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LICENSEE'S EXHIBIT 17

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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judge  
Peter B. Bloch

DEPT. OF ENERGY  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20545

In the Matter of	)	Docket Nos. 70-00270
	)	30-02278-MLA
THE CURATORS OF	)	
THE UNIVERSITY OF MISSOURI	)	RE: TRUMP-S Project
(Byproduct License	)	
No. 24-00513-32;	)	ASLBP No. 90-613-02-MLA
Special Nuclear Materials	)	
License No. SNM-247)	)	

AFFIDAVIT OF DR. J. STEVEN MORRIS  
RESPONDING TO PORTIONS OF INTERVENORS' REBUTTAL

I, J. Steven Morris, being duly sworn, hereby state as follows:

1. I am the Group Leader of the Nuclear Analysis Program of the University of Missouri-Columbia Research Reactor Facility ("MURR"). During the period beginning March 1, 1989, and ending December 26, 1990, I was the Interim Director of the MURR.<sup>1/</sup>

2. I received a B.S. in Chemistry from Central Missouri State University in 1966 and a Ph.D. in Chemistry from the University of Missouri-Columbia in 1973. I have been employed at the MURR since 1973. in the positions of Radiochemist (1973 to 1975), Research Scientist (1975 to 1978), Sr. Research Scientist (1978 to 1983) and as Group Leader, Nuclear Analysis Program (1983 to present), a position I held concurrently with that of Interim Director. A copy of my resume is attached to Licensee's Exhibit 3 as Attachment 1.

3. I have reviewed the documents filed on December 24, 1990, by the Intervenors. These documents include: Intervenors' Response to Licensee's Written Presentation ("Intervenors' Rebuttal"), Declaration of T<sup>3</sup>UMP-S Review Panel (Intervenors'

<sup>1/</sup> Dr. James Rhyne, formally a senior scientist and neutron scattering program director at the National Institute for Standards and Technology, Washington, D.C., assumed responsibilities as the Director of MURR on December, 26, 1990.

1 Exhibit 20"), and Declaration of Donald W. Wallace ("Intervenors'  
2 Exhibit 21").

3 4. The purpose of this affidavit is to respond to portions  
4 of Intervenors' Rebuttal and Declaration of the TRUMP-S Review  
5 Panel which pertain to the following topics:

- 6 1. Actinide release fractions
- 7 2. Licensee's decision not to install an  
8 additional HEPA filter
- 9 3. Response to Wallace Declaration
- 10 4. Isotopic composition of plutonium
- 11 5. Available information
- 12 6. Epidemiology

13 It is not my intention to repeat previous testimony, rather this  
14 material will be referenced as appropriate.

#### 15 Actinide Release Fractions

16 5. Most of the work concerning release fractions has been  
17 done to better understand the fate of plutonium materials that  
18 could be released as a result of a fire or explosion. The term  
19 release fraction has been defined in NUREG-0767 to be: "that  
20 portion of materials in inventory likely to be dispersed in a  
21 severe real accident".<sup>2/</sup> Despite this, many studies reported  
22 in the literature and cited by the TRUMP-S Review Panel are  
23 actually entrainment fractions, i.e., the portion initially  
24 separated from the source, some of which is not released because  
25 of fallout, plating and filtration. The predominant interest in  
26 plutonium is due both to its radiotoxicity and its large  
27 inventories compared to the other man-made actinide elements.

28 6. Plutonium is produced and separated in kilogram  
29 quantities. Consequently, most of the research that has been  
30 done addresses fires and explosions that might take place at  
31 facilities in which these practices take place, or in which the  
32 plutonium or processing waste is stored. Some of these  
33 facilities utilize various chemical processes including flammable  
34 solvents. The amounts of plutonium metal are a significant  
35 component of the potentially combustible materials. The other  
36 major actinide inventory (including plutonium) is spent nuclear  
37 fuel from nuclear power production plants.

38 7. The Licensee has applied and received amendments to the  
39 appropriate University-held NRC licenses so that basic research  
40 and education regarding fundamental properties of the actinides

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41 <sup>2/</sup> NUREG-0767, "Criteria for Selection of Fuel Cycle and Major  
42 Materials Licenses Needing Radiological Contingency Plans",  
43 March 1981, at page 5.

1 can be safely studied at one of this nation's publicly-held  
2 comprehensive universities. See Licensee's Exhibit 14, ¶ 4. A  
3 specific example of the product of the TRUMP-S research project  
4 at the University of Missouri is provided in Attachment 6 of that  
5 exhibit. The experiment described in Attachment 6 was submitted  
6 for publication in the open literature within a few months of its  
7 completion. The work was done in the Alpha Laboratory at MURR  
8 under the subject amendments. Neptunium was the focus of this  
9 particular experiment; however, almost identical experiments have  
10 also been accomplished with uranium and plutonium. As described  
11 in the paper, some of the salient features are as follows:

- 12 • Approximately 1.1 grams of a salt "solution" containing  
13 approximately 1% NpCl<sub>3</sub> were used in the experiment.<sup>3/</sup>  
14
- 15 • Hence, the total Np used in a given experiment was  
16 approximately 0.008 grams.
- 17 • The experiments were conducted at a temperature of 400  
18 to 500 °C.
- 19 • The experiments were conducted in an inert argon  
20 atmosphere in which the monitored oxygen content was  
21 less than 0.1 ppm.

