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July 4, 1968

SECRETARIAT

AEC 907/36

INFORMATION MEETING ITEM

DISPOSAL OF THE CONTAMINATED RESIDUE FROM THE THULE ACCIDENT

Note by the Secretary

The General Manager has requested that the attached report by the Assistant General Manager for Military Application be circulated for consideration by the Commission at the Information Meeting scheduled for Monday, July 8, 1968, noting:

> "This staff paper considers the various means of and AEC sites for disposing of the contaminated residue which is to be returned to the Continental United States from Thule Air Base, Greenland. The ATSD(AE) has been advised informally of the content of the proposed letter to the Secretary of Defense (Appendix "C") as it relates to cost reimbursement."

W. B. McCool

Secretary

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ATOMIC ENERGY COMMISSION

DISPOSAL OF THE CONTAMINATED RESIDUE FROM
THE THULE ACCIDENT

Report to the General Manager by the
Assistant General Manager for Military Application

THE PROBLEM

1. To consider the various means of disposing of the contaminated residue which is to be returned from the B-52 crash site at Thule Air Base, Greenland, and to identify the site or sites for final disposition.

BACKGROUND AND SUMMARY

2. The cleanup operations conducted subsequent to the January 21, 1968, B-52 crash near Thule, Greenland, have resulted in the accumulation of approximately 10,500 Measurement Tons (MT) (40 cubic feet of cargo freight) of contaminated residue at Thule Air Base, Greenland, The residue will consist of liquid (melted ice and snow) sealed in two hundred and thirty-two 1800 gallon tanks and a wide variety of sealed containers of contaminated solid residue, primarily aircraft parts. On February 23, 1968, Dr. Walske verbally advised the DMA staff that the DoD wanted the AEC to receive and dispose of the contaminated residue. Dr. Walske was, in turn, advised that the AEC would assist the DoD.

3. The Air Force Logistics Command (AFLC) was given the overall task of removing the contaminated residue and, in turn, gave the San Antonio Air Materiel Area (SAAMA) the task of managing and directing the effort. Preliminary to the development of a detailed operation plan, SAAMA conducted a study of various plans for removing the residue, applying the following criteria:

a. The contaminated residue must be removed from Greenland as soon as possible.

b. In the event filtration or distillation methods are used to concentrate the liquid residue and the effluent discharged into North Star Bay, the radioactive level of the effluent must not exceed a level to be established by joint U.S.-Danish agreements.

c. The disposal plan must insure maximum safety for personnel engaged in disposal, handling and transporting tasks.

d. The plan adopted must provide assurance that no critical mass will result during the course of removal and transportation operations.

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Three basic solutions to the problem of removing the melted ice and snow were considered in detail and are summarized at Appendix "A". Based on the diplomatic considerations, the time available to do the task, and the personnel safety factor involved, the solution discussed in Plan III which provides for transfer of the liquid residue into smaller transportable tanks for return to the continental United States was considered the best solution. The AEC staff concurred in the technical aspects of Plan III, and the plan was coordinated with and concurred in by Danish national authorities.

4. The various potentially capable AEC Operations Offices developed cost estimates for disposing of the contaminated residue based on the concepts described below:

a. Savannah River Operations Office Concept:

(1) If the residue is transported to the Savannah River Plant (SRP) by rail, off-loading will be accomplished at the site, but, if transported by barge, the residue will be off-loaded at the SRP dock and transported by truck to the site.

(2) All solid residue will be stored on the surface at the site until the new classified burial ground is completed (about February 1, 1969). Appropriate security surveillance will be provided.

(3) Upon receipt of the liquid waste, it will be processed as follows:

(a) Liquid with high Pu concentrations will be delivered directly to a high level underground waste storage tank.

(b) As for the liquid with low Pu concentrations, the organic layers will be separated from the aqueous by decantation to assure more positive containment of the Pu. The organic will be stored in the underground waste solvent tanks. The aqueous will be evaporated in the waste farm evaporator, with the overheads being released to the seepage basin and the evaporator bottoms containing the radioactive material being delivered to the underground waste storage tanks.

b. Oak Ridge Operations Office Concept: Since the evaporative capacity at Oak Ridge National Laboratory (ORNL) is insufficient to cope with the amount of CONTAMINATED LIQUID TO BE RETURNED FOR disposal, the cost estimates developed

and submitted by ORNL were developed on the concept of direct land burial for all the waste. The costs were found to be comparable for delivery to ORNL either by rail or barge, but rail shipment was considered to be more desirable due to the difficulty of barge operations at OR.

c. Nevada Operations Office and Richland Operations Office: The Manager, NVO, estimated that cost of disposing of the residue at NTS (including movement of the residue by truck from the Las Vegas, Nevada, railhead to the NTS) would be approximately $315,000. He further reported that time did not permit development of estimates based on disposal using subsidence craters. No individual cost estimates were requested of Richland since experience has shown that disposal operations at Richland are very similar to those at Savannah River.

