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Secretary
US Nuclear Regulatory Commission
ATTN: Rulemaking and Adjudications
Washington D.C. 20555

Date: 18 September 2000

Re: Proposed revision of 10CFR Part 71, Compatibility with ST-1

DOCKET NUMBER PROPOSED RULE PR 71
(65FR 44360)

Gentlemen:

This letter is in response to NRC's proposed rulemaking to amend its Regulations pertaining to the transportation of radioactive materials to conform to the recommended provisions published in the International Atomic Energy Agency document referred to as "ST-1".

Item 1: Revision of A_1 and A_2, Issue 3 of the NRC's request for comments as published in the Federal Register on July 17, 2000 and in particular, the proposed reduction of the A_1 quantity for californium-252 from its present value of 0.1 TBq (2.7 Ci) to 0.05 TBq (1.35 Ci).

Frontier Technology Corporation very strongly opposes the proposal to reduce the A_1 quantity for californium-252 from its present value of 0.1 TBq (2.7 Ci, or 5040 micrograms) to one-half that quantity, i.e., to 0.05 TBq (1.35 Ci, or 2520 micrograms).

Frontier is the world's major commercial fabricator and distributor of sealed Cf-252 neutron sources. We have shipped or received more than eight hundred fifteen Type A shipments of special form Cf-252 material since 1985. Seventeen such shipments contained Cf-252 contents between the proposed new Type A limit of 0.05 TBq and the pre-HM-169 (pre-1995) limit of 0.74 TBq, and an additional four shipments since 1997 contained quantities just below the present 0.1 TBq limit. Approximately three hundred of the shipments, including three having contents above the proposed new, 0.05 TBq limit, were international air shipments. No significant transport incidents occurred during any of these shipments: i.e., zero radioactive materials releases, zero package surface or one-meter dose rates above normal limits. In addition, Frontier has shipped or received more than four hundred eighty-five empty Type A packages of the designs used for californium source shipments. While most of these were truck shipments, some international shipments were by air and by vessel. There were no transport incidents during these shipments, and none of the packages would have released radioactive material or emitted above-limit levels of radiation had they contained californium sources during the shipments. We strongly believe that our incident-free experience with more than one thousand five hundred shipments of Type A packages is clear evidence that properly designed, constructed and maintained Type A packages are quite capable of

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withstanding the normal conditions of transport without endangering any person or the environment.

Our transport experience demonstrates that the probability of significant damage to a Type A package containing Cf-252 special form sources during transport is very small; less than one chance in fifteen hundred, or 0.067 percent. Since no amount of experience can preclude the possibility of an accident or other incident, let us consider the result of an occurrence which would breach the package, and release the sealed Special Form source or sources. For reference, Tables 1 and 2 (appended to this letter) summarize the proposed (ST-1), present (HM-161), and previous (pre-1995) Type A package limits and radiation field intensities in air at three meters corresponding to those limits, respectively, for Cf-252 and for several other radioactive materials used in sealed radiation sources. A major historical criteria for setting A_1 quantities was to set the A_1 limit at that quantity of material which would produce a radiation level of one Rem per hour (10 mSv/hr) at a distance of three meters from the unshielded material in air. Referring to Table 2, it is seen that the pre-1995 A_1 limits closely matched this criteria, with the unshielded 3-meter radiation levels for Cf-252, Co-60, Cs-137 and Ir-192 being 0.98, 1.03, 1.19 and 1.13 Rem/hr, respectively. HM-161 increased the A_1 limits in 1995 such that the unshielded dose rates at three meters from A_1 quantities became 1.32, 1.58, 2.14 and 1.53 Rem/hr, respectively. The A_1 limits for these four materials proposed in ST-1 would reduce the 3-meter unshielded dose rate from an A_1 quantity of Cf-252 to 0.66 Rem/hr, while retaining the HM-161 values of A_1 for the other three materials.

The proposed reduction in the A_1 limit for Cf-252 is clearly not justifiable based on potential radiation exposure rates.