22 8. This then --the nature of the intended work-- is one of  
23 the major contexts in which such parameters as release fractions  
24 must be discussed. When the TRUMP-S Review Panel proposes  
25 release fractions resulting from invoking large amounts of  
26 plutonium (or other actinides), large quantities of combustibles,  
27 and involvement of flammable solvents, it should be readily  
28 apparent that these conditions lie far beyond the context of the  
29 TRUMP-S research at Missouri in both scale and experimental  
30 theater. Such arguments should, like an ether, disappear from  
31 these proceedings, for they have no substance or weight.

32 9. The other major context is the Alpha Laboratory itself  
33 and the many safety features associated with it. The latter has  
34 been extensively discussed by Licensee throughout this  
35 proceeding. Again the Intervenor rejects this context and would  
36 have the Presiding Officer believe that no credit can be taken  
37 for the fact that the milligram-scaled experiments, exemplified  
38 by Attachment 6 of Licensee's Exhibit 14, are conducted in a  
39 purified inert atmosphere in redundantly-filtered, redundant  
40 envelopes of confinement. It should be obvious that the Alpha  
41 Laboratory's safety features, along with the scale of the  
42 experiments, the benign experimental methods, the high technical

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43 <sup>3/</sup> This salt solution is not flammable. In fact it could be  
44 used to extinguish a pyrophoric metal fire.

1 and ethical quality of the Licensee's staff, and not in the  
2 least, the natural instinct for self preservation, are all  
3 factors working in concert to assure the public safety.

4 10. A fire in the Alpha Laboratory is a very unlikely event  
5 due to the scarcity of combustible materials. Flammable solvents  
6 are not used, and the experiments are conducted in a purified and  
7 monitored inert gas atmosphere making the glove box an even more  
8 unlikely origin for a fire. However, if a fire were to occur, it  
9 would be detected almost immediately --especially if it  
10 implicated the glove box-- and would be extinguished within  
11 minutes. The MURR is continuously staffed by licensed reactor  
12 operators who monitor the Alpha Laboratory remotely and  
13 physically check it during their frequent routine patrols of the  
14 facility. These operators have been trained specifically  
15 regarding emergency response to the Alpha Laboratory.

16 11. The TRUMP-S Review Panel (and its key members) has now  
17 filed three declarations: June 12, 1990;<sup>4/</sup> October 15, 1990  
18 (Intervenors' Exhibit 1); and, December 24, 1990 (Intervenors'  
19 Exhibit 20). The Panel members have discussed release fractions  
20 in each of these declarations and in so doing have repeatedly  
21 misrepresented the issue as it applies to the TRUMP-S research at  
22 MU. The misrepresentations seem to fall into one or more of  
23 three basic categories: 1) they make statements that are  
24 factually incorrect; 2) they make improper use of information  
25 reported by authorities working in the field; and, 3) they invoke  
26 conditions that are not possible at the MURR Alpha Laboratory.

#### 27 Factually Incorrect Statements

28 12. Some examples of factually incorrect statements made by  
29 the TRUMP-S Review Panel in Intervenors' Exhibit 20 are as  
30 follows in ¶¶ 13-27 below.

31 13. At ¶ 11, the Panel, while protesting Licensee having  
32 pointed out (See Lic. Exh. 3, ¶¶ 19-23) the Intervenors' improper  
33 utilization of the Chernobyl fire as a basis for comparison,  
34 states:

35 "Furthermore, we find it strange that the Applicant would  
36 repeatedly attempt to characterize our discussion of release  
37 fractions as an attempt to misapply Chernobyl, when there is  
38 no such discussion whatsoever in our October declaration and  
39 the sole reference to Chernobyl in our June declaration was  
40 to show that the Applicant's assertion of something magical

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41 <sup>4/</sup> The June 12, 1990, declaration was jointly filed by James C.  
42 Warf and Daniel O. Hirsch who are two members of the TRUMP-S  
43 Review Panel.



1 about plutonium release such that it could never be greater  
2 than  $10^6$  was demonstrably wrong."

