CONF-851115--26

CONF-851115--26

DE86 002182

ECONOMICS OF THE SPECIFICATION 6M SAFETY RE-EVALUATION AND REGULATORY REQUIREMENTS

C. M. Hopper

COMPUTING AND TELECOMMUNICATIONS DIVISION
at
Oak Ridge National Laboratory*
Post Office Box X
Oak Ridge, Tennessee 37831

Paper to be
Presented at the Winter Meeting of the
American Nuclear Society
San Francisco, California
November 10-14, 1985

*Operated by Martin Marietta Energy Systems, Inc., under Contract DE-AC05-84OR21400 for the U.S. Department of Energy

ECONOMICS OF THE SPECIFICATION 6M SAFETY RE-EVALUATION AND REGULATORY REQUIREMENTS

C. M. Hopper

INTRODUCTION

The objective of this work was to examine the potential economic impact of the DOT Specification 6M criticality safety re-evaluation[1] a regulatory requirements. The examination was based upon comparative analyses of current authorized fissile material load limits for the 6M, current Federal regulations (and interpretations) limiting the content of Type B fissile material packages, limiting aggregates of fissile material packages, and recent proposed fissile material mass limits derived from specialized criticality safety analyses of the 6M package. The work examines influences on cost in transportation, handling, and storage of fissile materials.

BASES OF COMPARATIVE ANALYSES

Current Authorized 6M Load Limits

The current authorized fissile material load limits of the Specification 6M package are provided in Title 49 of the Code of Federal Regulations Part 173.417(b)(2)(i & ii). Though 49 CFR 178.104 specifies 6M packages to range in rated capacities between 0.03785 m^3 (10 gallons) and 0.4164 m^3 (110 gallons) inclusively, the authorized contents apply to all package sizes, indicating excessively conservative load limits for packages larger than 0.03785 m^3 (10 gallons).

Type B Single Package Analyses Limitation of Fissile Material Contents

Criticality standards for fissile material packages are specified in Title 10 of the Code of Federal Regulations Part 71.55(e)(1-3). These specifications have been interpreted to mean that the package contents must be subcritical if water leaks into the containment vessel, and: (1) water moderation of the contents occurs to the most reactive extent determinable with the chemical and physical form of the contents; and (2) the containment vessel is fully reflected on all sides by water. For the Specification 2R vessel described in 49 CFR 178.34, the limiting contents would be on the order of 7.39 and 11.0 kgs of U-233 metal and compounds, and 23.56 and 147.3 kgs of U-235 metal and compounds, respectively. The Pu-239 would be limited to about 4.5 kgs of either metal or compounds due to the associated thermal decay heat.

Limits for Aggregates of Fissile Material Packages

Regulatory restrictions on the accumulation of fissile material packages in storage or multiple shipment cargo holds are specified in various parts of 49 CFR (e.g., 49 CFR 176.704 through 176.708). In general, the aggregate transport index (T.I.) of all packages in a grouping may not exceed 50 and each grouping of such fissile material packages must be separated by a minimum of 6.1 m (20 feet).

Re-evaluated Criticality Safety Mass Limits for the DOT Spec. 6M

Recent criticality safety evaluations of the DOT Spec. 6M package, in accordance with 10 CFR Part 71, demonstrate the acceptability and safety of substantially increased fissile material mass limits as applied to specific sizes of 6M packages. Also, the evaluation extended the practical forms of fissile materials permitted in the 6M package.

EXAMPLE COMPARISON OF AUTHORIZED AND RE-EVALUATED CONTENTS

Current fissile material mass limits are consolidated from 49 CFR 173.417(b)(2)(i & ii) and presented in Table I along with recently evaluated mass limits for a 30-gallon DOT Spec. 6M.

DISCUSSION

Table I demonstrates the substantial increase in fissile material mass limits resulting from a specialized criticality safety analysis or, conversely, the reduction in transport index for a given mass of material. Though the nuclear criticality safety package array re-evaluation permits substantial mass increases, the maximum thermal decay heat load of 10 watts limits the quantity of 239-Pu to 4.5 kg or less. Also, the single package analysis limits the mass of 233-U metal to 7.2 kg or less.

