul C. Bender
Secretary of the Commission

ENCLOSURE "B"

DRAFT LETTER TO THE JOINT COMMITTEE ON ATOMIC ENERGY

1. Enclosed for the information of the Joint Committee on Atomic Energy is a copy of a notice of proposed rule making to amend 10 CFR Part 71, "Packaging of Radioactive Material for Transport and Transportation of Radioactive Materials under Certain Conditions."

2. The objective of the proposed amendments is to enhance the safety of shipping plutonium by requiring that plutonium be in solid form when shipped and that the shipping container provide at least double containment of the contents.

3. Existing regulations permit the shipment of plutonium in any chemical or physical form, including liquid plutonium nitrate. Using present regulatory criteria, hundreds of plutonium nitrate shipments have been made with no reported instances of plutonium leakage from the containment vessel. However, the present situation with respect to plutonium transportation in the private sector will change drastically over the next several years. First, increasingly larger quantities of plutonium will be recovered from power reactor fuels. Second, the specific activity of the plutonium will increase with higher reactor fuel burnup, resulting in higher gamma and neutron radiation levels, greater heat generation, and greater pressure generation potential from plutonium nitrate solutions in shipping containers. Because of these expected changes in the plutonium transport picture and the inherent susceptibility of liquids to leakage, the Commission

believes that a significant enhancement of safety would be achieved if the basic form of plutonium for shipment is changed from liquid to solid. Such a change is considered feasible from an economic and technical standpoint. Further, the solid form of plutonium would be required to be shipped in a package providing at least double containment of the contents.

4. The notice of proposed rule making is being transmitted to the Office of the Federal Register and will allow 60 days for public comment after publication in the Federal Register.

5. Enclosed also is a copy of a public announcement which we plan to issue on this matter in the next few days.

ENCLOSURE "C"

DRAFT PUBLIC ANNOUNCEMENT

AEC PROPOSES RULE CHANGE ON SHIPPING PLUTONIUM

The Atomic Energy Commission is considering requiring that the shipment of plutonium be in solid form in packages providing at least double containment except in single packages of 20 curies or less.

The Commission, following a safety review of plutonium transport practices, has concluded that while current criteria are sufficient for present shipments, both the quantity and specific activity of plutonium recovered from power reactor fuel will increase considerably in the private sector over the next several years. Because of the inherent susceptibility of liquids to leakage, the Commission believes the change to solid form would bring a significant enhancement in safety.

The amount of plutonium available for recovery in 1973 is estimated at 500 kilograms compared to 21,000 kilograms forecast for 1980. The specific activity of the plutonium will increase with higher reactor fuel burnup, resulting in higher gamma and neutron radiation levels, greater pressure generation potential from plutonium nitrate solutions in shipping containers.

The effective date of the requirement for the shipment of plutonium in solid form would be three years from the adoption date of the

proposed amendment, taking into account the time when increased plutonium shipments will occur and allowing time for the process and equipment changes at reprocessing plants required to convert the plutonium to the oxide form for shipment to fuel fabricators.

Interested persons have until _____ (60 days from publication) to submit written comments or suggestions on the proposed amendment to AEC Regulations to: Secretary of the Commission, U. S. Atomic Energy Commission, Washington, D. C. 20545, Attention: Chief, Public Proceedings Staff.

Copies of comments on the proposed amendment may be examined at the Commission's Public Document Room at 1717 H Street, NW, Washington, D. C.

ENCLOSURE "D"

BACKGROUND REPORT

CONSIDERATION OF FORM FOR SHIPPING PLUTONIUM

Fuels and Materials
Directorate of Licensing

April 1973

Introduction

Previous staff papers by both the General Manager and Regulatory staffs^(1,2), considered by the Commission in 1970, on the matter of shipping plutonium nitrate concluded that no regulatory changes should be made at that time to prohibit the shipment of plutonium nitrate, but that the AEC should encourage the development and use of processes which would lead to the transportation of most of the plutonium in the oxide form, preferably in particle sizes above the respirable range. The Commission then requested the staff to evaluate the economic effects of a policy which would require that all plutonium shipments be made in the form of oxide and that the oxide be composed of large particles. An economic study to this effect⁽³⁾ was considered by the Commission in 1971, and the Commission requested further staff recommendations. This paper responds to that request. Also, the ACRS considered this matter in 1970 and made a recommendation to "strongly encourage shipment of plutonium in the nonrespirable oxide or other solid form by 1975."

The above referenced staff papers predicted that economic and technological considerations would ultimately dictate that plutonium be shipped as oxide and/or fabrication and reprocessing plants would be located at the same or contiguous sites. Thus, while solid form was considered desirable for

(1) SECY-R 62, "Shipment of Plutonium" October 16, 1970

(2) Report by Plutonium Transportation Task Group, April 30, 1970

(3) SECY-1552, "Economic Impact of Requiring Plutonium Shipments as Oxide," May 20, 1971.

shipment, it was not suggested that this be accomplished by rule change. To date there has not yet been an indication that shipments of plutonium nitrate solution will be phased out in the near future.

While fabrication plants for mixed oxide fuel are planned to be located adjacent to the sites of 2 of the 3 reprocessing plants already built or under construction, other mixed oxide plants will be removed from the source of plutonium. Furthermore, all of the reprocessing plants at present are designed to process and recover plutonium as nitrate solution.

Plutonium available for recovery from irradiated fuel is estimated to be about 500 kg in 1973 as compared to 21,000 kg in 1980. If a large fraction of this material is transported as nitrate, the small capacity of the present nitrate container, as well as the changes in the characteristics of the plutonium with increasing reactor exposure, will require container redesign; one licensee has already developed a preliminary conceptual design of a container to transport 25 kg of plutonium in 100 liters of solution. Major problems are anticipated in designing containers for safe transport of large volumes of plutonium nitrate solution, principally in the areas of pressurization of containers, heat dissipation and nuclear criticality safety. Thus, eventually it is likely that industry would undoubtedly tend to change over to shipment of the oxide form. However, because of the increased quantities of

plutonium to be shipped, the changing characteristics of the plutonium, and the increased potential for leakage, we believe the Commission should make the judgment to require solid form for shipment and not leave the option open to industry.

This study summarizes the results of an overall review of the relative safety and long term economic effects of shipping plutonium in forms other than the nitrate and in containers of higher integrity than those now in use.

Present Practices in Shipping Plutonium

Plutonium is shipped as metal, as oxide powder, as mixed-oxide pellets in fuel rods, and as nitrate solution. Nearly all of the metal shipments are related to AEC weapons programs. Most of the shipments in the private sector, other than finished fuel rods and assemblies, have been made as nitrate solution because it is a convenient form resulting from processing and is readily amenable to further processing. It is estimated that several hundred kilograms of plutonium as nitrate solution will be shipped during CY 1973. During the next 18 months, it is estimated that 800 kg of plutonium as oxide powder and 800 kg as nitrate solution* will be shipped from Hanford to the two licensed fuel fabricators for the FFTF program.

At present, most of the plutonium nitrate solution is shipped in packages having a 10 liter capacity containing up to 2.5 kilograms of plutonium.

* One fabricator has a coprecipitation process for FFTF and starts with plutonium nitrate

The solution is contained in a polyethylene bottle inside a polyethylene bag inside a stainless steel pressure vessel. (A typical container is shown in Figure 1). The polyethylene bottle is vented to allow the gases evolved, directly or indirectly due to radiolysis, to separate from the solution and be released to the pressure vessel. The pressure vessel contains a protected vent valve so that the receiver can safely release any pressure buildup before opening the container.

Regulatory Controls

AEC and DOT regulations⁽⁴⁾ do not specify the form of plutonium for shipment. Rather, the standards set forth package performance requirements for normal conditions of transport and severe accidents and apply to all types of radioactive materials, including plutonium nitrate. International transport regulations published by the IAEA and the regulations of many other countries are based on this same concept.

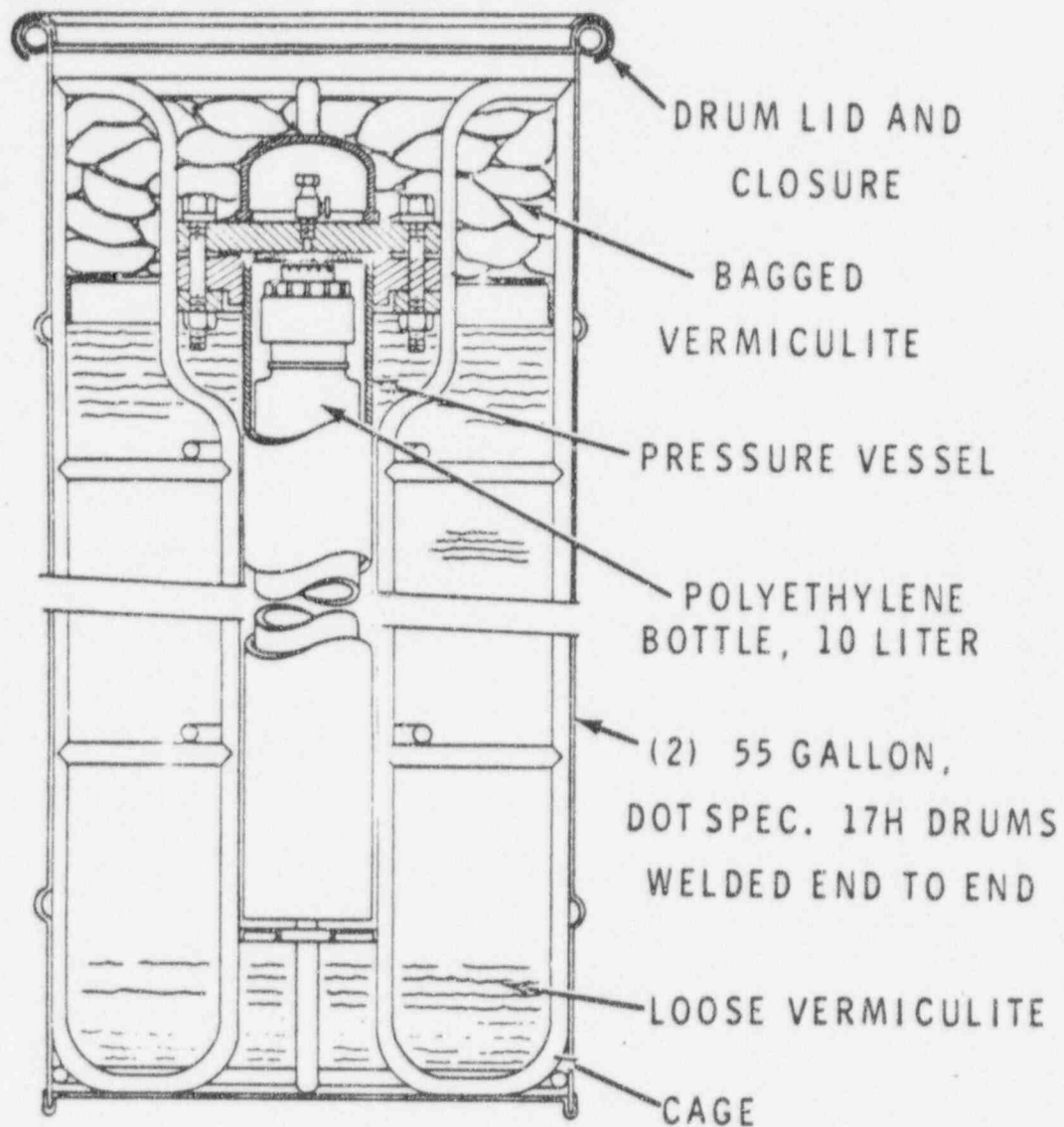
Basically, the shipping regulations require that (except for small quantities) plutonium shipping containers be designed to retain the material in the form in which it is shipped and remain subcritical under both normal and accident test conditions⁽⁵⁾ as specified in the regulations. Each design of shipping container for shipping more than a few milligrams of plutonium must be reviewed and approved by the AEC before it can be used.