5. The following summarizes the overall estimated cost to the government for delivery to and disposal at the various AEC sites considered (see Appendix "B" for detailed cost estimates):

a. At Savannah River Plant	
(1) Solids and Liquids (rail delivery)	$625,120
(2) Solids Only (barge delivery)	$217,465
(3) Liquids Only (rail delivery)	$429,014
b. At Oak Ridge National Laboratory	
(1) Solids and Liquids (barge delivery)	$645,219
(2) Solids Only (barge delivery)	$468,660
(3) Liquids Only (barge delivery)	$259,560
c. At Richland	
(1) Solids and Liquids (rail delivery)	$941,939
(2) Solids Only (rail delivery)	$388,777
(3) Liquids Only (rail delivery)	$587,424
d. At NTS	
Solids and Liquids (rail delivery)	$892,553
e. Solids at SRP and Liquids at ORNL	$477,025

6. The following resume presents the Oak Ridge and Savannah River Operations proposed solutions, along with the advantages and disadvantages of each; in view of the excessive overall cost to the GOVERNMENT and extensive overland movement of the liquid residue, NTS AND RICHLAND ARE NOT INCLUDED IN THIS analysis:

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a. Disposal of Solids and Liquids at SRP

(1) Advantages.

(a) Contaminated liquids would be processed for positive containment of Pu.

(b) Cost of transportation from Charleston, S. C., to burial site is the least.

(c) Railhead at the burial site minimizes handling of residue.

(d) Minimum movement of liquid waste containers over land.

(e) Most economical solution to disposal at a single site.

(2) Disadvantage.

More expensive than disposal of solids at SRP and liquids at ORNL.

b. Disposal of Solids and Liquids at ORNL

(1) Advantage.

Outright burial is less complicated than SRP concept.

(2) Disadvantages.

(a) Contaminated liquid would not be processed for positive containment of Pu.

(b) Increases the amount of handling of contaminated residue due to lack of railhead at the disposal site.

(c) More expensive than SRP for single site disposal.

(d) Greater overland or barge movement of liquid waste containers.

c. Disposal of Solids at ORNL and Liquids at SRP

(1) Advantages.

(a) Liquids would be processed for positive containment of Pu.

(b) Minimum handling of liquid waste containers.

(c) Minimum movement of liquid waste containers over land or by barge.

(2) Disadvantages.

(a) Excessive overall cost to the government.

(b) Complications inherent in shipment to multiple destinations.

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d. Disposal of Solids at SRP and Liquids at ORNL

(1) Advantage.

Least costly to the government of all solutions considered.

(2) Disadvantages.

(a) Liquids would not be processed for positive containment of Pu.

(b) Complications inherent in shipment to multiple destinations.

(c) Increased handling of liquid waste containers.

(d) Increased movement of liquid waste containers over land or by barge.

Notwithstanding the fact that disposal of solids at SRP and liquids at ORNL would be the least expensive solution, the staff considers that there are two overriding factors in favor of disposing of both solids and liquids at SRP; namely, (1) the liquids will be processed for positive containment of Pu, and (2) the overland movement of liquid waste containers will be minimized.

7. Both ORNL and SRP were requested to provide estimates of additional cost involved in establishing material balance. Both are of the opinion that any attempt to improve upon the current estimate of plutonium content in the liquid residue would cost at least $100,000 and would yield only questionable results. On the other hand, the solid residue will be measured in an attempt to establish a better estimate of plutonium content, whether it is disposed of at SRP or ORNL. The current estimate of plutonium in the melted ice and snow is 2.8 kg and inspection of the weapon residue (including parachutes) accounted for approximately .119 kg. To date, no measurements have been made of all the solid debris; however, an earlier analysis of some 127 drums of aircraft debris resulted in an estimate of approximately .200 kg Pu. There is no requirement for the U.S. Government to advise the Danish Government as to the final estimate of fissile material remaining in the vicinity of Thule, Greenland. Also, there has been no requirement levied by the Department of Defense to establish a material balance. Consequently, the staff proposes that further measurements taken at the burial site be oriented toward the development of a final record of fissile material disposed of in the burial site.