3 14. The careless disregard for the facts in just this one  
4 sentence is alarming. First, contrary to the Panel's statement,  
5 there is a discussion of Chernobyl in the Panel's October  
6 declaration (See page 11 of the "Critique of the TRUMP-S  
7 Process").5/ In fact the Panel, in October, states that their  
8 purpose in discussing Chernobyl is to "demonstrate the  
9 qualitative similarity", presumably with the TRUMP-S project.  
10 Licensee believes there exists neither a qualitative nor  
11 quantitative similarity between the TRUMP-S research at MU and  
12 the Chernobyl fire. Second, the Panel misrepresents its previous  
13 intent, in June and October, when it states, in December, that  
14 its reference to Chernobyl was something other than an attempt to  
15 establish 3% as the release fraction which it maintains, at a  
16 minimum, should apply to the MU TRUMP-S project.6/2/ Third,

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17 5/ The TRUMP-S Review Panel seem to be suggesting in ¶ 11 of  
18 Intervenor's Exhibit 20 that, in filing a declaration in  
19 October, they should not be accountable for the one filed in  
20 June. Licensee disagrees. In June, the panel-to-be,  
21 quoting NUREG-1250 ("A Report on the Accident at the  
22 Chernobyl Nuclear Power Station, Revision 1"), at pages A17-  
23 18, ¶ 8, proposed 3% as a minimum release factor for the  
24 TRUMP-S work at MU. The use of 3% persists in the Panel's  
25 October Declaration (see, for example, ¶ 75 and Table III).

26 6/ The necessity to minimize the Panel's reliance on Chernobyl  
27 is likely the result of the November 16, 1990, Memorandum  
28 and Order (Dissolution of Stay), at page 8, where the  
29 Presiding Officer states: "Indeed, based on what I now  
30 know, the use of Chernobyl for comparison seems highly  
31 inappropriate here." This is exactly correct, and  
32 apparently the TRUMP-S Review Panel now realizes how absurd  
33 its comparison was. Hence, it has "found" a new authority  
34 for their 3% release fraction. However, as will be shown  
35 subsequently in this affidavit, the Panel has grossly  
36 misrepresented this "new" authority.

37 7/ Attachment C to Int. Exh. 20 protests the Presiding  
38 Officer's statement appropriately holding the Panel  
39 accountable for its statements and arguments. In Attachment  
40 C, Warf maintains that "[t]he Intervenor's mentioned the  
41 Chernobyl disaster only in a cursory manner...." In fact,  
42 the Panel obtained (incorrectly --but that is another  
43 matter) the 3% release fraction, that they used in  
44 subsequent arguments, from NUREG-1250 dealing with Chernobyl  
45 (see note 5). Obtaining a release fraction, which was

(continued...)

1 contrary to the Panel's statement, the Licensee has never  
2 asserted that there is "something magical about plutonium release  
3 such that it could never be greater than  $10^6$ ". Int. Exh. 20, ¶  
4 11. To suggest otherwise falsifies the record and should not be  
5 tolerated.

6 15. Other examples of documentable, factually-incorrect  
7 statements made by the TRUMP-S Review Panel regarding release  
8 fractions can be found in ¶ 50. Here the Panel states:

9 "Dr. Morris now seems to be claiming that his release  
10 fraction of  $10^6$  in his accident 'summary' was meant to be a  
11 combination of two different  $10^3$  factors --one for [the]  
12 amount of material made airborne, the second for the amount  
13 that escapes through an operational HEPA filter."

14 16. This statement misrepresents the derivation of the  $10^6$   
15 factor which is explained in ¶¶ 33 through 37 of Licensee's  
16 Exhibit 3, on pages 43 and 44, and again on pages 53 and 54, of  
17 Licensee's Written Presentation (November 14, 1990). These  
18 discussions clearly show that the factor is a combination of two  
19 conservative factors, one  $10^4$  and the other  $10^2$ . While the  
20 product is the same as two  $10^3$  factors, the meaning is different.  
21 The conservative nature of each these factors is fully developed  
22 in these discussions.

23 17. The statements made in ¶ 50 by the Panel regarding  
24 NUREG 1140 are also misleading, leaving the reader to conclude  
25 that the analysis in this document is not based on conservative  
26 factors. Fortunately, there is no need to speculate about this  
27 point. The Presiding Officer is directed to pages 16-18, of  
28 NUREG-1140, Section 2.1.5.1 entitled "A Discussion of the  
29 Conservatism in the Calculations"; and to Section 2.1.5.2, pages  
30 18-19, entitled "Nonconservative Factors". In addition, the  
31 relevance of NUREG-1140 has been thoroughly discussed by Dr.  
32 Langhorst in ¶¶ 8 through 32 of Licensee's Exhibit 2. The  
33 conservative nature of NUREG-1140 is specifically discussed in ¶¶  
34 15 through 19. Id. These two sections from NUREG-1140 and  
35 Dr. Langhorst's discussion leave no doubt that radiation doses  
36 derived from NUREG 1140 are conservative. One of the  
37 introductory paragraphs of Section 2.1.5.1 states:

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38 Z/(...continued)

39 ultimately utilized to miscalculate airborne actinide  
40 concentrations can hardly be characterized as "cursory use".