(4) AEC's 10 CFR Part 71 and AEC Manual Chapter 0529. DOT's 49 CFR Parts 170-179.

(5) The hypothetical accident test conditions include in sequence a 30-foot free drop on an unyielding surface, a puncture test involving a 40-inch drop on a 6-inch diameter rod, a 30-minute fire test at 1475 F and immersion in water.

TYPE L-10
SHIPPING CONTAINER

(DOT - SP - 5061)



(Plastic bag around polyethylene bottle not shown)

FIGURE 1

A container design is approved only after a thorough evaluation of the structural, shielding, heat transfer and nuclear critical safety characteristics of the container against the packaging standards in 10 CFR Part 71, taking into account the results of tests of prototypes of the container which have been conducted.

The present general requirements for quality assurance (QA) in design, fabrication, use and maintenance of shipping containers in Part 71 are being revised to include more specific definition of a QA program and acceptance tests covering leak tightness, structural integrity, shielding and thermal tests will be specified.

Extra Severe Tests of a Plutonium Nitrate Container

Extra severe tests of the L-10 plutonium nitrate container (most commonly used) and other plutonium containers were conducted by Sandia Corporation⁽⁶⁾ on initially undamaged containers, i.e., each test was conducted on a fresh package without test sequencing. The (simulated) contents were retained following a drop of 260 feet, a one-hour fire at approximately 1800 F and a puncture test from 9.7 feet. It can be concluded from these tests that the present packages for low burnup plutonium have a large margin of safety in terms of the regulatory requirements. There is no assurance

(6) SC-DR-72 0597, "Special Tests for Plutonium Shipping Containers 6M, SP 5795, and L-10," L. F. Stravasnik, September 1972.

that future package designs to handle high burnup plutonium will necessarily have comparable margins of safety with respect to the regulatory requirements.

Experience in Shipping Nitrate

In the many hundreds of shipments of plutonium nitrate during the last several years, there have been no reported instances of plutonium leakage outside the containment vessel. A high frequency of leakage from the inner polyethylene bottle and plastic bag into the pressure vessel was experienced prior to 1968 but was reduced by changes in the closure of the plastic bottle and in the filling and shipping procedures. However, there have been occasional instances of leakage of plutonium into the plastic bag since the foregoing changes were effected. (7)

Basis for Concern with Plutonium Nitrate Shipments

Previous studies have led to the conclusion that there are no overriding safety advantages of one form of plutonium over another if the plutonium is released from a package, except for oxide in particle sizes above the respirable range. Although it was recognized⁽⁸⁾ that liquid forms such as nitrate solution are the least inherently safe form, the emphasis on

(7) SECY-1172, "Contamination in Plutonium Shipment to Karlsruhe,"
March 16, 1971.

(8) Letter, R. F. Fraley, Exec. Sec'y ACRS, to H. L. Price, Dir. of Reg.,
Dec. 15, 1970, recommended that steps be taken to encourage shipment of plutonium in the form of nonrespirable oxide or other solid form by 1975.

the adequacy of regulatory standards, the good safety record in shipping plutonium nitrate, lack of significant safety advantage of one form over another after release, and the anticipated long term tendency to conversion to oxide shipments by the industry, has tended to divert attention from troublesome characteristics of the nitrate. Review of the difficulties characteristic of nitrate shipments listed below and the expected large increase in plutonium shipments leads to the conclusion that safety in shipping plutonium would be significantly enhanced by a change to solid form, respirable or otherwise:

- (1) The liquid form of the nitrate is more susceptible to leakage than a solid form, thus making human errors in packaging more significant for liquids than for solids.
- (2) The nitrate solution in a shipping container is self-pressurizing. Pressurization of the container occurs from gas evolution (hydrogen and oxygen) caused by radiolysis and related reactions in the solution. Since gas evolution increases with the specific activity of the plutonium, there will be increased gas evolution with the higher burnup plutonium. Pressurization also presents a driving force for leakage in the event of defective packaging. Also, such pressurization may require consideration of the amount of time containers may be in transit. Containers in storage must be vented at periodic intervals (e.g., 30 to 60 days). For example, present plutonium nitrate shipped in the L-10 container generates about 0.8 psi pressure for each day it is sealed. Under the same circumstances, the pressure generated from radiolytic decomposition of high burnup plutonium (27% Pu-240) would be 4.9 psi per day, a rate 6 times as high.

- (3) Deterioration of the polyethylene bottles limits storage time; requires repackaging at intervals of 1 to 2 years. Metal containers could be used, but they would have to be replaced at approximately 5-year intervals. Design would probably be more complicated if plastic cannot be used.
- (4) The liquid form tends to cause handling and contamination problems at the receiver facility.
- (5) The liquid form in shipment is more vulnerable to fire in the event of inadequate insulation through packaging error.
- (6) The nitrate solution has a higher potential for accidental criticality since the minimum critical mass in solution is at least a factor of 10 below that of the oxide.

Judgments in Past Decisions Concerning Shipment of Radioactive Liquids

The following discussion is intended to indicate that the Commission has taken action in the past to restrict the form of a material for shipment, rather than specifying performance standards or container specifications. In 1971, based on a recommendation by the General Manager and Regulatory staffs, the Commission adopted Appendix F to 10 CFR Part 50 which requires, among other things, that high level waste must be converted to solids for both shipment and long term storage because of the inherent hazards associated with liquids and the dependence on the human element for safety assurance.

In the staff paper recommending this action, the following statement was made regarding the concern with respect to shipping high level waste in liquid form:

"Studies and assessments conducted to date have shown that severe safety and economic problems would be encountered in attempting to design a bulk liquid high-level waste shipping system which would meet existing regulations. For example, the decay-heat generated within the wastes could result in steam-pressure buildup within the shipping cask following a loss-of-coolant incident, and lead to release of liquid waste to the environment.

"For these and related reasons, the shipment of bulk high-level liquid waste is, from a practical standpoint, considered unacceptable and such wastes should be converted to solid form prior to shipment beyond the fuel reprocessing plant site.

"Characteristics of waste solids which are of major significance during shipment (as well as in interim storage as solids) include:

- 1) Insolubility,
- 2) Good thermal conductivity,
- 3) Thermal stability,
- 4) Ruggedness or resistance to dispersion,
- 5) Chemical inertness.

"As these qualities are enhanced or improved, less reliance need be placed on the balance of the shipping system to provide assurance against release of activity to the environment in the event of an accident. The technological effort and experience which have accrued from the shipment of irradiated fuels provide a firm basis for development of safe, reliable systems for the transport of solidified waste."

The Commission's Division of Waste Management and Transportation has established policies and criteria dealing with liquid radioactive wastes generated by the AEC and its contractors. In its "Plan for the Management of AEC-Generated Radioactive Wastes" (WASH-1202, January 1972) the following statement is made as a general policy:

"3. Liquid radioactive wastes shall not be transported offsite."

Even though there are several hundred thousand shipments of radioactive materials per year with very few leaks, those incidents that have resulted in the greatest public impact in the form of widespread contamination, extensive publicity, congressional concern, and lawsuits, have involved liquid radioactive materials and have been caused by packaging error. We are not aware of evidence that widespread contamination resulted from incidents involving solid forms of radioactive materials.

In the most recent of these incidents, about seven curies of molybdenum-99 in solution leaked from a package on board a Delta Airlines passenger flight. Molybdenum-99 is a beta-gamma emitter with a 66-hour half life which decays to technetium-99m, which has a 6-hour half life. The latter is used for medical diagnosis. The public reaction to the contamination of the aircraft was prompt and extensive; much more, perhaps, than a strictly technical evaluation of the hazards of the short lived isotopes would support. The incident prompted recommendations from the National Transportation Safety Board resulting in rule changes by both the Department of Transportation and the Atomic Energy Commission. The DOT clarified specifications on package preparation and the AEC is proposing specific requirements with respect to prompt pickup of packages from carrier facilities, monitoring for contamination of packages on receipt, and notification if evidence of leakage is found.

Factors Favoring a Decision Now

There are several reasons why it is important to make a decision now as to a more suitable form for plutonium shipment:

- (1) The anticipated sharp increase in plutonium production and handling during the next five years.
- (2) The lead time needed to accomplish major process, equipment or facility changes.
- (3) The changing nature of the plutonium with increasing exposure, e.g., increased heat generation rate, increased rate of evolution of radiolytic gas from solution and higher radiation levels (both gamma and neutron), which will require redesign of the shipping containers.
- (4) The opportunity provided industry to reduce any adverse cost effects
 - a) by choice of plant locations,
 - b) by installation of equipment at reprocessing plants to produce oxide with characteristics suitable for subsequent fabrication into LWR recycle and LMFBR fuel without an intermediate nitrate dissolution step at the fuel fabrication plant, and
 - c) by avoiding investments by reprocessors or fuel fabricators that would be rendered obsolete by the changed regulatory requirements.

