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SAFETY ASSESSMENT
CANAL© TRANSPORTATION

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Introduction

This document assesses the safety of the proposed transportation of CANAL© from Shieldalloy Metallurgical Corporation's (SMC's) Newfield, N.J. site to the Port of Richmond, Virginia. It evaluates the impacts on the driver, the public, and emergency response personnel from the natural-occurring radioactivity contained in the product. The evaluation includes scenarios for both routine operations and hypothetical accidents.

For the purposes of this assessment, the CANAL© to be transported is assumed to contain 500 pCi/g of Thorium-232 and 300 pCi/g of Uranium-238, a conservatively high estimate of the radioactivity it contains. Furthermore, both of these radionuclides are assumed to be in equilibrium with all of their progeny.

Routine Operations

This assessment assumes the CANAL© will be packaged in 20 kilogram sacks, which are stacked on pallets. Each pallet holds 128 sacks. Eight pallets are loaded onto a flat bed tractor-trailer truck for transport from Newfield to Richmond. The trip is assumed to take four hours (one way). The driver makes one trip per week.

Under normal conditions, the only radiological impact associated with transportation is the direct exposure resulting from proximity to the bags. Two types of exposure are of concern:

- Exposure of the driver, and
- Exposure of the general public.

Exposures to these people were calculated using the computer code Microshield 4.10.[1]

The driver is assumed to be five feet from the end of the pallets. No credit is taken for the structures between the driver and the bags. For the general public, a distance of one meter from the side of the vehicle was assumed, to assess doses to passers-by and to evaluate compliance with U.S. Department of Transportation (DOT) regulations.

The results of these analyses indicate that the driver will be exposed to 0.26 mR/hour from the CANAL©. The dose per trip will therefore be approximately two mrem. With one trip being made per week, the driver's annual dose will be less than 100 mrem per year.

For the general public, the exposure rate one meter from the side of the vehicle is calculated to be 0.63 mR/hour. This exposure rate is negligible for personnel standing next to the vehicle, and is

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[1] Microshield 4.10 is a computer code developed by the Grove Engineering Company for the assessment of direct radiation exposures from sources of radioactivity with various geometries.

also well within the limits imposed by DOT regulations.

Based on this analysis, direct radiation exposures associated with routine transportation of CANAL© pose no threat to either the driver or the public, and are well-within the regulatory limits for members of the general population[2].

Accident Analysis

Two accidents were evaluated to ensure that transportation of CANAL© can be accomplished safely:

- An truck accident while it is on the road, and
- Loss of the truck's load into the ocean.

The following sections describe each accident scenario and evaluate its consequences.

Road Accident

The limiting event associated with CANAL© transportation is a truck accident on the road that would generate a cloud of dust, which could then be inhaled. Three groups of people could potentially be exposed to radioactivity in the event of such an accident:

- The driver,
- the general public, and
- emergency response personnel.

To assess the radiological impact on these groups, an accident scenario was developed. In this scenario, the truck overturns, causing some of the sacks to rupture. The rupture instantaneously creates a cloud of dust, with a CANAL© concentration of 100 mg/m^3.[3] The driver and a passerby are exposed to this plume for a period of one minute, as they move out of its way.

Once the plume passes, the driver waits by the truck until a recovery team arrives. During this

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2 Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation," Section 20.1301.

3 Mishima, J., Data Useful in Evaluation of Airborne Plutonium from Postulated Accident Situations, Appendix F of *Considerations in the assessment of Consequences of Effluents from Mixed-Oxide Fuel Fabrication Plants*, J.M. Selby et al, BNWL-1697, Rev. 1, Pacific Northwest Laboratory, Richland, Washington (1975).

period (assumed to last four hours), the driver breathes in dust at a concentration of 0.2 mg/m^3.[4] When the recovery team arrives, the spilled slag is repackaged and the truck righted. During this period (assumed to last four hours), members of the recovery team and the driver are exposed to airborne dust concentrations of 5.0 mg/m^3.[5]

During exposure to the initial plume, the passerby and the driver are assumed to have a respiratory rate established for high physical exertion (100 liters of air/minute).[6] After the plume passes, the driver and the response team are assumed to have respiratory rates of 20 liters/minute, associated with light work. No respiratory protection is assumed for anyone involved in this accident scenario.

The intakes of dust thus calculated were then converted into doses using dose conversion factors published by the U.S. Environmental Protection Agency (EPA).[7] The following doses would result for the three groups of concern:

- Member of the General Public - 9.1 mrem.
- Member of Response Team - 22 mrem.
- Driver - 32 mrem.

None of these doses are of any health significance. They are also well below regulatory limits.

Loss of Load into the Ocean

In this scenario, a trailer load of CANAL falls off of the pier in the Port of Richmond. As a result of the fall, ten percent of the bags on the trailer rupture and spread their contents over a twenty foot by forty foot area of the ocean floor. Intact bags of CANAL are removed by a recovery team. No recovery of the spilled CANAL occurs, however.

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4 National Council on Radiation Protection and Measurements, Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation," dated June 1, 1994.

5 American Conference of Governmental Industrial Hygienists, "Threshold Limit Values for Chemical Substances and Physical Agents," limit for nuisance dusts, dated 1992.

6 International Commission on Radiological Protection, Report No. 23, "Reference man," 1974.

7 EPA, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Federal Guidance Report No. 11, dated September 1988.

The uranium, thorium, and their progeny (assumed to be in equilibrium) begin to leach out of the CANAL. The following leach rates are assumed[8]:

Element	Leach Rate (Fraction/Second)
Uranium	1E-10
Thorium	8E-10
All Progeny	3E-9

The leach rate for all progeny were assumed to be the same as that for Radium. To convert this leach rate into a radionuclide concentration in water, the following conservative assumptions were made:

- Activity builds up in a column of water defined by the area of the spill (twenty feet by forty feet) and a ten foot mixing height.
- Activity builds up for a twelve hour period, after which the tide replaces the water in the column.

Fish and shellfish are assumed to live in this water column, where they concentrate the radioactivity in the water. Bioaccumulation factors were obtained for both marine finfish and shellfish[9] in order to model this concentration.

Human intake of these marine fish was assumed to be 13.4 grams per day, of which 11.3 grams per day come from finfish and 2.1 grams per day from shellfish.[10] Finally, intakes were converted into committed equivalent dose equivalents (CEDEs) using the dose conversion factors in Federal Guidance Report No. 11.[11]

Based on this conservative methodology, a person consuming fish as described above would receive an incremental CEDE of 16 mrem per year. This dose is well within regulatory limits and would not pose a health concern to members of the public.

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8 "Ferro-Columbium Leachability Report," Teledyne Isotopes, Inc., 12/16/91.

9 DOE/TIC-11468, "Models and Parameters for Environmental Radiological Assessments," edited by C. W. Miller, 1984.

10 EPA-503/8-89-002, "Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual," dated September, 1989.

11 EPA-520/1-88-020, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," dated September, 1988

Summary

This analysis assessed the impact of transporting CANAL© from SMC's Newfield facility to the Port of Richmond. Both routine exposures and the hypothetical accident doses were calculated assuming 500 pCi/g of Thorium-232 and 300 pCi/g of Uranium-238, with all progeny in equilibrium. The resulting doses were found to be insignificant and well within regulatory limits.

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