To relate the potential economic impact of the re-evaluated load limits, a simplified pricing algorithm was developed to incorporate cost influences per year such as

* type and form of fissile material to be packaged,
* total mass of fissile material to be shipped per year,
* maximum desired contents per package (e.g., 5 kgs, maximum allowed, etc.),
* manpower and administrative cost per container loading and unloading,
* cost of containers (purchase & maintenance),
* package size and weight,
* frequency of shipments per year (fixed or flexible),
* number of containers allowed per square foot storage,
* cost of storage floor space per year ($ per square foot),

Table I. Current and Re-evaluated Mass Limits for a 30-gallon (or larger) Spec. 6M Package in kgs of Fissile Material*

Fissile Isotope Form	H/X	Transport Index 0.0	0.1	0.2	0.5	1.0	5.0	10.0
233-U Metal	0	0.5	3.6	4.2	5.2	---	---	---
		(6.6)	---	---	---	---	---	---
Compounds	0	0.5	4.4	5.2	6.8	---	---	---
		(8.2)	(10.2)	---	(13.0)	(14.1)	(15.6)	(16.6)
	<1	0.5	---	---	---	---	---	---
		(8.2)	(10.2)	---	(13.0)	(14.1)	(15.6)	(16.6)
	<3	0.5	2.9	3.5	4.5	---	---	---
		(6.3)	(8.4)	---	(10.3)	(11.8)	(13.6)	(14.6)
	<10	---	---	---	---	---	---	---
		(3.7)	(4.9)	---	(6.2)	(7.0)	(8.5)	(9.4)
235-U Metal	0	1.6	7.2	8.7	11.2	13.5	---	---
		(15.9)	(18.2)	---	(20.0)	(21.8)	---	---
Compounds	0	1.6	7.6	9.6	13.9	16.0	26.0	32.0
		(13.2)	(18.5)	---	(23.5)	(28.0)	(35.0)	(39.0)
	<1	1.6	5.3	6.4	8.3	10.1	16.1	19.5
		(13.2)	(18.5)	---	(23.5)	(28.0)	(35.0)	(39.0)
	<3	1.6	5.3	6.4	8.3	10.1	16.1	19.5
		(10.4)	(13.8)	---	(18.0)	(20.8)	(27.2)	(31.0)
	<10	---	---	---	---	---	---	---
		(5.4)	(7.1)	---	(9.4)	(11.3)	(14.2)	(15.7)
239-Pu Metal	0	0.9	3.1	3.4	4.2	4.5	---	---
		(4.5)	---	---	---	---	---	---
Compounds	0	0.9	4.1	4.5	---	---	---	---
		(4.5)	---	---	---	---	---	---
	<1	0.9	4.1	4.5	---	---	---	---
		(4.5)	---	---	---	---	---	---
	<3	0.9	3.4	4.1	4.5	---	---	---
		(4.5)	---	---	---	---	---	---
	<10	---	---	---	---	---	---	---
		(4.5)	---	---	---	---	---	---

* Current fissile isotope mass limits stand alone. Re-evaluated fissile element mass limits are in parentheses. H/X is the atom ratio of hydrogen to fissile isotope (for current mass limits) or hydrogen to fissile element (for re-evaluated mass limits).

* transport vehicle capacity in containers per vehicle (gross weight, volume and T.I. dependent), and
* cost per shipment as a function of number, weight and volume of packages.

Annuity of savings, depreciation and potential costs of changes to site-specific statutory operating safety limits were not incorporated into the algorithm.

CONCLUSIONS

Depending upon facility throughput requirements (and assumed incremental costs of fissile material packaging, storage, and transport), operating, facility storage capacity, and transportation costs can be reduced significantly. As an example of the pricing algorithm application based upon reasonable cost influences, the magnitude of the first year cost reductions could extend beyond four times the cost of the packaging nuclear criticality safety re-evaluation.

REFERENCE

1. J. T. Thomas and C. M. Hopper, "Nuclear Criticality Safety Analyses for the 6M Specification Package," ORNL-6176, Oak Ridge National Laboratory (to be published).