Cost Benefit Analysis with respect to Plutonium Shipping Alternatives

Introduction:

The proposed rule changes recommended by this paper are predicated on the staff's judgment that additional conservatisms are warranted for the protection of the health and safety given the increased quantities and higher

specific activities of plutonium to be shipped in the next few years, and it appears to the staff that the attendant costs are justified by the desired safety objectives. In fact, as will be shown in the analysis, there is likely to be a significant cost advantage associated with the recommended change. The staff has given similar consideration to the other alternatives identified and discussed below. For the reasons set forth in the conclusion of this section, the staff does not believe that less restrictive approaches are sufficiently conservative, nor that more restrictive approaches with the attendant augmentation of costs, as shown in this section, can be justified on safety grounds since the further diminution of risk would be negligible.

In analyzing the alternatives it was necessary to express the costs of some parameters in qualitative terms because numerical values were difficult, if not impossible, to assess. Estimated dollar costs associated with the various process operations have been developed and these costs appear to have the greatest effect on judging the alternatives as will be seen from the analysis.

Identification of Alternatives:

1. Make no change in existing requirements with respect to plutonium shipments.
2. Permit the continued shipment of plutonium nitrate but revise the present package performance standards of Part 71 to require double containment of the contents.

3. Require that plutonium be shipped as a solid in special form capsules within packages meeting the requirements of Part 71 for material in normal form so that there would be two complete high integrity barriers to the release of plutonium.
4. Require that plutonium be shipped as a nonrespirable solid in packages which meet Part 71 requirements for material in normal form.
5. Require that plutonium be shipped as a nonrespirable solid in special form capsules within packages meeting the requirements of Part 71 for material in normal form so that there would be two complete high integrity barriers to the release of plutonium.
6. Require fuel fabrication plants and reprocessing plants to be located on the same site or on sites separated by a small distance in order to reduce the risk of accidents in shipping plutonium, or the risk of leakage in transit, to insignificant proportions.
7. Place a moratorium on plutonium recycle and, therefore, all plutonium shipments.

The latter two alternatives were rejected as being inappropriate to the scope of this study since the starting point of this paper is that plutonium is allowed to be shipped and the considerations are whether or not a particular form should be specified for plutonium shipments. These

alternatives are, however, important fundamental issues bearing on future plutonium economy and may warrant being the subject of another study.

Discussions of Alternatives:

The alternatives described above will now be discussed in terms of three parameters which should show the relative costs of each alternative. The parameters are process costs, packaging and shipping costs, and health and safety benefits (environmental costs). Cost estimates have been derived for those cases in which process changes are required in order to accommodate the alternative. Such cost estimates take into account the matter of process compatibility between the producer and user of the material. These costs, and a discussion of how they were derived, are set forth in a following section entitled Summary of Relative Process Costs. The packaging and transportation costs and health and safety benefits associated with the alternatives are dealt with qualitatively based on staff judgement because available information does not permit quantitative assessment. The incremental costs of the various alternatives are displayed in Table I at the end of this section.

Alternative 1, no change in existing requirements

Under this alternative, the option would be left open as to what form of plutonium should be shipped. Since the industry is currently set up to ship and receive plutonium in the nitrate form there would be no changes required in the process methods. Plutonium would continue to be produced at the reprocessing plant as the nitrate and shipped in that form to the fuel fabricator for conversion to oxide and subsequent fabrication. Thus, process costs and compatibility would not change.

It is expected that future costs for packaging and shipping plutonium will increase in the nitrate form because the increase in specific activity and quantities of plutonium to be shipped will make the present nitrate packages obsolete. The increased costs will principally be associated with design, fabrication, testing, and maintenance of the packages and with obtaining the necessary Regulatory approval. It is expected that the level of safety associated with this alternative would decrease to some extent because of the increased number of packages and shipments coupled with the relatively high degree of dependence on the human element to prepare and maintain packages so as to preclude leakage.

Alternative 2, shipped as nitrate in double containment

The discussion of alternative 1 is applicable to this alternative, except that packaging costs would be somewhat greater because of the additional degree of containment required. The health and safety aspects would be improved since leakage due to a single packaging error would be minimized. However, there would still exist a relatively high degree of dependence on the human element to properly prepare packages to preclude leakage of the liquid.

Alternative 3, shipped as solid in double containment

Under this alternative, plutonium would be converted to a solid form undoubtedly the oxide, at the reprocessing plant and shipped to the various fuel fabrication plants for subsequent use. Since plutonium oxide can be

produced which is directly usable for fuel fabrication for commercial LWR's and for LMFBR's, additional processing to redissolve the oxide would not in general be necessary. The cost estimate for conversion of the nitrate to the oxide at the reprocessing plant is \$130/kilogram as compared to \$300/kilogram for conversion of nitrate to oxide at the fuel fabrication plant. Thus, for plutonium oxide which can be used directly without significant pretreatment by the fuel fabricator, there would be an economic advantage of about \$170/kilogram. This cost advantage results from the reprocessor's larger scale of operation, cheaper handling of liquid wastes, and the relative ease of handling oxide versus nitrate forms of plutonium at loading and unloading stations.

In the unlikely situation where the plutonium oxide must be redissolved to nitrate by the fuel fabricator because of process incompatibility, a cost penalty of about \$320/kilogram would result. This cost is made up of two components, \$130/kilogram for conversion of nitrate to oxide at the reprocessing plant and \$190/kilogram for preparation of nitrate at the fuel fabrication plant. For this unlikely case, the \$320/kilogram would represent approximately 10% of the present fuel fabrication costs for LMFBR type fuel (a ratio which would be expected to increase by perhaps a factor of 2 as the cost of LMFBR fabrication is lowered). To put this \$320/kilogram cost penalty into perspective, this would represent an increase in the fuel cycle cost for an LWR by about 2%, resulting

in an increase in generating costs of about 0.5% which would increase the consumer's cost by about 0.2%.

Packaging costs are expected to be less than for similar quantities of nitrate because of simpler package design. Present packaging and transportation costs are estimated to be about \$50/kilogram less for plutonium metal or oxide than for nitrate solutions. Larger capacity packages designed to accommodate changing characteristics of plutonium would no doubt increase the cost differential between nitrate and oxide shipping. Thus, economics would favor, to an even greater extent, the shipping of solid versus liquid form. In addition, the anticipated requirements for the physical protection of plutonium in transit, regardless of form, will likely establish the overriding costs of transportation and will place a high premium on getting as many packages as possible on a vehicle, a situation which would most likely favor oxide because of its higher density.

With respect to the health and safety benefits, it is the staff's judgment that the level of safety in shipping plutonium would be significantly enhanced by requiring a solid form. Such a change would avoid the difficult problem of containing liquids under pressurized conditions and decrease the dependence on the human element for high performance in preparing packages for shipment. In addition, personnel exposure at both the reprocessing plant and fabrication plant would decrease by

elimination of the load-out and load-in of liquid nitrate. We believe that requiring double containment of the solid by specifying a special form capsule inside a regular package more than compensates for not specifying that the plutonium be in a nonrespirable form. The nonrespirable form alternative is discussed below.

Alternative 4, nonrespirable solid in packages meeting Part 71 requirements

Little is known about the form of plutonium which satisfies the non-respirability characteristic except that the available particle size must be greater than ten microns. Possible forms which can be identified, such as high fired ceramic spheres or pellets that are large enough to avoid the problem of inhalation and widespread dispersion and strong enough to maintain their characteristics under transport conditions, are generally considered to be incompatible with known and anticipated technology and may require major treatment by the fabricator before utilization. The type and extent of pretreatment is difficult to predict at this time. Even if such a form could be readily defined and produced, the process costs would be expected to be significantly higher than estimated for the unlikely situation of alternative 3, including both the cost of producing the nondispersible form at the reprocessing plant and converting it to a usable form at the fabrication plant. Thus, it appears that there would be major technological problems and higher costs associated with the process aspects of this alternative.

Packaging and transportation costs should be generally the same as those described in alternative 3, although packaging costs could be lower because of the elimination of the special form capsule considered in alternative 3.

The health and safety considerations discussed in alternative 3, as they relate to the advantages of a solid form over liquid, are also applicable to this alternative. In addition, a nonrespirable form provides greater protection against acute human exposure in the event of release of the plutonium from the package. However, the assurance against such release is somewhat reduced because of the lesser degree of containment specified for the packaging. Even though the immediate exposure consequences are reduced by this form of material, if it were not fully recovered after release, a long term environmental contamination problem would exist.

Alternative 5, shipped as nonrespirable solid in double containment packages

The considerations for this alternative are the same as those discussed under alternative 4, except that the health and safety benefits would be somewhat increased by the double containment provision which would provide greater assurance against release of the material.

Summary of Relative Process Costs

Cost estimates have been derived for processing of plutonium under three different circumstances related to the consideration of form for shipping plutonium. These three processes are (a) conversion of plutonium nitrate to plutonium oxide by the reprocessor, (b) preparation of plutonium nitrate solution from plutonium oxide by the fuel fabricator, and (c) conversion of plutonium nitrate to plutonium oxide by the fuel fabricator.

The cost estimates used information in Enclosure 2, SECY-1552, "Capital and Operating Costs for Converting Plutonium Oxide to Plutonium Nitrate," appropriately modified for the three processes estimated. Unit capital costs were estimated on the basis of 24% amortization as per SECY-1552.

In all three cases, it was assumed that staffing and support services take advantage of the fact that the processes take place as part of a larger facility and certain costs are shared. It was further assumed in all three cases that the facilities are constructed to meet the general design criteria for natural phenomena.