Now we consider an even more severe incident which not only releases the sources from the package, but also breaches the Special Form encapsulation and releases the radioactive contents. Californium-252 is available in several chemical/physical forms, one of which is Cf-Pd cermet or alloy material as currently made by Oak Ridge National Laboratory. This material is a uniform dispersion of californium sesquioxide, Cf_2O_3, throughout a larger volume of a noble metal, palladium. It is made by processes documented in the literature (Refs. 1-a, 1-b, 1-c), for the express purpose of providing a primary confinement for the radioactive material. Neither the Cf_2O_3 nor the palladium are soluble in water or burnable in air. The Cf-Pd materials are ductile, essentially inert solid wires or pellets. The level of removable radioactive material on the surfaces is approximately one-millionth (10^{-6}) of the radioactive content (ref. 2). Should a capsule containing a quantity of Cf-Pd material equal to the present A_1 maximum of 0.1 TBq (2.7 Ci) be breached and release its contents, those contents would not dissolve in water, burn or otherwise disperse in air, and the mechanically removable quantity of Cf-252 would be only about 0.1 TBq x 10^{-6} or 0.1 MBq (2.7 microCurie). This is to be compared with Cs-137, commonly used in the form of the salt, cesium chloride (CsCl). CsCl is a powder or granular material which is easily dispersible in dry form, and which is very soluble in water and most other common liquids. Should a capsule containing either the present or proposed A_1 quantity of Cs-137 as CsCl release its contents, the result would be 2 TBq (54 Ci) of dispersible, soluble radioactive material which would be very likely to result in significant contamination of people and the environment.

Although Frontier uses only the Cf-Pd forms in its sources, Cf-252 is available in several other forms usable for large sources (greater than a few hundred micrograms): californium sesquioxide and californium oxysulfate, $(CfO)_2SO_4$. The oxide is insoluble in water and non-burnable in air, but may be mechanically dispersible. This form is somewhat more likely to result in contamination than are the Cf-Pd forms, but much less likely to do so than is CsCl. The oxysulfate form is made by blending oxysulfate particles into a larger volume of aluminum powder, then pressing the powder into a solid. The resulting pellet is essentially non-soluble in water, non-burnable in air, and non-dispersible. This form is used at Oak Ridge National Laboratory to make some californium sources for government and research uses. As with other californium forms, it has much less potential for personnel and/or environmental contamination than does $^{137}CsCl$.

Reduction of the A_1 limit for Cf-252 is not required or justified from the viewpoint of potential contamination, particularly for Cf-252 in the Cf-Pd forms.

Please note that ST-1 proposes to increase the A_2 limit for Cf-252 to 3×10^{-3} TBq (81.1 milliCuries), which is three times greater than the present A_1 limit of 1×10^{-3} TBq, or 9.1 times greater than the pre-HM-169 A_1 limit of 3.3×10^{-4} TBq (9 milliCuries). Specifically, ST-1 proposes to permit Type A shipments of 3×10^{-3} TBq of Cf-252 in normal form, an unspecified, and thereby conceivably dispersible and/or soluble, form. Thus, the potential of a release of 3×10^{-3} TBq of Cf-252 in a dispersible/soluble form is considered an acceptable risk. This quantity is approximately $(3 \times 10^{-3}$ TBq$)$ /$(0.1 \times 10^{-6}$ TBq$)$ or 30,000 times the quantity of removable (i.e., dispersible or soluble) Cf-252 from ^{252}Cf-Pd pellets or wire segments containing the present Type A limit quantity of 0.1 TBq.

The IAEA's reason for the recommended reduction is not given in ST-1. It is given only in Appendix 1 of IAEA ST-2, which has not been published and is not readily available to the public, although a draft version of ST-2 <u>without</u> the appendices is available at the DOT's internet site.

The A_1 quantity, as stated in ST-2, Appendix 1, is that quantity of special form material which would result in an unshielded radiation exposure rate of 0.1 Sv/hr (10 Rem/hr) at a distance of one meter. The specific reason for the recommended reduction in the A_1 value for Cf-252 is stated in paragraph A.I.3 of that appendix as resulting from an "increase of a factor of 2 in the radiation weighting factor for neutrons recommended by ICRP" in ICRP Publication 60. Thus, the reduction in A_1 for Cf-252 results solely from a recommendation in ICRP 60, published in 1985. ICRP 60 itself (as reported on page 543 of The Health Physics and Radiological Health Handbook, Revised Edition, 1992) states that the recommendation to change the weighting factors (also called Q values) for fast neutrons from 10 to 20 is an interim recommendation while further study is undertaken over "the next four years or so".