41 B/ Dr. Langhorst expands on this subject in Lic. Exh. 16 at ¶¶  
42 8-17.

1 "The doses calculated in this Regulatory Analysis  
2 [meaning NUREG-1140] have been conservatively  
3 calculated. Doses to people near a plant experiencing  
4 a severe accident are likely to be far below the doses  
5 in this analysis, probably by an order of magnitude or  
6 more, except in very unusual circumstances. The  
7 accident history of such facilities in the U.S. is that  
8 there is no known case of a member of the public  
9 receiving even as much as 1% of the doses calculated in  
10 this analysis as the result of an accidental airborne  
11 release from any nonreactor facility. A number of  
12 factors which cause this analysis to be conservative  
13 are discussed below." (Emphasis added)

14 18. Finally, the release fraction of 0.007 referred to by  
15 the TRUMP-S Review Panel, in Int. Exh. 20, ¶ 50, apparently comes  
16 from Section 2.3.1.2 of NUREG-1140, specifically from the  
17 subsection entitled "Nonvolatile elements in flammable liquids"  
18 on pages 76 and 77. This factor applies to cerium burning with a  
19 flammable solvent and subsequently heated with a propane torch.  
20 As previously discussed in Licensee's Exhibits 3, 4 and 5  
21 flammable solvents are not used, nor would Licensee use a propane  
22 torch to increase entrainment of actinide particles.  
23 Consequently, this scenario is not credible. Licensee, in  
24 referring to release fractions from NUREG-1140 for the actinides,  
25 used the value of 0.001 which can be found in Table 13, page 80.  
26 This factor is deemed to be conservative by the authors of NUREG-  
27 1140. In Section 2.1.5.1.2, "Worst-case release fractions", they  
28 state:

29 "The release fractions due to fires (the accidents with  
30 highest potential release) were determined from experiments  
31 designed to maximize releases. In such experiments a finely  
32 powdered material is typically placed on top of a large  
33 amount of combustible material. Having the entire licensed  
34 inventory unenclosed on top of a large quantity of  
35 combustible material would be most unusual. Radioactive  
36 materials are usually within shielded 'pigs' and kept in  
37 metal safes or well shielded hot cells or glove boxes.  
38 Amounts of combustible materials present are generally kept  
39 low." Emphasis added.

40 Certainly 0.001 is a very conservative release fraction in the  
41 context of the actinide experiments at the MURR, since Licensee  
42 will NOT burn the inventory in finely divided form with an  
43 abundance of combustible material.

44 19. The TRUMP-S Review Panel has revisited the Seehars and  
45 Hochrainer report in ¶¶ 54 and 55 of Intervenor's Exhibit 20.  
46 Several points must be made to correct the Panel's misstatements.

1           20. First, the TRUMP-S Review Panel states in ¶ 54: "(he  
2 [referring to Morris] claimed it [referring to the Seehars and  
3 Hochrainer report] showed a maximum release fraction of  $5 \times 10^{-5}$   
4 for open air burning)". In fact, as shown below (¶¶ 23-25), I  
5 did not make that claim. Also, in ¶ 54, in referring to my  
6 citation of the  $5 \times 10^{-5}$  release factor, the Panel inaccurately  
7 states "[h]e picked the smallest number again". In fact this is  
8 not true. Of the 32 plutonium experiments 2/ reported by  
9 Seehars and Hochrainer, 13 had release fractions that were less  
10 than  $5 \times 10^{-5}$ . As is their custom, the Intervenors have altered  
11 the record to suit their purpose.

12           21. Second, the experiments done by Seehars and Hochrainer  
13 involved subjecting plutonium materials to kerosene fires.  
14 Depending on the precise conditions and materials used, the  
15 release fractions from individual experiments varied from  
16  $-0.00001$  to  $-0.001$ . No credit was taken for containment or  
17 filtration in the determination of release fractions from these  
18 experiments. The release is totally dependent on the  
19 availability of fuel --in this case kerosene-- which was  
20 continuously supplied for the entire duration of the burn (15-30  
21 minutes). Likewise, oxygen is required in the Seehars and  
22 Hochrainer experiments and it too was continuously supplied. My  
23 point, as I described it in detail in Lic. Exh. 3 at ¶¶ 38-50, is  
24 that there is no significant or continuous supply of fuel in the  
25 TRUMP-S glove box. There are no flammable liquids such as  
26 kerosene which is a worst-case fuel because of the large fraction  
27 of aerosol (soot) produced when burned. Nor is there adequate  
28 oxygen to burn anything. Even if the oxygen-starvation were  
29 lost, there is still no significant amount of fuel. Certainly  
30 the 0.001 release fraction prescribed by NUREG-1140 is at the  
31 conservative end of the range of results reported by Seehars and  
32 Hochrainer.