A. Conversion of plutonium nitrate to plutonium oxide by the reprocessor.

The reprocessing plant is considered to have an annual throughput of 15,000 kilograms of plutonium. This is approximately the size of the Allied Gulf Nuclear Services facility at Barnwell, South Carolina, a

1,500 metric ton per year capacity plant. It is assumed that the conversion would be done using the oxalate precipitate flow sheet, the standard oxide preparation process used at Hanford to produce plutonium oxide. The waste streams from this process would be recycled to the reprocessing plant with capital cost assessed for pretreatment only. In order to handle powders efficiently in relatively large quantities in restricted geometries, \$500,000 was allocated to research and development.

Based on these assumptions, it is estimated that a capital cost would be incurred by the reprocessor of \$3,100,000. Using the 24% annual amortization formula in SECY-1552, the cost per kilogram attributable to capital costs, at 15,000 kg/yr throughput, is \$50. Annual operating costs are estimated to be \$1,200,000, adding \$80 cost to each kilogram of plutonium converted. Thus, the total cost per kilogram for conversion by the reprocessor is \$130.

B. Preparation of plutonium nitrate solution from plutonium oxide by the fuel fabricator.

The fuel fabricator is considered to have a throughput capacity of 5,000 kilograms of plutonium per year, a typical plant. Because of the presence of fluoride ions, it is assumed that the oxide would first be dissolved and then purified by solvent extraction. The

solvent extraction operations are considered to be a part of an already existing scrap recovery capability at the fabricator's plant. Half of the cost of the wet scrap recovery facility is charged to purification of the dissolved plutonium oxide, the other half being charged to scrap recovery.

Based on these assumptions, it is estimated that a capital cost of \$1,000,000 would be incurred by the fabricator. An additional capital cost of \$1,000,000 would be required, but would be allocated to wet scrap recovery, since plutonium scrap recovery operation is an important component of the fabrication plant whether or not plutonium oxide would have to be dissolved. Using the 24% amortization rate, the cost per kilogram of plutonium attributable to capital costs is \$50.00. Annual operating costs are estimated at \$700,000, adding \$140 per kilogram to the cost, based on the assumed throughput of 5,000 kilograms per year. Thus, the total cost per kilogram for preparation of plutonium nitrate solution from plutonium oxide by the fuel fabricator is \$190.

C. Conversion of plutonium nitrate to plutonium oxide by the fuel fabricator.

The fuel fabricator is considered to have a throughput capacity of 5,000 kilograms of plutonium per year. It is assumed that the conversion would be done using the oxalate precipitate flow sheet. Because of the problems of handling powders efficiently in relatively

TABLE I

Incremental Costs of Plutonium Shipping Alternatives^a

(With Respect to Reference Case, Defined as the Shipment of Plutonium Nitrate Solution in Packages Meeting Part 71 Standards)

Incremental Costs (From Reference Case)Economic Costs^b

Processing Costs

Shipping Costs^cEnvironmental Costs

General Public Exposure

Normal Operations

Abnormal Operations^d

Double Containment Plutonium Nitrate Solution	Double Containment Plutonium Oxide	Single Containment Non-Respirable Plutonium Oxide	Double Containment Non-Respirable Plutonium Oxide
Same as Reference	-\$170/Kg. Pu ^e (-0.1% of the cost of electric power to the consumer from LWR's)	+\$320/Kg. Pu ^f or more (+0.2% of the cost of electric power to the consumer from LWR's)	+\$320/Kg. Pu ^f or more
Higher than Reference	-\$50/Kg. Pu (-0.03% of the cost of electric power to the consumer from LWR's)	-\$50/Kg. Pu or more	-\$50/Kg. Pu or less
Same as Reference	Same as Reference	Same as Reference	Same as Reference
Somewhat Lower Risk than Reference	Lower Risk than Reference	Lower Risk than Reference	Lowest Risk

- a. Incremental benefits of plutonium shipping alternatives are zero, insofar as the benefits of plutonium shipment are reflected by the benefits to society of plutonium utilization.
- b. Economic costs are aggregate costs to the entire industry.
- c. Shipping costs do not include unknown costs of physical protection for safeguards purposes.
- d. The most likely abnormal operations consist of small leaks resulting from human error. The risk of public exposure from high consequence, low probability accidents is assumed to be negligible in comparison with more likely, small leaks of material.
- e. This estimate is for the likely case that the plutonium oxide is directly usable at the head end of the fabrication process. In the unlikely case that the plutonium must be converted to nitrate, a cost of +\$320/Kg. is incurred. (See page 25, Enclosure "D" for discussion.)
- f. This estimate assumes the cost of both preparation and pretreatment for use of the non-respirable form will be higher than the unlikely case in footnote e. (See page 28, Enclosure "D" for discussion.)

large quantities in restricted geometries, \$300,000 was allocated to research and development, a smaller amount than that assumed for the reprocessor because of the smaller capacity of the fabricator's conversion system.

Based on these assumptions, it is estimated that a capital cost of \$2,000,000 would be incurred by the fuel fabricator. Using the 24% amortization rate, the cost per kilogram of plutonium attributable to capital costs is \$100. Annual operating costs are estimated to be \$1,000,000, adding \$200 per kilogram to the cost. Thus, the total cost per kilogram of plutonium for conversion of plutonium nitrate to plutonium oxide by the fuel fabricator is \$300.

Recommended Alternative

Based on a reconsideration of the overall question of plutonium shipment, and taking into account the points summarized above, the staff recommends that the Commission adopt a policy of shipping plutonium (except for specified small quantities) in solid form in packages which provide at least double containment of the material (Alternative 3 above). The double containment provision is intended to compensate for not specifying a nonrespirable or nondispersible form, which is felt to be impractical at this time. The staff believes that such a policy would offer a significant enhancement of safety over shipping

plutonium in liquid form, and is capable of being implemented by the industry, both from a technical and economic standpoint.

•
Timing of Implementation

It is the staff's judgment that plutonium will be generated as existing codes indicate and that the value of plutonium is fixed by the value of U-235 for which it is a direct substitute in LWR recycle. Thus, as plutonium is generated it is assumed that the economic pressures for its utilization in place of U-235 will become great enough to stimulate the LWR recycle use. An appropriate time for implementation of a requirement for shipping solid forms of plutonium is based on two considerations; the time when this increased recycle use becomes a reality, and the time required for industry to implement the plant changes necessary to accommodate the new requirement. It is felt that a decision should be announced as soon as possible, since most plutonium recycle facilities are now in the design or early construction phase. The staff judges that the time frame for requiring the change of form should be three years, based on our estimates on the reality of recycle and time required for implementation. If a proposed rule is published to this effect, the public comment period would provide an opportunity for the industry to comment on the suitability of this estimate. The staff would be receptive to industry's views on

timing, consistent with its desire to implement a change coincident with the anticipated large increase in plutonium shipments.

Small Quantity Exemption

The need for the shipment of small quantities of plutonium as the nitrate solution is recognized. It is expected that this will consist primarily of items such as analytical samples. To accommodate this need, it is suggested that quantities not exceeding 20 curies be exempted from any requirement for solid form shipment. The value of 20 curies represents a "large quantity" of plutonium as defined in the AEC's transportation regulations, 10 CFR Part 71. This represents about 320 grams of plutonium-239 or about 2 grams of high burnup plutonium with its higher specific activity. It is also recognized that there may be unusual cases where the shipment of small quantities of plutonium nitrate in excess of 20 curies would be warranted. Under the provisions of Part 71, specific exemptions can be granted if the Commission determines that life or property or the common defense and security would not be endangered and that the exemptions are authorized by law.

Need for Environmental Statement for Rulemaking

The staff plans to prepare an environmental statement in connection with the proposed rule change.

ENCLOSURE "E"

SUMMARY EVALUATION OF THE GENERAL MANAGER'S COMMENTS BY
THE REGULATORY STAFF

SUMMARY EVALUATION OF THE GENERAL MANAGER'S COMMENTS BY
THE REGULATORY STAFF

The Division of Operational Safety, on behalf of the General Manager, does not concur in the recommendations of this paper. In accordance with their request, the memoranda presenting their views are provided in Enclosure "F". Our summary of the comments made by each responding division follows:

Division of Reactor Development and Technology

RDT agrees in principle that there are advantages to safety in shipping large quantities of plutonium if the shipments are made in solid form. RDT states that their information on commercial process costs, while ranging somewhat higher than the values on which the staff paper statement is based, is of the same general order. They point out that should the low-cost commercial processes not become available before the end of the three year phase out period for plutonium nitrate, the economic effects could be more severe, at least for an interim period, than indicated in the staff paper. RDT further comments that requiring non-respirable forms for shipment could require high-cost additional conversions to produce a useful form and such additional conversions could run counter to safety interests. Finally, RDT suggests that in view of the good experience, continued use of the existing nitrate containers (L-3 and L-10) should be permitted in a single container, exclusive use of vehicle, basis. They expressed concern that the 20 curie limit proposed in the paper might lead to proliferation of multi-small container shipments.

Division of Waste Management and Transportation

WMT strongly recommends that the regulations should be written to allow the licensee the option of shipping aqueous plutonium nitrate or any other form he chooses so long as he can show that health and safety of the public will not be compromised.

WMT maintains that the contention that shipment of plutonium as a liquid nitrate is significantly less safe than as a solid oxide is not necessarily true. It is true, they state, that liquids are generally more mobile than solids, although in the case of finely divided oxide powder the difference is perhaps not very great. They believe that requiring that plutonium be in solid form for shipment would present both severe technical and economic problems in plutonium utilization which would outweigh the potential advantages. Our cost benefit analysis, as well as the comments of RDT, indicates that there are no significant technical problems and the economics may well favor the change to a solid form.

Division of Environmental Affairs

This division believes that an environmental statement should be prepared in connection with the proposed rule. The regulatory staff plans to prepare an environmental statement.

Special Assistant for Industrial Participation

This office comments that a change to increase safety should be done only if the costs are justified by significant incremental increase in the margin of safety. They favor improved package design and quality assurance,

citing lower cost. They further feel that direct use of oxide from re-processing plants may not be technically feasible and would be costly. They express a concern with possible vertical integration of the industry.

Division of Military Application

DMA sees no reason to prohibit nitrate shipments. They express confidence in the ability to design suitable nitrate packages and are concerned about a precedent which establishes a safety standard just for plutonium nitrate based on other than scientific or technical rationale. A concern is also expressed over international implications without further discussion.