The results of that "further study" do not appear to have been published, nor has the recommendation to increase the Q value for fast neutrons to 20 been generally accepted. The use of the ICRP 60 value of 20 for setting the A_1 value of Cf-252 is inconsistent with the Q values accepted by the following (and most other) organizations:

(1) U.S. Department of Transportation. See 49CFR, section 173.403.
(2) **U.S. Nuclear Regulatory Commission. See 10CFR, Part 20,** paragraphs 20.2401 (b) and 20.2401 (c).
(3) U.S. Department of Energy. See DOE Order 5480.11, Change 3 (6/17/92), section 9, Figure 3, "Quality Factors for Neutrons".
(4) International Standards Organization (ISO). See International Standard, ISO 8529:1989(E), "Neutron Reference Radiations For Calibrating Neutron-Measuring Devices Used For Radiation Protection Purposes and For Determining Their Response As A Function Of Neutron Energy", esp. Annex B.

The references above report neutron flux to dose factors and/or Q values in a variety of different units and forms. The values in all references are equivalent to each other and are consistent with maximum Q values of 10 or 11, not the twenty recommended by ICRP 60. None of the referenced organizations is known to be considering the adoption of the ICRP 60 neutron Q value recommendations, nor is there reason for them to do so. Discussions with colleagues at several national laboratories and institutions, universities and private organizations indicates that there is no clear evidence or consensus supporting the ICRP 60 values.

Acceptance of the ST-1 A_1 value of 0.05 TBq for Cf-252 by the United States by incorporation of it into NRC Regulations implies acceptance of the doubled neutron dose weighting factors upon which that value is based. This would have implications far beyond the amount of Cf-252 which may be shipped in a Type A package. These include:

(1) The capacities of ALL packages for shipment of neutron-emitters would be halved, because the capacities are limited by dose outside the package, and the neutron "dose" would double. This would double the costs of neutron-source shipments. Larger packages would have to be fabricated, adding more costs. Total number of shipments would increase.

(2) All existing neutron dose-measuring equipment in the U.S. would have to be replaced, modified, or at least recalibrated to indicate twice what is now indicated in any given neutron field.

(3) Allowable exposures to individuals by neutron fields would be halved.

(4) Persons previously exposed to neutrons would find their doses had been under-reported by 100 percent. Persons who received more than half of the regulatory dose limit in any period based on current Q values would be found to have received exposures above regulatory limits.

(5) All regulations incorporating the present Q values would need revision.

Reducing the A_1 limit for Cf-252 will have adverse effects.

Frontier uses only Type A packages for Cf-252 shipments because the costs of designing, qualifying and using Type B packages are high and not necessary. We purchase bulk Cf-252 from Oak Ridge in Type A limit quantities as a means of minimizing certain quantity-insensitive service charges and shipping costs. Halving the Type A limit will double the number of shipments, thereby increasing the risk of transport damage and increasing the potential exposure of transport workers to radiation.

Service and transportation fees on a recent shipment of 4623 micrograms of Cf-252 totaled $29965, and the cost of the californium material itself was $277,380. Total unit cost was $66.48 per microgram. Reducing the Type A limit to the proposed 0.05 TBq, or 2520 micrograms, would effectively increase our costs to about ($277,380/2) + $29965 = $168,655 for a near-limit quantity of 2312 micrograms, or $72.95 per microgram, an increase of 9.7%. This will result in price increases for the neutron sources we fabricate.

Most of our shipments to customers are of quantities of Cf-252 well below the Type A limit and ship in Type A packages ranging in weight from about fifteen to about five hundred pounds. Shipments use the smallest standard package which will meet the external radiation limits in order to minimize shipping costs. Adoption of The ST-1 proposed Type A limit for Cf-252, and of the doubled Q value for fast neutrons upon which that limit is based, will effectively halve the maximum quantity of Cf-252 shippable in <u>any</u> Type A package. This means that most shipments would require a larger package having twice or more the weight of the current package, or that the shipment would have to be split into two packages. Either would result in at least a doubled shipping cost. The number of packages shipped would also increase, thereby increasing shipping-related exposure and increasing the risk of transport accidents. We would have to increase our inventory of shipping packages, and would have to design, qualify and fabricate new package models of increased physical size. Higher effective source prices would result.

The half-life of Cf-252 is only 2.7 years, so industrial equipment requires on the order of ten source replacements over a life of twenty years. Increases in source prices could result in decisions to discontinue use of existing equipment or to forego the purchase of new equipment. As much of the equipment in which californium sources are used relates to environmental improvement or personnel safety (coal analysis, cement production control, hazardous waste analysis, explosives detection, toxic materials analysis or detection, contraband detection, etc.) decreasing the Type A limit for Cf-252 could ultimately result in significant adverse environmental or health effects.