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8. The broad basis for funding is spelled out in the "Joint Department of Defense and Atomic Energy Commission Agreement in Response to Accidents Involving Radioactive Material", dated May 9, 1966, as follows:

> "The Military Service or Agency providing the necessary assistance will fund such costs initially within existing fund availability. The Military Service or Agency having physical possession of the weapon or radiological material at the time of the accident will be responsible for reimbursing, upon request, the Military Service or Agency providing the necessary assistance for those costs which are in addition to normal operating expenses and which are directly chargeable to, and caused by, the radiological accident."

Although a joint AEC-DoD provision for cost reimbursement was in effect at the time that the residue from Palomares, Spain, was buried at Savannah River, the cost of disposal was funded by the AEC and no request for reimbursement was made. The draft letter to the ATSD(AE) at Appendix "C" refers to the above policy in addressing the matter of cost reimbursement.

9. In view of the nature of this problem, the staff proposes that the JCAE be notified. A proposed draft letter to the JCAE is attached as Appendix "D".

STAFF JUDGMENT

10. The Controller, the Offices of the General Counsel and Congressional Relations and the Divisions of Biology and Medicine, Operational Safety, and Production concur in the recommendation of this staff paper.

RECOMMENDATION

11. The General Manager recommends that the Atomic Energy Commission:

a. Note that the most economical solution to the final disposal of the residue is to bury the containers of liquid at the Oak Ridge National Laboratory and the solid residue at the Savannah River Plant;

b. Find that, from an overall standpoint, the best solution is to dispose of all the residue at the Savannah River Plant;

c. Approve the draft letter to the ATSD(AE) at Appendix "C"; and

d. Approve the draft letter to the JCAE at Appendix "D".

LIST OF ENCLOSURES

APPENDIX "A"

SUMMARY OF STUDY TO DEVELOP A PLAN
FOR REMOVING CONTAMINATED WASTE

1. GENERAL. Three basic solutions to the problem were considered in detail. The short period of time available to accomplish the disposal, the need to satisfy existing U.S. and Danish Government agreements and to insure personnel safety were primary considerations in developing possible solutions. A discussion of each basic solution follows:

2. PLAN 1. This plan would involve removal and transport of the 25,000 gallon POL tanks with existing contents to CONUS for disposal.

a. Advantages:

(1) Melting and transfer of tank contents would not be required.

(2) Minimum physical health problems.

(3) Additional tanks, pumps, filters, etc., would not be required and shipped to Greenland.

(4) Radiological monitoring would be minimized.

b. Disadvantages:

(1) Preliminary calculation based on information from DNS and LASL indicate criticality under this plan will not be a problem; however, this plan would maximize the probabilities of occurrence compared to use of smaller tanks.

(2) To insure structural integrity of the tanks during transport would require extensive cradling supports both on board ship and in transit from tank farm to ship and subsequent transfer at rail heads or barges.

(3) SAC Civil Engineering studies reveal it is doubtful that the existing roadbeds and culverts between tank farm and dock will support the approximately 30 ton tank (tank + contents) unless special multi-axle trailer/tractor are shipped to Thule. Available 40 foot, 40,000 lbs. capacity trailers cannot be used for this purpose.

(4) The loading aboard ship of partially filled POL tanks will impose serious problems. Tilted entry through hatches of partly filled tanks would have to be carefully engineered. Special harnesses to handle shifting

and unbalanced loads would be required. At best, these procedures are hazardous. Methods of skidding 30 ton loads below decks would need to be devised.

(5) The tank contents would melt enroute and, in accordance with MSTS, such a dynamic sloshing load is not acceptable. The tanks cannot be internally baffled and, therefore, must be filled before departure. This creates a requirement to distribute weights in excess of 100 tons to insure load bearing limitations of the deck are not exceeded.

(6) Heavy cradling for the 100 ton filled tanks would be required. These would require extensive fabrication and shipment to Thule. The short time available to on-dock date is a factor in this respect.

(7) The inability/difficulty in safely skidding and hoisting filled tanks would make it necessary to transfer the liquid waste:

(a) From POL tanks to transport tank.

(b) From transport tank to tank on ship.

(c) From ship tank to CONUS transport system.

(d) From CONUS transport system to final location for disposal processing.

Multiple transfer greatly increases the spillage hazard and physiological health problems.