Division of Production and Materials Management

No objection.

In summary, we have drawn the following conclusions from the comments of the General Manager's offices and divisions:

1. There seems to be no basic disagreement with our contention that safety would be enhanced if plutonium were shipped in a solid form rather than a liquid; RDT has made a positive statement to this effect; others have not disputed the point. Further, WMT supports the double containment concept. Operational Safety cites as the first summary objection to the paper that "The experts disagree

on whether or not one form of plutonium for shipment is inherently safer than another. A decision at this time would therefore be arbitrary." No elaboration of this point was made.

2. There is disagreement over the technical and economic feasibility of utilization of plutonium if shipped in solid form. The Division of Reactor Development and Technology generally supports our contentions both from the technical and economic point of view. Other responding divisions commenting on this point (WMT and SA/IP) do not share this point of view, but have not substantiated their comments.
3. The Division of Environmental Affairs believes that an environmental statement is necessary in connection with the proposed rule change. The regulatory staff plans to prepare an environmental statement.
4. There seems to be agreement among most of the responding GM divisions and offices that the use of comprehensive quality assurance procedures in packaging is the best way to eliminate human

error so as not to compromise package design safety. Our proposal to change the allowable form for shipping plutonium to a solid is intended to minimize the dependence on the necessary high degree of performance by people to protect against leakage.



UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

APR 30 1973

S. H. Smiley, Deputy Director
for Fuels and Materials
Directorate of Licensing

REGULATORY STAFF PAPER: "CONSIDERATION OF FORM FOR SHIPPING PLUTONIUM"
(DL'S APRIL 23, 1973, REQUEST TO OS FOR COMMENTS OR CONCURRENCE)

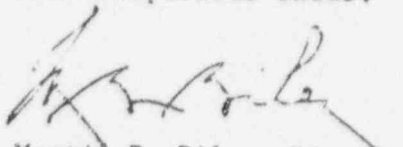
We do not concur in your proposal to restrict the shipments of plutonium as proposed in the subject draft staff paper. Substantive comments and issues raised by the GM divisions on an earlier draft are not adequately reflected in this paper. Specifically, we believe the safety interests of the public and the AEC are best served by Regulatory requirements which adequately define the conditions under which the integrity and the geometry of the plutonium container must be assured, and then allow industry to determine the best means of meeting the requirements.

Should you present the paper to the Commission in its present form, please revise it to note the General Manager's nonconcurrence. In addition, it is requested that this memorandum and its enclosures be attached to the staff paper in its final form.

Our objections to the staff paper as presently proposed are summarized as follows:

1. The experts disagree on whether or not one form of plutonium for shipment is inherently safer than another. A decision at this time would therefore be arbitrary.
2. The possibility of human error in packaging resulting in leaking packages, mentioned in the staff paper as a major reason for justifying shipments of plutonium in the solid form, is true of many radioactive material shipments other than plutonium nitrate. The use of comprehensive quality assurance procedures in packaging is the best way to eliminate human error and not compromise package design safety. The paper does not propose license requirements to support and reinforce such AEC and DOT packaging standards requirements.

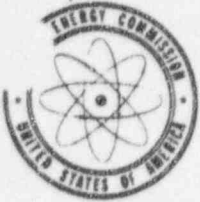
3. The paper concludes that there is no need for an environmental statement, but since a decision to restrict the shipment of plutonium to unspecified solid forms constitutes a major federal action which could significantly affect the quality of the human environment, the environmental statement issue requires further consideration. This is based on the conclusions in the paper relative to the need to require a nonrespirable oxide.



Martin B. Biles, Director
Division of Operational Safety

Enclosure:
GM Division Comments

cc: R. E. Hollingsworth, GM
J. H. Rubin, AGMES
Maj. Gen. F. A. Camm, AGMMA
J. J. Flaherty, AGMED
M. Shaw, RDT
R. Catlin, EA
F. Pittman, WMT
Vadm. H. G. Rickover, NR
F. P. Baranowski, PMM
R. W. Ritzmann, IP



UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

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S. H. Smiley, Deputy Director for Fuels and Materials,
Directorate of Licensing

REGULATORY STAFF PAPER: "CONSIDERATION OF FORM FOR SHIPPING
PLUTONIUM"

RDT comments on the subject staff paper were transmitted by memorandum dated April 30, 1973, to M. B. Biles, Director, Division of Operational Safety. These comments were discussed in a meeting held at your request on May 3, 1973 among RDT personnel and you and your staff, which resulted in a clarification of your intent in the staff paper and of the bases on which our memorandum was written. As a result of the clarifications in that meeting the following supplementary comments are forwarded for your consideration:


1. We would agree in principle that there are advantages to safety in shipping large quantities of plutonium if the shipments are made in solid form.
2. The staff paper states "Estimated cost for implementing a change to solid form for shipment are not of such a magnitude as to be a significant factor in making a decision." RDT comments transmitted April 30, 1973 stated a belief that, on the contrary, the costs are of such a magnitude as to be a significant factor. RDT's comment was based on current prices for conversions (including price and loss values published in the Federal Register), whereas the basis for the staff paper statement is forecast process cost in large commercial plants not yet in service. RDT's information on these commercial process costs, while ranging somewhat higher than the values on which the staff paper statement is based, are of the same general order. Hence, these costs, if reflected in reduced price structure when the large commercial reprocessing plants enter into service, would result in moderate, not severe, (maximum of 10%) fuel cycle cost increases.

However, the staff paper provides for a three year phase-out of aqueous plutonium nitrate as an allowable shipping form. Should these low-cost commercial processes not become available before the three year transition period expires, the economic effect would be more severe, at least for an interim period, than the staff paper recognizes. Hence, the issue pivots on timing of commercial size plant operation relative to the cutoff date for existing plutonium

nitrate shipping container licenses and realization of conversion process cost estimates forming the basis for the staff paper.

3. RDT interpreted the discussion of the paper as suggesting the possibility of requiring transport in non-respirable form under the proposed regulatory action. Non-respirable forms could require high-cost additional conversion to produce a useful form, and such additional conversions could run counter to safety interests. As a result of the meeting we understand that you do not consider specifying the form in which solid plutonium would be shipped as necessary from a safety viewpoint.
4. RDT believes the proposed 20 gram limit for aqueous plutonium nitrate should be reconsidered since it will inevitably lead to a proliferation of multi small container shipments. In view of the good experience with L-3 and L-10 containers, the proposed action should permit their continued use on a single container, exclusive use of vehicle, basis. We doubt that commercial or safety incentives exist to develop and license an aqueous plutonium nitrate shipping container in larger than ten liter size.

Should you wish to discuss this matter further, please give me a call.


Milton Shaw, Director
Division of Reactor Development
and Technology

cc: R. E. Hollingsworth, GM
J. J. Flaherty, AGMED
M. B. Biles, Director, OS
J. F. O'Leary, Director, DL



UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

APR 30 1973

Martin B. Biles, Director, Division of Operational Safety

DRAFT POSITION PAPER FOR CONSIDERATION OF FORM FOR SHIPPING
PLUTONIUM

This responds to R. E. Yoder's memorandum dated April 24, 1973 requesting comments on the subject document (April 23, 1973 revision) not later than April 27.

As you anticipate in your transmittal memorandum, RDT considers that our comments transmitted to you by my memorandum of March 5, 1973 apply to this revision as well. We would further add that the first paragraph of page 4 illustrates a point we have consistently tried to make; specifically, that when a useful intermediate oxide species can be specified by the fuel fabricator the economics of transport, packaging and reprocessing/refabrication will compel the industry to adopt that form. Thus, the forecast burgeoning volume of nitrate shipments, which apparently motivates Directorate of Licensing to advocate nitrate shipment prohibition, is not likely to occur, if positive and constructive action is taken in the near future. Thus, the effect of the proposed action could be to force, by regulatory action, an extremely inefficient costly conversion of form, purely for transport, to avoid a condition which should never occur, and impose severe economic and performance penalties on the Government and industry in the process.

Further, we believe that, contrary to paragraph 2, page 4, the estimated costs for implementing the change to solid form are of such a magnitude as to be a significant factor in making a decision, particularly when acknowledged experts in the field have consistently held that such actions as the proposed prohibition cannot be justified on the basis of experience or expected developments. Rather, a positive approach could provide the economic pressure that would motivate a conversion to a useful form in an orderly fashion. Thus, if timely actions are taken to identify a useful intermediate oxide species, and a suitable standard, there is reason to believe that the actual volume of nitrate shipments will not increase dramatically over current levels.

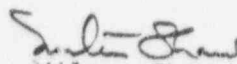
Finally, RDT notes for your consideration that the suggested prohibition would deny the industry the form acknowledged to be

Martin B. Biles

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most flexible and useful for the broad range of industrial uses of the 3 and 10 liter order quantity range. It is basically this limited quantity user who will be hurt in the long run, not the high volume shipper who has initiated steps to adopt a standard oxide for totally different reasons than the proposed regulatory action recognizes.

Please advise if we may be of further assistance.



Milton Shaw, Director
Division of Reactor Development
and Technology

cc: R. E. Hollingsworth, GM
J. J. Flaherty, AGMED
John F. O'Leary, Director, Licensing



UNITED STATES
ATOMIC ENERGY COMMISSION

WASHINGTON, D.C. 20545

MAR 5 1973

Martin B. Biles, Director, Division of Operational Safety

DRAFT POSITION PAPER FOR CONSIDERATION OF FORM FOR SHIPPING
PLUTONIUM

This is in response to R. E. Yoder's memorandum dated February 23, 1973, which transmitted a February 21, 1973 version of the subject document for review and comment.

RDT persists in its belief that Regulatory actions toward prohibition of shipment of plutonium in aqueous nitrate form are not justified.

In previous attempts to proscribe shipment of plutonium in aqueous nitrate form diverse teams of experts have examined packaging and transportation practices, hazards and Regulatory requirements and have consistently concluded that no single useful form can be held inherently more or less safe for all accidents or incidents. These evaluations are acknowledged and cited in part in the subject draft. The only evidence produced since the last review by experts is the results of the recent extra severe plutonium shipping container tests conducted by Sandia Corporation (cited on Page 8 of the subject draft) which re-affirmed the ability of the containers to withstand accidents far in excess of Regulatory requirements.