33           22. Seehars and Hochrainer have also reported on outdoor  
34 burning experiments using  $CeO_2$  as a surrogate for plutonium.  
35 These experiments provide a useful comparison to corresponding  
36 accident scenarios given in NUREG-1140. In these experiments,  
37 Seehars and Hochrainer burned the material in kerosene and the  
38 airborne concentrations of  $CeO_2$  were measured between 100 to 1000  
39 meters from the burn site. The fraction of inhaled fine dust  
40 resulting from a 4 minute fire was reported as ranging from  
41  $1.5 \times 10^{-11}$  to  $1.3 \times 10^{-12}$  for distances ranging from 100 to 1000  
42 meters, respectively. These inhaled fractions can be adjusted to  
43 correspond to a NUREG-1140 accident scenario. In NUREG-1140, the  
44 release fraction for plutonium and the other actinides is given

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45     2/ The experimental variables in the plutonium experiments  
46     were: type of sample, type of fire, duration of the burn,  
47     and sampling time.



1 as 0.001. The intercept fraction --defined as the maximum  
2 fraction inhaled in an accident-- is given as  $1 \times 10^{-6}$  at 100  
3 meters for a 30 minute fire. Hence the product of the release  
4 fraction and the intercept fraction corresponds to what Seehars  
5 and Hochrainer have referred to as an inhaled fraction. At 100  
6 meters the product from the NUREG-1140 data is  $1 \times 10^{-9}$  for a 30  
7 minute fire and can be compared to  $1.1 \times 10^{-10}$  10/ for Seehars  
8 and Hochrainer. Therefore, one can see that NUREG-1140  
9 overestimates the inhaled fraction by approximately a factor of  
10 ten as compared to the Seehars and Hochrainer experiments,  
11 demonstrating the conservative nature of the NUREG-1140 accident  
12 scenario assumptions.

13 23. In support of the first point (§ 20 above), the  
14 Presiding Officer is referred to §§ 16-18 of Licensee's Exhibit  
15 3. In § 16 I discussed those plutonium experiments designed by  
16 the authors to mimic what might happen if plutonium materials  
17 from fuel reprocessing or fabrication were to become involved in  
18 a fire fueled by kerosene spillage resulting from an airplane  
19 crash on the plutonium facility. I stated:

20 "In the context of the May 30, 1990 meeting, I utilized the  
21 Seehars and Hochrainer Report, not as a principal authority,  
22 but instead to make the single point that even under  
23 conditions of open burning, fueled by flammable liquids and  
24 without benefit of containment or filtration, release  
25 fractions have been observed to be quite small,  
26 i.e.  $5 \times 10^{-5}$ . I was particularly interested in the short-  
27 duration release, for which the  $5 \times 10^{-5}$  release factor was  
28 obtained, because credible fires in the Alpha Laboratory  
29 would be of short duration due to the absence of significant  
30 fuel." Id.

31 24. This passage has been "revised" by the TRUMP-S Review  
32 Panel in Int. Exh. 20 at § 54, to state:

33 "(he [referring to Morris] claimed it [referring to the  
34 Seehars and Hochrainer report] showed a maximum release  
35 fraction of  $5 \times 10^{-5}$  for open air burning)".

36 25. It is obvious that the meanings of these two passages  
37 are entirely different. In my affidavit I described the origin  
38 of the  $5 \times 10^{-5}$  factor (a short duration fire) and why I thought  
39 that factor was relevant to the Alpha Laboratory. I did not  
40 claim it was the maximum release fraction shown in the report.

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41 10/ This value is derived by :  $1.5 \times 10^{-11} \times 7.5 = 1.1 \times 10^{-10}$ .  
42 The 7.5 factor converts the 4 minute fire in Seehars and  
43 Hochrainer to correspond to the 30 minute fire assumed in  
44 NUREG-1140.

1 Intervenor's are free to disagree with me concerning the  
2 applicability of the factor for a short duration fire; however,  
3 they do not have license to take statements by or on behalf of  
4 Licensee, maliciously alter their meanings --as well as the  
5 record, and leave the Licensee the tedious task of correcting and  
6 documenting the record.

7 26. In ¶ 55 (Int. Exh. 20), the Panel suggests that release  
8 fractions should be scaled according to the duration of the fire.  
9 As explained above there is no justification for this based on  
10 the type, availability, and continuity of fuel in the Alpha  
11 Laboratory, and especially the glove box. Furthermore, the  
12 experiment reported by Seehars and Hochrainer 11/ that the  
13 Panel wants to "scale" from 2% to 5% is described by the authors  
14 in the following manner:

15 "A few minutes after the fire was ignited, the kerosene in  
16 the fire dish [the CeO<sub>2</sub> is submerged in the kerosene] began  
17 to boil rapidly; the bubbles breaking at the liquid surface  
18 may lead to the release of CeO<sub>2</sub>. The CeO<sub>2</sub> within the  
19 kerosene was subjected to severe swirling."