Frontier has a substantial investment in Type A packages for Cf-252 shipment quantities above the proposed 0.05 TBq limit. Some are designed for specific customers to match source array requirements. A general-purpose unit for five milligrams of Cf-252 (0.1 TBq) is approximately fifty inches diameter by 64 inches long and weighs 7400 pounds. A specialty container for californium sources in rod arrays is approximately 49 inches diameter by 192 inches long and weighs about 6900 pounds. Reduction of the Type A limit to 0.05 TBq will render such packages unusable. Not only will we lose our design, analysis, and fabrication costs, but we will need to decommission and dispose of the units. Since Cf-252 sources are neutron emitters, parts of the packages may contain activation products. This implies surveys, controlled dismantlement, and/or disposal of activated components as radioactive waste. Frontier's total costs resulting from the loss of these packages due to decreasing the Type A limit are not known, but would be expected to be on the order of $500,000, excluding the costs of designing and constructing new specialty containers.

Our customers and we currently have a joint inventory of smaller Type A packages (less than approx. 500 pounds each) of 400 to 500 packages. Average cost is about $1000 per package. Adoption of the proposed ST-1 Type A limit for Cf-252 and of the related Q value will render some of the present packages useless for their intended purpose. Disposal problems and costs will be similar to those described above for larger packages. Additional packages will have to be fabricated and since these will tend to be of larger size than present packages, will have costs substantially greater (i.e., approx, twice) the present $1000 average. Expected costs related to small package disposal and upgrading are estimated as $500,000 to $1,500,000.

Frontier expects loss of future source sales should the Type A limit be decreased to 0.05 TBq for Cf-252. Applications exist which require Cf-252 sources or source sets in the 0.05 to 0.1 TBq range; Frontier has delivered sources for such requirements in Type A packages. Californium for those applications which do not require a single point source of neutrons may be divided into two or more sources and shipped in several packages, but only at increased expense, exposure and risk to workers, the public and the environment. Sources for applications requiring greater than 0.05 TBq in a single source could be shipped only in a Type B or C package, which is impractical due to the very high costs associated with certification, construction, licensing fees and use of such packages. Frontier will be effectively forced out of the larger Cf-252 source market, and users of such sources may be unable to find a replacement supplier. Frontier has already been unable to complete a bid on a 3700 micrograms (0.074 TBq) contract for delivery overseas due to uncertainty in our ability to ship the product. Increased shipping-related costs for smaller sources are expected to reduce sales of such sources.

Item 2: Requirement for all rail or road vehicles carrying W-I, Y-II or Y-III packages to be placarded "Radioactive". This item is not mentioned in the Federal Register request as one of the "Issues", but is a requirement of ST-1, paragraph 570.

Placarding of vehicles carrying hazardous materials is done, at least in part, to inform responders to an accident of the presence of specific classes of material without their having to closely approach or enter the vehicle. Consider a truck carrying a Radioactive White-I package of dimensions 8" x 8" x 8", plus five fifty-five gallon drums of acetone and which is placarded for both. A responder to an accident seeing the Radioactive placard might expose himself to a significant and immediate risk associated with acetone in order to locate and secure a W-I package which poses no immediate risk and has little potential for long-term risk. Consider another truck carrying a Yellow-II package plus a package of poison gas; the truck is placarded "Dangerous". Here, the presence of the Y-II package which poses no immediate danger results in the loss of important information to the responder, i.e., that the truck contains a shipment of poison gas. All the responder is aware of is that the truck contains two or more "hazardous" items, but not what type they are, and this increases his risk.

We believe that any benefit derived from placarding vehicles carrying Radioactive White-I and Yellow-II packages is outweighed by the potential of increased risk to accident responders.

We respectfully recommend and request:

1. That the NRC retain the present A_1 value of 0.1 TBq for Cf-252 in future revisions of its regulations,
2. That the NRC seek the reinstatement of 0.1 TBq as the A_1 value for Cf-252 in IAEA ST-1, which is currently undergoing revision,
3. That the NRC seek amendment, prior to its acceptance by the U.S., of the draft IAEA ST-2 as necessary to support an A_1 value of 0.1 TBq for Cf-252, and to eliminate inconsistencies by removing from ST-2 the implied acceptance of the increased neutron radiation weighting factors recommended in ICRP Publication 60, and
4. That the NRC not incorporate into its future regulations requirements for placarding vehicles carrying Radioactive White-I or Yellow-II labeled packages.