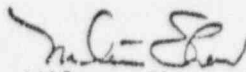
RDT considers that the AEC standard form, the aqueous nitrate, is the most versatile and economic physical and chemical form for the current broad range of uses and today's limited market. The economic consequences of conversion-for-shipment to any form which is not a directly useful intermediate species, would overshadow any saving associated with shipping cost of the converted form (relative to aqueous plutonium nitrate). When an intermediate plutonium oxide species is evolved as a desirable feed material for fuel fabrication, it will emerge as the predominant shipping form in the private sector because it will facilitate lower fuel cycle costs.

The safety interests of the public and the AEC are best served by Regulatory requirements which adequately characterize the conditions under which the integrity and the geometry of the plutonium

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container (regardless of the chemical or physical form of the plutonium) must be assured and, then, assuring that the industry complies with them. Such efforts would be much more beneficial to the public interest than attempts to legislate form, particularly when acknowledged experts consistently disagree with the suppositions on which these attempts to legislate are based.

Please advise if we may be of further assistance.



Milton Shaw, Director
Division of Reactor Development
and Technology

cc: J. J. Flaherty, AGMED



UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

April 27, 1973

Martin B. Biles, Director
Division of Operational Safety

DRAFT REGULATORY POSITION PAPER "CONSIDERATION OF FORM FOR SHIPPING
PLUTONIUM"

While this draft of the subject paper does not contain some of the more questionable statements which appeared in the previous draft, it still manages to convey the impression that the technical justifications it presents are carefully selected to fit the needs of a preconceived conclusion.

For reasons which will become clear, I cannot recommend that the General Manager concur in this paper.

If, as a matter of policy, the Commission wishes to decide that it will not allow the shipment of plutonium as a nitrate solution - or, for that matter, as any other solution - I could accept the decision. But to have the Commission make this decision on the basis of supposedly scientific and technical rationale that is patently inaccurate in some instances and incomplete in others, can only damage the image of the Commission as an objective regulatory agency.

I was surprised to note that, in spite of a rather complete rewrite of the paper, the bulk of the substantive comments made by the General Manager's Divisions on the previous draft have been almost completely ignored.

I would like to open this discussion by acknowledging that the paper makes a number of valid points regarding the shipment of plutonium nitrate such as (1) the past and present shipments of plutonium have not presented a public transportation hazard; (2) the present package designs for plutonium nitrate have a large margin of safety compared to the Regulatory standards; (3) future shipments of high burnup plutonium will require different package designs; (4) the number of plutonium shipments will increase significantly; and (5) there is a

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need for continued vigilance to ensure maintenance of our past good safety record.

Beyond this, however, the paper loses objectivity and perspective. Qualitative judgments are presented without support. The paper does not make a valid case in support of its recommendation. The method of presentation of the judgments and conclusions are such as to make it appear that the potential problems are much greater than they really are, and that there will be a significant increase in public hazard if the Commission does not adopt the recommended alternative. I disagree with the recommendation, with much of the information presented in the paper, and with the method of its presentation.

The paper gives no comparative evaluation of the effects of plutonium releases as solid versus liquid, and there is no information presented regarding the probabilities of occurrence of the types of incidents or releases discussed. As a result, it is not possible to determine whether the probability of release of either liquid or solid and the consequence is such as to warrant serious concern.

I certainly agree that adequate control is necessary to assure a high degree of freedom from operating error, but I cannot agree that "control" should be accomplished by "prohibition."

The paper states categorically that the shipment of plutonium as a liquid nitrate is significantly less safe than the shipment as a solid oxide. That statement is not supported in the paper, nor is it necessarily true. It is true that liquids are generally more mobile than solids, although in the case of finely divided oxide powder the difference is perhaps not very great. The Commission should note that the previous careful studies referred to in the paper concluded that the difference in public hazard between oxide and nitrate, if released to the environment in quantity, is not sufficiently great to warrant the prohibition of liquid nitrate shipments.

The cost/benefits treatment by the paper seems to be incomplete. There is no consideration of either the occupational or environmental exposure aspects, under normal or accident conditions, entailed by the additional conversion processes that could be required at either end of the transportation step.

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The generation of additional plutonium-contaminated solid waste from possible additional steps has not been covered in the paper, nor has consideration been given to the added burden of treating, handling, interim storage, transportation, and ultimate disposal of such additional quantities of waste.

The alternate of designing a new and satisfactory container for liquid nitrate as opposed to the prohibition of shipment of liquid seems to be brushed aside rather lightly. The paper admits that new containers must and can be designed for solids, but does not really treat with the question of similar redesign of containers for liquid nitrate. We have a program at Oak Ridge which will, by the end of this year, develop a prototype double containment vessel for the safe shipment of plutonium nitrate.

The reference to the Commission's previous action on liquid high-level radioactive waste as a precedent to the proposed prohibition of the shipment of liquid plutonium nitrate is a little surprising. I fail to see how any decision made with regard to the handling of tens of millions of gallons of valueless waste solution can have any bearing on decisions regarding the handling of very small volumes of very valuable material.

We are unaware of any previous decision by the Commission which established a policy of encouraging plutonium shipment in solid form. Quite to the contrary, the previous studies showed quite clearly that there should be no prohibition against liquids, or even a favoring over one form or another. We recognize that the ACRS did recommend the prohibition of nitrate shipments, in face of contradictory conclusions in the AEC studies.

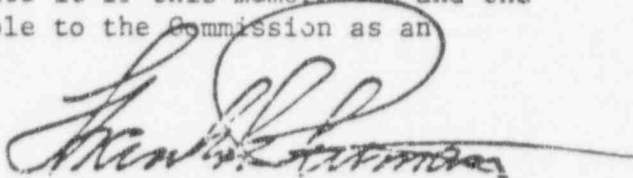
Based on our contacts with the industry, it appears that Regulatory has misrepresented the desires of the industry regarding nitrate shipments. To the best of our knowledge, the only reason that industry might have for favoring prohibition of nitrate shipments, at this time, is their fear that the Commission might arbitrarily prohibit nitrate shipments at a later date, after the industry has already invested in plant equipment to handle nitrate. It is true that if a decision to prohibit the transport of nitrate is to be made, it should be made now in order to spare industry this economic burden. However, to imply that the industry would prefer not to ship nitrate because of shipping problems is misleading. If industry should decide all on its own that it does

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not want to ship plutonium nitrate, they are free to do so. But the Commission should make this decision for them only if there were evidence of a serious public safety hazard. No such evidence has been developed so far.

In summary, I feel strongly that the regulations should be written to allow the licensee the option of shipping aqueous plutonium nitrate or any other form he chooses so long as he can show that health and safety of the public will not be compromised. If more stringent requirements are required for packaging and shipping aqueous nitrate than for other forms, the requirements should be spelled out in the regulations and the decision as to what is to be shipped should be left to the licensee. If, as the paper indicates, the overall economics favor oxide, you can be sure the industry will move in that direction.

Enclosed herewith are the much more extensive and detailed comments of the WMT staff. I would appreciate it if this memorandum and the enclosed comments were made available to the Commission as an attachment to the Regulatory paper.



Frank K. Pittman, Director
Division of Waste Management
and Transportation

Enclosure:
Detailed Comments

cc: J. H. Rubin, AGMES

DETAILED STAFF COMMENTS ON DRAFT POSITION PAPER
"CONSIDERATION OF FORM FOR SHIPPING PLUTONIUM"
DATED APRIL 4, 1973

General Comments

It appears that the bulk of the substantive comments which WMT made on the earlier draft (February 22, 1973) have been largely ignored or, at least, not incorporated in this new draft. The paper still lacks objectivity and perspective, and a number of items in the paper are misleading.

The paper is incomplete without an evaluation of the effects of plutonium releases in both their solid and liquid forms. Without this kind of information, it is not possible for the reader to gain a meaningful perspective on just how bad a plutonium release might be. Further, there is no information presented regarding the probabilities of the types of incidents or releases discussed. As a result, the reader is unable to determine whether the probability of release of either nitrate or oxide is, or is likely to be, high enough to be of serious concern.

The generation of additional plutonium-contaminated solid waste from these conversion steps has not been covered in the paper. Consideration should be given to the added burden of treating, handling, interim storage, transportation, and ultimate disposal of the increased quantities of waste.

Specific Comments

Transmittal Memorandum

We completely agree that the projected increase in the number of plutonium shipments, along with the increase in specific activity of the plutonium (causing increased heat and pressure generation in containers), will require redesign of plutonium nitrate packages in the future. We are convinced that this redesign problem can be solved by industry. The fact that redesign of nitrate packages might be required is not a valid reason for prohibiting the shipment of nitrate. We have an AEC program about to be started at Oak Ridge which will develop a prototype double containment vessel design for plutonium nitrate.

We agree that both present and future packages must be used under conditions which will provide a high degree of assurance that packages are properly assembled and closed. No matter what packaging systems are developed, there must always be a dependence on both shippers and engineered safeguards. Regulatory's claim that double containment for nitrate is unacceptable because it depends on people rather than engineered safeguards is just not true.

It is true that future plutonium shipments will involve higher pressure generation rates than past shipments. However, this is another matter which can be controlled with changes in procedures, and does not require prohibition of nitrate shipments. We fail to see how the conditions stated here by Regulatory can validly lead

to the conclusions they have drawn. We would agree that the probability of plutonium leakage through human error would be substantially reduced if package designs were made more fool-proof, and we are supporting efforts to that end.

Regulatory states that the probability of leakage through human error would be "substantially reduced and safety enhanced" if liquids were prohibited. However, the paper is woefully deficient in that it does not discuss qualitatively just what the probabilities would be for both cases -- liquid and solid. The words in WASH-1238 (page 56) seem particularly appropriate here: "...although the consequences of credible accidents are serious, the probability is so small that the overall risk is not sufficient to justify any significant effort to further reduce the consequences."

The transmittal memorandum implies that Congressional concern and lawsuits are more likely to result from the shipment of radioactive liquids than radioactive solids. This rather surprising conclusion is misleading. Three instances are cited of liquid leakages. Other cases could be cited of solid leakages. We are not arguing that the cited cases are not real but only that they have been carefully selected to support Regulatory's conclusion.