20 There are two obvious points: 1) a significant, if not dominant,  
21 fraction of the CeO<sub>2</sub> released may have been mechanical, i.e.,  
22 thrown out by the rigorous boiling, precluding that fraction from  
23 being released as part of the aerosol soot; and 2) this scenario  
24 requires not only there be kerosene in the Alpha Laboratory glove  
25 box (which there is not), but also that the plutonium be  
26 submerged in that kerosene while being boiled and burned. This  
27 experiment, like Chernobyl and the burning B-52 with warheads  
28 (See ¶ 33), is not under consideration by the Licensee.

29 27. In summary, as I have stated above in ¶ 23, I have not  
30 relied on Seehars and Hochrainer as a principal authority in that  
31 their kerosene-fueled fires bore no resemblance to credible fires  
32 that could occur in the Alpha Laboratory. However, their outdoor  
33 burning experiments using CeO<sub>2</sub> do support the conservative  
34 assumptions used in NUREG-1140.

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35 11/ In this experiment CeO<sub>2</sub> was being used as a surrogate for  
36 plutonium. The CeO<sub>2</sub> was immersed in kerosene, the kerosene  
37 heated to its flash point and ignited, and then kerosene was  
38 continually added at a rate of 5 mL/minute to sustain the  
39 fire. Total dust was being measured in this experiment  
40 which would include the non-breathable fallout. Fine dust  
41 fractions, which were substantially less, were measured by  
42 these workers in subsequent experiments.

1 Improper Use of Authorities:

2 28. In ¶ 51 of Intervenors' Exhibit 20, the Panel claims  
3 that:

4 "an examination of the literature indicates that the 0.001  
5 figure used by NUREG-1140, and now apparently adopted by Dr.  
6 Morris for the release if the escape is not via the HEPA  
7 filters, is an average value for numerous experiments under  
8 varying conditions."

9 The Panel is apparently relying on an unpublished report by  
10 Condit,<sup>12/</sup> which, as I show below, the Panel uses improperly.  
11 However, there is an additional basic error in this sentence.  
12 The 0.001 figure used in NUREG-1140 is not an "average value."  
13 As I show in ¶ 18 above, 0.001 is a conservative release fraction  
14 "determined from experiments designed to maximize releases."

15 29. In ¶ 51, the Panel, attributing Condit, states:

16 "they [meaning release fractions] varied over about six  
17 orders of magnitude, with the average value being about  
18  $10^{-3}$ ."<sup>13/</sup> (Emphasis added by the TRUMP-S Review Panel)

19 Toward the end of ¶ 51, after a meandering discussion of  
20 parameters affecting release fractions, the Panel states:

21 "To average these various experiments is obviously  
22 inappropriate for conservative safety analysis attempting to  
23 estimate release fractions from a major fire"

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24 <sup>12/</sup> Condit, Ralph H., "Plutonium Dispersal in Fires: Summary of  
25 What is Known", (Livermore, CA: Plutonium Technology  
26 Section, Chemistry and Materials Science Department,  
27 Lawrence Livermore National Laboratory, October 1986).

28 <sup>13/</sup> The actual quotation from Condit at page 13 of his paper is:

29 "It can be seen that the median aerosol fraction is  
30 around  $6 \times 10^{-4}$  with steps of standard deviation from  
31 this being roughly a decade on the logarithmic  
32 ordinates. Thus, if we know nothing about the source  
33 term for burning plutonium this provides us with  
34 statistical guidance."

35 Not surprisingly the TRUMP-S Review Panel has altered the  
36 author's actual statement and completely ignores the context  
37 in which the author's words apply, i.e., the source term  
38 determines the release fraction.

1 30. In this paragraph the Panel has "answered" an argument  
2 that the Licensee has never made and in so doing has improperly  
3 utilized Condit. Nowhere has Licensee suggested that release  
4 fractions, resulting from different experimental designs, should  
5 be averaged. Licensee's point, and Condit's point, is that the  
6 source term must be considered. For example, applying release  
7 fractions resulting from the Chernobyl fire to the TRUMP-S  
8 experiments at MURR is conservative but not credible. In fact,  
9 since the source term in the actinide experiments at the MURR is  
10 precisely known to be very small, and the laboratory environment  
11 is intentionally over-compensated by large margins, release  
12 fractions even as low as  $10^{-6}$  are both conservative and credible.

13 31. The TRUMP-S Review Panel's misrepresentation of  
14 scientific authorities continues in §§ 52 and 53 of Intervenors'  
15 Exhibit 20. In § 52, the Panel claims that both Dr. Morris and  
16 Dr. Krueger cite Hilliard 14/ as stating:

17 "no significant inhalation hazard would be produced at 200  
18 yards and beyond as the result of burning several kilograms  
19 of the metal"

20 The Panel is again mistaken. Morris and Krueger did not cite  
21 Hilliard for that statement. Hilliard did not make that  
22 statement. Morris 15/ and Krueger 16/, like Hilliard  
23 before them, properly attributed that conclusion to Stewart  
24 17/. On the surface this error by the TRUMP-S Review Panel in  
25 referencing the literature seems harmless enough. It is,

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26 14/ Hilliard, RK. "Characteristics of burning plutonium", HW-  
27 77531, April 23, 1963.