Should the NRC decide to incorporate the proposed ST-1 Type A limit of 0.05 TBq for Cf-252 in general, we request that the present A_1 value of 0.1 TBq be retained for Special Form encapsulated Cf-252 in specific chemical and physical forms including the Cf-Pd cermet and alloy forms.

Respectfully,

Edward F. Janzow

Edward F. Janzow, Ph. D.
President

Table 1

A_1 & A_2 Limits

per: Proposed ST-1 [HM-230] — Present Aug 30, 1995 [HM-169] — Previous [10-1-94 edition of 49CFR]

	Proposed (ST-1) A_1	Proposed (ST-1) A_2	Present A_1	Present A_2	Previous A_1	Previous A_2	T 1/2 Years
Cf-252	$5x10^{-2}$ TBq 1.35 Ci 2520 ug	$3x10^{-3}$ TBq 0.0811 Ci 151.2 ug	0.1 TBq 2.70 Ci 5040 ug	$1x10^{-3}$ TBq 0.027 Ci 50.4 ug	.074 TBq 2.0 Ci 3730 ug	$3.3x10^{-4}$ TBq 0.009 Ci 16.8 ug	2.65
Co-60	$4x10^{-1}$ TBq 10.81 Ci	$4x10^{-1}$ TBq 10.81 Ci	0.4 TBq 10.8 Ci	0.4 TBq 10.8 Ci	 7.0 Ci	 7.0 Ci	5.27
Cs-137 with daughter	$2x10^{0}$ TBq 54.05 Ci	$6x10^{-1}$ TBq 16.22 Ci	2.0 TBq 54.1 Ci	0.5 TBq 13.51 Ci	 30.0 Ci	 10.0 Ci	33
Ir-92	$1x10^{0}$ TBq 27.03 Ci	$6x10^{-1}$ TBq 16.22 Ci	1.0 TBq 27.0 Ci	0.5 TBq 13.5 Ci	0.74 TBq 20.0 Ci	$3.7x10^{-1}$ TBq 10 Ci	74.5 Days
Unknown Beta Gamma Only	0.1 TBq 2.703 Ci	0.02 TBq 0.541 Ci	0.2 TBq 5.0 Ci	0.02 TBq 0.5 Ci	 2.0 Ci	 0.4 Ci	
Unknown Alpha Only	0.2 TBq 5.405 Ci	$9x10^{-5}$ TBq .0024 Ci	0.1 TBq 2.70 Ci	$2x10^{-5}$ TBq 5.4x10-4 Ci	 2.0 Ci	 0.002 Ci	

Table 2

Dose Rate @ three meters from A_1 and A_2 quantities (unshielded)

	Proposed (ST-1)		Present (HM-169)		Previous (Pre-1995)	
	A_1	A_2	A_1	A_2	A_1	A_2
Cf-252	0.661 Rem/hr	.0396 Rem/hr	1.322 Rem/hr	.0071 Rem/hr	0.978 Rem/hr	.0044 Rem/hr
Co-60	1.586 R/hr	1.586 R/hr	1.584 R/hr	1.584 R/hr	1.027 R/hr	1.027 R/hr
Cs-137	2.140 R/hr	.637 R/hr	2.140 R/hr	.534 R/hr	1.187 R/hr	.396 R/hr
Ir-192	1.532 R/hr	.919 R/hr	1.532 R/hr	.765 R/hr	1.133 R/hr	.567 R/hr

Dose rates from Cf-252 based on data in Ref. 3, other dose rates based on data from Ref. 4.

References:

1. "Californium-252 Progress", US Atomic Energy Commission, Savannah River Operations Office, Aiken, SC,
   A. Number 8, July 1971, page 7
   B. Number 9, October 1971, page 4
   C. Number 11, April 1972, page 6

2. "Specification for Pd-Cf_2O_3 Pellets and Wire", contained in "^{252}Cf Source and Shipping Capsule Assembly Design and Test Information", US Atomic Energy Commission, Savannah River Operations Office, Post Office Box A, Aiken, SC 29801, May 15, 1972, pages 2-4

3. "Guide for Fabricating and Handling ^{252}Cf Sources", US Atomic Energy Commission, Savannah River Operations Office, Aiken, SC, January 1971. SRO-153, pages 8 and 9.

4. "Radiological Handbook", US Army Chemical Corps School, Pamphlet 25, May 1958, page 139.