The reference to the Commission's decision regarding shipment of radioactive waste in liquid forms is grossly misrepresentative. The decision not to ship liquid waste was based primarily on a Commission decision not to handle high-level liquid waste at a

Federal repository. Long-term storage of high-level liquid waste involves leakage problems of a totally different nature than one might expect in transportation. WMT's waste management plan (WASH 1202) does in fact state, "(High-level) Liquid radioactive waste shall not be transported offsite." This statement is not made because of a particular concern about insurmountable transportation hazards but only to be consistent with the Commission's decision to require onsite solidification of high-level fuel reprocessing liquid wastes. We do not believe that this is a precedent with regard to other liquids. High-level liquid wastes would have to be shipped in great volumes -- hundreds of gallons per cask -- in order to be practical from an operational viewpoint. To be sure, there are practical problems in designing containers for this purpose. However, we would not foreclose against the industry in this regard. The primary concern is storage, not transportation. High-level waste has no value, whereas recycled plutonium does. For that reason, one can put much more money and effort into small package design for usable products than could be justified for bulk commodities having no value.

The discussion of cost is misleading. A number of qualitative conclusions are presented without support. These conclusions appear to disagree with earlier conclusions made by other Commission studies and by RDT.

It is interesting to note that Regulatory apparently has very little faith in the new quality assurance procedures which it is about to propose. These quality assurance procedures, if followed, should produce a significant increase in assurance that packages are properly fabricated, assembled, and closed. We believe that better quality assurance procedures, along with an improved package design, will probably result in more safety (and would be more practical) than a prohibition against liquids. The use of comprehensive quality assurance procedures in filling and closing packages is the best way to see that human error does not compromise package design safety. Such quality assurance requirements are already imposed by DOT regulations, and to support and reinforce them through licensee regulations and AEC Manual Chapter requirements seems to be a much more reasonable course of action than barring a material form.

In conclusion, WMT staff believes that the Regulatory paper is highly subjective, presented out of perspective, and developed in such a way to attempt to support a preconceived conclusion that nitrate shipments should be prohibited. WMT staff disagrees with this approach in presenting information to the Commission and also disagrees with the conclusion.

Background Report

Page 1 - As mentioned earlier, we question the alleged Commission policy of encouraging shipment of plutonium in the solid oxide form.

Page 2 - We agree that container redesign will be necessary.

We also agree that the areas of internal pressurization, heat dissipation, and nuclear criticality safety may well present a challenge to package design engineers. However, we believe it would be improper for the Commission to arbitrarily assume that the industry is not capable of designing packages which will not only meet the Regulatory standards but will provide a high degree of reliability in operation.

Page 5 - In the second paragraph, DOT approval is no longer necessary.

Page 6 - Extra Severe Tests: The last sentence is misleading in that it implies reasonable doubt that future designs will also incorporate adequate safety margins. Indeed, according to the regulations, no margin of safety is required at all. Merely because one package has a lower safety margin than a second package does not mean that the first package is not adequate, so long as both packages meet the standards. We have no reason to believe that future package designs will not incorporate adequate and acceptable safety margins.

Page 7 - Basis for concern. We disagree with the categorical statement that nitrate is the least inherently safe form. We are surprised by the path of logic used in this paragraph whereby it is claimed that good standards and a good safety record diverts attention from potential problems involved! This negative

rationalization appears to be grasping at straws to support a very weak case.

Pages 8 & 9 - As discussed in the comments which WMT staff made on the previous version of this paper, each of the specific "difficulties" can be offset by a change in packaging design, an alternative omitted from the staff paper discussion.

1. The use of two internal pressure vessels, one within the other, would reduce the probability of leakage to an even lower level than it is now. It must be noted, and should be pointed out to the Commission, that, although there have been instances of leakage of polyethylene bottles with the present single containment vessel, there has never been a leakage outside of the containment vessel. WMT has funded a project at ORNL to develop just such a double containment package design. The final design is expected to be ready within eight months.
2. Pressurization problems are not new. They have always been an important consideration in plutonium nitrate shipment. Polyethylene bottles were designed with vents to eliminate the need for pressure venting during storage. The pressurization problem can be solved by a requirement for double pressure vessel containment. We would also recommend a requirement that the inner pressure vessel be vented just prior to shipment, and that both of the

pressure vessels be designed to withstand any credible pressure that might build up in transit from either radiolysis or a transport accident fire.

3. Every one seems to recognize the problems with continuing use of polyethylene bottles. Although this problem relates to operations in plutonium storage facilities rather than to transportation regulations, it seems open to solution by changing from polyethylene bottles to stainless steel, aluminum alloy, or properly cushioned glass bottles, as in chemical industry usage for nitrate solutions. If the industry finds it necessary to replace the metal containment vessels at five-year intervals, what does it matter to Regulatory? That is not a transportation safety problem. Even oxide containers will wear out. All containers eventually have to be replaced.
4. Although the problem of internal contamination does not involve carrier employees or the public, the use of double pressure vessels and the elimination of polyethylene bottles, as noted above, should help resolve it. However, it should be noted that good occupational safety practice requires great care in handling any concentrated form of plutonium, and it is not evident from the record that powders are that much easier to handle than liquids.

5. Regulatory provides no support for their concern that a packaging error might result in inadequate insulation. We fail to see the logic in this argument. Again, they appear to have no faith in normal routine quality assurance programs. If the insulation is made a permanent part of the package, how can it be missing? We believe that the probability of missing insulation would be so low as to be incredible. The use of loose vermiculite has been questioned before and reflects what we feel to be a valid concern. However, this is not a problem of solid versus liquid, but purely a matter of packaging design.
6. This question of criticality is specious. If a system is subcritical even under specified accident test conditions, as is true of Type B packages, the margin by which it is subcritical is relatively unimportant unless it may credibly be exposed to some criticality risk outside the scope of the tests. No such risk is described by the draft staff paper. One hypothetical chain of events which might have been considered is an accident with extremely severe mechanical damage but no fire, after which well-meaning but uninstructed salvage workers begin assembling or stacking inner containers or their contents. Under some variations of this chain, the liquid form might actually be safer.

Page 9 - Judgments in Past. Paragraph 1 contains a number of vague unsupported claims. We cannot tell what Regulatory is referring to, and we suspect that the judgments which they imply are widely accepted are really only those of a few people in Regulatory and on the ACRS. Regulatory uses three selected incidents to support their conclusion. All three of these incidents involve flagrant violations of the regulations. These incidents could have easily been avoided had a quality assurance program been in effect. All three incidents involve shipments which, at the time of the occurrence, were not subject to AEC regulations. Under the new AEC regulations, such shipments would now fall under the purview of 10 CFR Part 71 which does require a quality assurance program and which probably will soon require very comprehensive such programs. It appears doubtful to us that these incidents would have occurred had they been subject to AEC regulation. Regulatory implies that operating procedures and design performance standards, whatever they might be, should not be relied on when shipping liquids. This is tantamount to concluding that shipment of all liquids should be prohibited. WMT staff believes that this philosophy is dangerous and invalid, and undermines the entire concept of performance standards.

The example on water in-leakage is both nonpertinent to the situation at hand and misleading with regard to the actual facts.

Pages 11-15 - Discussion of Alternatives. WMT staff disagrees with the procedure Regulatory has used in presenting the alternatives.

We believe that the staff paper should be rewritten to present the factual background (separate from Regulatory's preconceived conclusion and alternative), followed by a list of all of the alternatives available, including the two which WNT had earlier recommended. This section should be extensively rewritten to clarify the economic costs and benefits and the environmental/occupational safety costs and benefits of the alternatives which are discussed, plus at least two alternatives which are omitted. If this section were to be used in its present form in an environmental statement supporting the proposed action, that statement would unquestionably be considered defective.

Alternative number 2 should be broken into two separate alternatives -- one to change the standards and another to change the specific package design requirements. The present title of and discussion under alternative two is both incorrect and objectionable. The imposition of a double containment requirement for plutonium nitrate does not require a change to the present packaging performance standards in Part 71. See pages 59-60 of WASH-1238 for a good discussion of the factors involved in a change of standards.

Information should be presented as to specifically how much pressure buildup might occur in order that the matter might be placed in perspective. The mere existence of pressure is not unacceptable. It is only if the pressure gets too high -- approaching the capability of the pressure vessel -- that it would

be a problem. The receipt and opening of a double containment package would present fewer problems than are presently encountered with the existing single containment vessel -- polyethylene bottle package. Contamination problems in the past have not been crippling, and have presented no offsite hazard. The facilities who receive these packages claim that this is not a major problem and one which should not be handled by AEC in the form of a prohibition against nitrate shipments. The last two paragraphs under this alternative are misleading, judgmental, and highly subjective. There is no reference as to what Regulatory would consider satisfactory since they have failed to quantify the problem.

Alternative number 3 - Regulatory claims that double containment of oxides "would improve the package integrity and reduce the likelihood of errors in packaging..." We fail to see how that can be true for oxides and not also be true for nitrates.

Additional Alternative - Another alternative which should be considered involves shipping plutonium nitrate as a solid, or adsorbed or fixed in some matrix so that it would be essentially immobile in transport, but could be readily recovered at the destination. The Division of Waste Management and Transportation has scheduled and scoped a fiscal year 1974 study of the possibilities, which seem attractive and could have a much lower cost and risk impact than the alternatives recommended by Regulatory.

The discussion of alternatives completely omits the environmental and occupational safety costs of the additional conversions of plutonium to and from the oxide required for shipment under the proposed action. This should be provided, both for routine operations and for accident conditions (the latter, for example, including the internal deposition of plutonium from contaminated minor injuries during maintenance and operation of the new equipment). In view of the current stress on reducing volumes and activity quantities of plutonium-contaminated solid wastes probably requiring repository storage, the amount of such waste expected from losses in the additional conversions should be specifically included as one of the environmental costs.

In order for the conclusions to be valid, they must be based on a comparison of the environmental and occupational safety costs of the various alternatives. This, in turn, would require for each alternative a statement of the probabilities of the significant types of accident, together with the consequences of such accidents. No such discussions appear in this paper.