28 15/ See Morris Affidavit, "Regarding Errors in Petitioners'  
29 Analyses", at § 6, June 14, 1990; and, Licensee's Exhibit 3,  
30 at §§ 17 and 23.

31 16/ Licensee's Exhibit 6, at §§ 5 and 6, November 14, 1990.

32 17/ Citation of Stewart by Hilliard is:

33 K. Stewart. "Experiments to study the release of  
34 particulate material during the combustion of  
35 plutonium, uranium and beryllium in a petrol fire",  
36 AWRE-T-1560.

37 Citation of Stewart by Morris and Krueger is:

38 K. Stewart. "The particulate material formed by  
39 oxidation of plutonium", Progress in Nuclear Energy,  
40 Pergamon Press, New York, 1963. Series IV, Vol 5.



1 however, again indicative of the careless nature of their  
2 approach.

3 32. There are more serious problems with statements made by  
4 the Panel in ¶ 52. For example, in referring to Stewart's  
5 conclusion stated above, the Panel speculates wildly, and without  
6 offering a shred of evidence, that Stewart's statement is not  
7 reliable and that he means something different than what he says  
8 explicitly. As thoroughly discussed in Lic. Exh. 6, and  
9 specifically in ¶¶ 5-14, Mishima, a leading authority with regard  
10 to plutonium release fractions, quotes the Stewart conclusion, in  
11 agreement, in his 1964 review 18/. Furthermore, there is  
12 nothing in Mishima's work a decade later that would lead one to  
13 believe that he did not still support Stewart's conclusion. For  
14 example, see ¶ 13 of Lic. Exh. 6. In addition, Condit -- on pages  
15 15 and 16 of the 1986 report cited by the TRUMP-S Review Panel,  
16 (See note 12) -- using the data taken in the 1959 Vixen A  
17 experiments in Australia 19/, estimates that the relative risk  
18 of a latent cancer death resulting from standing approximately  
19 100 meters downwind from the burning plutonium (data are  
20 normalized for 1 kilogram) for the entire period of the burn is  
21 less than 1.0001. By comparison, the unexposed person would have  
22 a relative risk of 1. It should be noted that a risk factor so  
23 small can be statistically estimated, but would be virtually  
24 impossible to actually measure. Furthermore, in an actual  
25 emergency, persons at the scene would expeditiously move out of  
26 the path of the combustion products as a result of their common  
27 sense or by action of emergency response teams. Hence the  
28 relative risk of subsequent health problems would be reduced even  
29 further.

30 33. The reference in Int. Exh. 20, ¶ 52, to the remarks of  
31 Dr. Roger Batzel 20/ is very misleading. The actual  
32 discussion at the hearing centered around arguments for funding  
33 the modernization of nuclear warheads, in particular, the use of  
34 "insensitive high explosives" instead of the current practice of  
35 using "sensitive high explosives" in some systems. Dr. Batzel  
36 made the comparison to Chernobyl in connection with an aircraft

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37 18/ Mishima, J. "A Review of Research on Plutonium Releases  
38 during Overheating and Fires", HW-83668, 1964.

39 19/ Like the British experiments reported by Stewart, the Vixen  
40 A experiments utilized open air burning of plutonium without  
41 filtration or containment. Both the British and Australian  
42 experiments were either accomplished with or normalized to  
43 kilogram quantities of plutonium.

44 20/ Energy and Water Development Appropriations for Fiscal Year  
45 1988, Hearings before a Subcommittee on the Senate  
46 Appropriations Committee, 74-239, p. 1135-6.

1 fire (B-52 in Grand Forks, ND) that "burned for hours". Had the  
2 wind been blowing differently as that fire burned, Dr. Batzel  
3 says, "the sensitive high explosives which are in those  
4 particular warheads would have detonated." The Panel  
5 conveniently omitted the context in which Dr. Batzel's remarks  
6 were made. This kind of scenario clearly does not apply to the  
7 MURR activities. It now seems --that after being criticized by  
8 the Licensee for comparing Chernobyl to TRUMP-S at MURR, and also  
9 after learning that the Presiding Officer is far from being  
10 convinced that the comparison is valid-- the TRUMP-S Review Panel  
11 has now vacated the Chernobyl comparison in favor of the burning  
12 B-52 bomber carrying nuclear warheads comparison.

13 34. In § 53 of Int. Exh. 20 the Panel suggests that Krueger  
14 and I fail to "quote the actual release fraction measurements  
15 cited by Hilliard". This is not true. I properly quote the  
16 release fraction as 0.0005 (0.05%) in my June 14, 1990, affidavit  
17 at § 3 and again in Licensee's Exhibit 3, at §§ 17 and 23; and  
18 Krueger does so in Licensee's Exhibit 6, at § 5.