3. PLAN 2. This SAC conceived plan would provide for concentration of radioactive waste by filtration and dilution. The frozen waste would be melted in the POL tanks. The "clear" liquid between scum and sludge layers would be pumped through a 5 micron filter, followed by three 1 micron filters placed in parallel and then to a holding tank. Effluent in the holding tank would be discharged into the bay when radioactivity is reduced to an acceptable level. Provisions must be provided to recycle waste from the most heavily contaminated tanks (Nos. 1 and 66) through the filtration system in order to obtain a manageable effluent. Pumps are to be provided for dilution in the final holding tanks. Contaminated pumps, plumbing, filters, holding tanks, and empty (dry) POL tanks would be shipped to an AEC-designated disposal site in the CONUS.

a. Advantages:

(1) Total volume of liquid waste would be concentrated to an estimated 20% of the present volume.

(2) Significant reduction in tonnage requiring return to CONUS.

b. Disadvantages:

(1) The criteria specifying the radioactive level of the water discharged into North Star Bay has not been established. If international drinking water standards are used and Los Alamos Scientific Laboratory (LASL) estimates of 95-98% filter efficiency are used, then a dilution ratio of 50 to 1 in the final holding tank would be required. Only 500 gallons per run could be attained and the holding tank filled with "fresh" sea water before discharge.

(2) The physiological health problems will be greatly increased due to the need for very extensive handling and close contact with the radioactive waste, during pumping operations, replacement of filters, batch sampling, etc. Some of the radioactive waste will be passed by the filters in the form of heavy water (tritium oxide), which can be absorbed through the skin, and under certain circumstances, may be inhaled. Considerable personnel protective equipment and extremely close technical supervision and radiological monitoring would be required.

(3) Continual radiological monitoring of each filter would be required to insure personnel safety. Hq SAC Civil Engineering personnel (who proposed the filtration system) have estimated that 22,000 filters will be required to process the liquid residue.

(4) An adequate filtration system, with necessary operating procedures, has not been designed, fabricated and service-tested to date. Production delays, parts shortages, design or operating problems, etc., may arise which would preclude removal of the residue during the summer months this year.

(5) The filtration and pumping system contaminated during the filtration process could not be economically decontaminated and must be returned to CONUS as radioactive waste.

(6) Accerding to calculations by Los Alamos, there is a potential for 20 to 22 critical masses in the waste as it sits today. Concentration of 20% would increase this hazard by a factor of 5 and neutron sensors would be required on each filter. Criticality seems remote but must be a consideration.

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4. PLAN 3. This plan would provide for transfer of the radioactive waste into smaller transportable tanks for return to CONUS for disposal. This method involves melting the radioactive residue in the POL tanks, pumping the liquid into smaller tanks (about 1,800 gallon capacity), transporting the tanks about two miles from the shoreline storage area to the ship docking area, loading the tanks aboard cargo ships, shipment to a CONUS port, transferring the tanks to railroad flat cars or barges for shipment to an AEC-designated disposal area. The empty (dry) POL tanks would be similarly transported to the AEC-designated disposal area. An adequate quantity of 1,800 gallon capacity transportable tanks are immediately available. The successful conversion of excess engine containers to a transportable tank by sealing and adding filler and vent pipes has been demonstrated and rigorously tested for structural handling integrity. Excess portable pumping equipment with demonstrated ability to safely handle the effluent is immediately available. When the disposal task is completed, the contaminated equipment will be returned to the AEC with other residue.

a. Advantages:

(1) Insures complete removal of all radioactive residue from Greenland and minimal handling and contamination problems.

(2) Physiological health hazards and monitoring equipment are kept to a minimum since there is only one liquid transfer operation. This operation can be accomplished without spillage.

(3) The probability of criticality would be negligible under this plan because the distribution of radioactive material can be controlled.

(4) The empty POL tanks can more easily be loaded and stowed aboard ship than if they were partly or completely filled.

b. Disadvantages:

Comparatively, a larger amount of tonnage/cubage will be involved in water and rail movement of small tanks to Thule AB and their return from Thule AB.

5. CONCLUSION. The postulated solutions have been carefully evaluated. Based on the diplomatic considerations, the time available to do the task, and, of major importance, the personnel safety factors involved, the solution discussed

in PLAN 3 is considered the best problem solution. That solution - to transfer the maximum quantity of liquid radioactive residue into smaller transportable tanks for return to CONUS for disposal - can be responsively managed with available resources (equipment/material) and the limited time frame imposed by the short Greenland summer. Additionally, considerable cost effectiveness will be realized through use of materials/equipment currently excess to Air Force requirements and minimizing the number and skill levels of personnel needed at Thule.