Page 15 - Conclusions. The basic conclusion of the paper is not substantiated by its own evidence, and other evidence negates it. The AEC has frequently used the adjective "excellent" in describing the safety record for all kinds of radioactive materials shipments, and from the experience description in the paper, and elsewhere, there is no need to exclude plutonium nitrate shipments

from the "excellent" categorization. It is easy to see how the stated conclusions could have been erroneously drawn, considering the method of presentation in the paper. We believe that if some attempt had been made to quantify the problem the conclusions would be quite different. For example, let us assume a frequency of shipments of 1000 per year (about 10 times the current rate) and an average distance per shipment of 1000 miles. Let us then use the same general approach to probabilities as used in Regulatory's WASH 1238, "Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants." An extension of this approach, as presented in a recent paper by Brobst on transportation accident probabilities, gives a value of about 5×10^{-10} per vehicle-mile for a small breach of a typical birdcage package, such as is used for plutonium nitrate. These estimates yield a value of 5×10^{-4} accidents per year, or one accident every 2000 years -- and this is for a small breach, with no catastrophic consequences and totally manageable in its public safety aspects. The probability of a large breach is probably at least two orders of magnitude less. This type of quantification puts the problem in an entirely different light than presented by Regulatory. If we go to double containment, the probability would be even less, since the probability figures used included operator errors.

We cannot concur with the conclusions as stated. However, with a few minor changes as noted below, we would concur in the conclusion section:

"Based on a reconsideration of the overall question of plutonium shipment and taking into account the points summarized above, the staff recommends that the Commission adopt a policy of shipping plutonium (except for specified small quantities) ~~in-solid-form~~ in packages which provide at least double containment of the material ~~(Alternative-3-above)~~. The double containment provision is included to compensate for not specifying a ~~nonrespirable-of-nondispersable~~ solid form, which is not practicable at this time. The staff believes that such a policy would offer a significant enhancement of safety over shipping plutonium in liquid form in present packaging designs, and is capable of being implemented by the industry, both from a technical and economic standpoint. The staff believes that even further enhancement of safety would could be achieved by requiring the plutonium form ~~not-only to be solid but-also-to-be-nondispersable~~ rather than liquid; however, we believe at present that this step would present both severe technical and economic problems in plutonium utilization which would outweigh the potential advantages."

(Proposed deletions lined out; proposed additions underscored.)

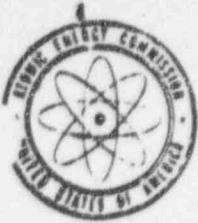
Attachment A

The examples cited here are not pertinent to the discussion of shipment of plutonium nitrate. That they occurred cannot be argued. The method of presentation is misleading. For example, it has been

conveniently not pointed out the 13-gallon carboy of plutonium was not placed in a protective overpack, as would have been required under current rules. It was shipped 10 years ago, prior to the enactment of packaging standards by AEC or DOT. It was an unauthorized shipment in an unauthorized container. The person shipping it reportedly did not even know it was plutonium! What relevance it has to the adequacy of existing or future package designs for plutonium nitrate is beyond us. We also note that the lawsuit referred to has already been rejected by two lower courts on the basis that there was no causal effect due to plutonium.

Attachment B

The manner in which increased costs are prorated to the kilograms of plutonium shipped masks the difference between capital and operating costs. Actually, there would be substantial capital costs to implement the proposed action followed by continuing increased operating costs. If the same capital were instead devoted to the redesign and fabrication of packaging, it is quite possible that increased operating costs could be avoided. If the packaging improvements made it acceptable to ship larger quantities of plutonium than in present packages, operating costs might actually decrease. With fewer shipments, the statistical probability of any one package being involved in an accident would decrease. The consequences of a single accident would not necessarily increase; however, improved design might well make the probability of release of material in an accident, which is already low, even lower.



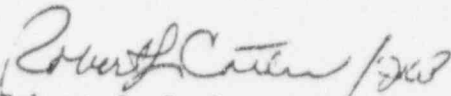
UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

APR 27 1973

Robert E. Yoder, Assistant Director
for Facilities Safety
Division of Operational Safety

REGULATORY POLICY PAPER ON FORM FOR SHIPPING PLUTONIUM

Regarding your request of April 24, 1973, The Division of Environmental Affairs considers its previous comments of March 12 on the above subject to remain valid. In addition, we object to the statement on page 6 of the draft paper which notes that an environmental statement need not be prepared, since the proposed amendments "will not significantly affect the quality of the human environment." According to page 1 of the proposed Appendix D, earlier GM and DR staff papers on plutonium shipping have concluded that should plutonium be released from the package during transportation, there is no certain safety advantage of one form over another, unless the plutonium is in the form of a nonrespirable oxide. On page 3 of the draft paper it is stated that requirements for nonrespirable forms appear impractical at this time. In view of these conclusions we consider that the decision to limit shipments of plutonium to solid form without a requirement that it be in the form of a nonrespirable oxide does indeed constitute a major Federal action that will significantly affect the quality of the human environment. We suggest that this be included in the draft paper for Commission consideration.


Robert J. Catlin, Director
Division of Environmental Affairs



UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

MAR 15 1973

Martin B. Biles, Director
Division of Operational Safety

CONSIDERATION OF FORM FOR SHIPPING PLUTONIUM

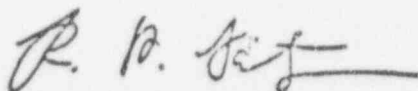
We have reviewed the draft position paper on the above subject that was forwarded to you for comment with Mr. Smiley's memorandum dated February 22, 1973. We wish to offer the following comments:

1. Since the present practice of shipping plutonium nitrate solutions in AEC or DOT approved shipping containers exceeds the current transportation safety standards, we feel that a change to increase the already very large margin of safety should be done only if the costs are justified by significant incremental increase in the margin of safety. An alternative that meets this objective was not included in the discussion of alternatives. This alternative is to improve the package design and institute an improved quality assurance program in design, fabrication, use and maintenance of shipping containers. This engineering approach will overcome many of the "difficulties characteristic of plutonium nitrate shipment," and would cost much less than the additional oxide conversion facilities that would be necessary if nitrate shipments are prohibited.
2. We believe the probability that fuel fabricators might make direct use of oxide shipped from reprocessing sites has been greatly over-simplified in the draft paper. The fuel characteristics can be highly dependent on the precise technique utilized in converting to the oxide, and some very specialized, proprietary processes are employed. In view of the extensive responsibilities for fuel performance that the fabricator must assume, it appears likely that he would either have to operate satellite facilities at or near reprocessing sites to perform his own oxide conversion or would require that the reprocessor follow his precise technique. This could add very significantly to the fabricator's costs and reduce flexibility to obtain his plutonium from any one of the various reprocessing sites.
3. Based largely on the above reasoning, it appears that prohibition of plutonium nitrate shipments would contribute strongly to a vertical integration within the fuel cycle

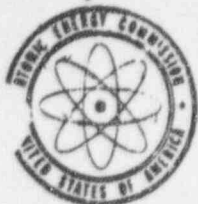
industry between the chemical reprocessors and the fuel fabricators. Requiring shipping as oxide would make it almost impossible for a plutonium fuel fabricator who is not tied in with a chemical reprocessor to compete for business.

In view of the above, we believe that a cost/benefits treatment of changing from the present practice to the shipment of plutonium as a dry oxide packaged in "special form" would not adequately justify the costs for the implied benefits in terms of safety. We believe that the proper role of the Government in this case should be to establish whatever requirements it thinks are necessary for the packages or shipments to meet and then leave it to industry to determine the best means of meeting the requirements. We believe that prohibition of plutonium nitrate shipments would add an unnecessary increment to the cost of nuclear power, would impede progress in fuel technology, would encourage vertical integration in the fuel cycle, and would stifle fuel cycle competition.

We would be pleased to elaborate further on the above comments if it is so desired.



R. W. Ritzmann
Special Assistant
for Industrial Participation



UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

APR 27 1973

Martin B. Biles, Director, OS
Attn: Robert E. Yoder

CONSIDERATION OF FORM FOR SHIPPING PLUTONIUM

We regret the short time allowed to consider such a serious matter as that proposed by Regulation. Four days seems rather short to perform an in-depth technical review of the matter. However, we have discussed the issue by phone with knowledgeable people at ALO and LASL. A summary of some of their comments are as follows:

1. A Plutonium Transportation Task Group submitted an in-depth report to John Ryan on April 30, 1970, after an extensive review of the problems posed by Regulation. This group found no reason to prohibit the shipment of plutonium in nitrate form. Regulation has introduced no evidence to change this finding.
2. The accident examples used in the staff paper are irrelevant since they do not involve plutonium nitrate shipments and were made under different rules and in different containers.
3. The responsible people are aware that the present container will probably have to be redesigned for the different plutonium nitrate of the future. Since past designs and standards have worked without fail, it seems illogical to assume future activity of the same kind must fail.
4. Present transportation standards are internationally established and accepted. Unilateral and arbitrary change of them does not seem to be in the best interests of the Commission.
5. Regulation should support their concern with facts. It is our understanding that the minor accident probability runs somewhere in the range of one every thousand years and the severe accident

probability several orders of magnitude less likely. We suggest that a cost-benefit analysis of the proposed policy change would disclose that this was not a sensible change.

6. There are many other hazardous materials shipped. We are concerned about a precedent which would seem to establish a safety standard just for plutonium nitrate based, as far as we can tell, on other than scientific or technical rationale.

If Regulation has a case, they have not presented it in a clear and professional manner. If they do not have a case, this paper should not go forward to the Commission.

Regulation has repeatedly presented the Division of Operational Safety with draft Commission papers for coordination on impossibly short time scales. It is recommended that Regulation be advised of a reasonable time interval which will be required henceforth for obtaining GM coordination.

for *ALF*

Alfred M. Howard
Captain, USN
Assistant Director for
Safety and Facilities
Division of Military Application




UNITED STATES
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APR 26 1973

R. E. Yoder, Assistant Director
for Facilities Safety
Division of Operational Safety

DRAFT POSITION PAPER FOR CONSIDERATION OF FORM FOR SHIPPING PLUTONIUM

We have reviewed the subject draft which was transmitted by your memorandum of April 24, 1973 and have no objection to the draft as written.


F. P. Baranowski, Director
Division of Production
and Materials Management

PRC:RJM