6. RECOMMENDATION. That PLAN 3 be adopted as the basic approach around which a detailed operational/procedural plan can be developed, coordinated and approved by necessary agencies of both the U.S. and Denmark. In consideration of the limited time available, a detailed operational/procedural plan is being formulated. AFLC will insure coordination with AF Directorate of Nuclear Safety, Air Defense Command and Atomic Energy Commission. AFLC will request Air Staff coordination and also request the Air Staff to obtain DoD and Danish coordination.

APPENDIX "B"

COST COMPARISONS

AEC SITE COSTS

To Dispose of	SAVANNAH RIVER	OAK RIDGE	NEVADA TEST SITE	RICHLAND
Solids and Liquids	$364,386(1) ($424,647)(2)	$376,100(1)	$315,000	$364,386
Solids Only	$100,000(1)	$334,100(1)	Not Estimated	$100,000
Liquids Only	$298,647 ($345,661)(2)	$125,000	Not Estimated	$298,647

(1) Includes $14,100 for measuring Pu content in solid residue.

(2) Cost if delivered to site by barge will be greater due to complexity of barge operations and need to move residue by truck from dock to disposal site.

USAF TRANSPORTATION COSTS

From Thule	SAVANNAH RIVER	OAK RIDGE	NEVADA TEST SITE	RICHLAND
Via Savannah, Ga., and barge to	$234,930	NA	NA	NA
Via Charleston, S. C., and rail to	$260,734	$288,254	$577,553	$577,553
Via Port Chicago and barge to	NA	$269,119	NA	NA
Via New Orleans and barge to	NA	$305,594	NA	NA

TOTAL COST COMPARISON

To Transport and Dispose		SAVANNAH RIVER	OAK RIDGE	NEVADA TEST SITE	RICHLAND
Solids and Liquids	R	$625,120	$664,354	$892,553	$941,939
	B	$659,577	$645,219(1)	-	-
Solids Only	R	$230,367	$478,227	-	$388,777
	B	$217,465	$468,660	-	-
Liquids Only	R	$429,014	$269,127	-	$587,424
	B	$463,126	$259,560	-	-

R - Rail from CONUS port to site.
B - Barge from CONUS port to site.

(1) Via Port Chicago least expensive.

APPENDIX "C"

DRAFT LETTER TO THE ATSD(AE)
FROM THE GENERAL MANAGER

1. This is to inform you that the Atomic Energy Commission has selected the USAEC's Savannah River Plant (SRP) as the disposal site for the contaminated residue which is to be removed from Thule Air Base, Greenland. This selection recognizes the use of the most desirable transportation concept proposed by the U. S. Air Force; i.e., by sea from Thule to Charleston, South Carolina, and then by rail to the SRP. Notwithstanding the fact that disposal of solid residue at the SRP and liquid residue at the Oak Ridge National Laboratory would be the least expensive solution, the SRP was selected to take advantage of its capability to effect positive containment of the plutonium in the liquid residue and to reduce to a minimum the overland movement of the contaminated residue.

2. The Commission considers that reimbursement for costs incurred by the AEC which are in addition to normal operating expenses fall within the provisions of the "Joint Department of Defense and Atomic Energy Commission Agreement in Response to Accidents Involving Radiological Material", dated May 9, 1966. The current estimated cost for disposing of the residue at the SRP which is reimbursable to the Atomic Energy Commission is approximately $365,000.

APPENDIX "D"

DRAFT LETTER TO THE EXECUTIVE DIRECTOR, JCAE
FROM THE GENERAL MANAGER

1. The cleanup operations conducted subsequent to the January 21, 1968, B-52 crash near Thule, Greenland, have resulted in the accumulation of approximately 10,500 measurement tons of contaminated residue at Thule Air Base, Greenland. This residue, which is part liquid and part solid, will be returned to the United States this summer for final disposal.

2. This is to advise that the Atomic Energy Commission has selected the USAEC's Savannah River Plant as the disposal site. This selection recognizes the use of the most desirable transportation concept proposed by the U. S. Air Force; i.e., by sea from Thule to Charleston, South Carolina, and then by rail to the Savannah River Plant. Notwithstanding the fact that disposal of solid residue at the Savannah River Plant and liquid residue at Oak Ridge National Laboratory would be the least expensive solution, the Savannah River Plant was selected to take advantage of its capability to effect positive containment of the plutonium in the liquid residue and to reduce to a minimum the overland movement of the contaminated residue. The current estimated cost for disposal at the Savannah River Plant is approximately $365,000.

3. If there should be questions concerning this matter, please let us know.