19 35. The Panel's suggestion that the release fraction should  
20 be 1 or 3 percent relies upon the weight loss data, not the  
21 aerosol release fraction. The exact data table given by Hilliard  
22 is as follows:

23 "TABLE II  
24 THE RELEASE OF PuO<sub>2</sub> IN A GASOLINE FIRE<sup>(7)</sup>

Method of Calculating Release	Per Cent Released From Chimney	
	Test 1	Test 2
Weight Loss	1	3
Integration of Deposition Contours	0.1	0.9
Integration of Air Con- centration	(a)	0.0035

32 (a) Insufficient data"

33  
34 The "(7)" in the table title line refers to Stewart in Hilliard's  
35 reference list.

36 36. Hilliard, quoting Stewart, continues by stating:

37 "The experimenters concluded that 'no significant inhalation  
38 hazard would be produced at 200 yards and beyond as the  
39 result of burning several kilograms of metal.' They also  
40 concluded that:

1. the release was fairly constant during heating, certainly not being limited to the beginning or end;
2. up-drafts swept particles to >300 feet elevation, the maximum height at which sampling was conducted;
3. possibly the lower release obtained in the first test was caused by the higher temperature -- a hard, adherent oxide layer was formed as opposed to the loose fragments produced in the second test; and,
4. 0.05 per cent release is a satisfactorily safe value to use for estimating the airborne hazard downwind from a fire involving plutonium. Emphasis added.

Conclusion 4, i.e., the release fraction of 0.0005 (0.05%), was precisely the value reported by Krueger and me in the previously referenced exhibits.

37. The Panel would like to use 3% as the release fraction, and they would like us to believe that Stewart --even though they seem to believe that the work is Hilliard's-- was their original authority for the three percent, not Chernobyl. As shown above, this is nonsense. Furthermore, it is wrong. Hilliard, referring to Table II (as reproduced above), states:

"The low figure [meaning 0.000035 (0.0035%)] obtained by air sampling is not anomalous; much of the released material was of particulate size sufficiently large to settle and deposit within the 500 yards radius."

38. This obviously means that the 1 and 3% weight loss data for tests 1 and 2, respectively, includes that fraction (most of it) that falls out in the immediate proximity of the burn site. The respirable fraction is approximated by 0.000035 and conservatively represented as 0.0005 by the author in his conclusion 4 as cited above in my ¶ 36.

39. In ¶ 56 (Int. Exh. 20), the Panel refers to the Schwendiman experiments discussed in Lic. Exh. 3 at ¶¶ 25-32 as "mere overheating" of plutonium metal. In reality the plutonium metal was undergoing a spontaneous exothermic chemical oxidation. Plutonium was being converted from Pu metal to PuO<sub>2</sub> (plutonium dioxide). When the same phenomenon occurs for the carbon contained in wood or coal, this spontaneous exothermic oxidation producing CO<sub>2</sub> (carbon dioxide) is referred to as burning, not overheating.

1 40. Continuing in §§ 56 and 57, the Panel states that the  
2 "most important" Mishima and Schwendiman work is "not cited by  
3 the University". This, of course, is not true. Krueger  
4 discussed these papers in Lic. Exh. 6 at §§ 5 and 12 and in note  
5 2. Paragraph 12 is repeated here in rebuttal to Int. Exh. 20, §  
6 57.

7 Lic. Exh. 6 at § 12: "In 1973, Mishima and Schwendiman  
8 (Warf's reference 15) considered the inadvertent burning of  
9 scrap and waste materials. They used uranium (as a stand-in  
10 for plutonium) in cartons of flammable waste containing  
11 cardboard, paper, plastic, etc. In their summary, they  
12 state: 'Measured airborne concentrations [within the 9.5  
13 ft. diameter by 10 ft. tall enclosure, CLK] indicated  
14 relatively low fractional releases ranging from 0.05 to  
15 0.003 percent of the uranium used as the source.' They do  
16 point out their previous result (Warf's reference 13) that,  
17 not surprisingly, 'As much as 40 percent of uranium dioxide  
18 powder on [burning, CLK] tissue paper was entrained at a  
19 nominal [air CLK] velocity of 100 cm per sec.' Unlike  
20 Professor Warf, they do not suggest that this [Mishima and  
21 Schwendiman's 'entrained', Warf's 'lofted', CLK.] material  
22 should be interpreted as a likely loss to the environment."

23 Therefore, a more accurate representation of this work by Mishima  
24 and Schwendiman is that large fractions of uranium can be  
25 entrained with the ash of high ash-producing substrates when  
26 burned in that fashion. However, the authors do not represent  
27 this entrainment as a likely loss to the environment. This is a  
28 moot point in that Licensee's utilization of the actinide  
29 elements does not produce a Kleenex, cheesecloth or corrugated  
30 cardboard substrate, impregnated with plutonium, or other  
31 actinides, which would then be burned without containment or  
32 filtration.

33 41. In § 58 21/ (Int. Exh. 20), the Panel seems to be  
34 invoking that both transuranic metals and an assortment of other  
35 materials --of the type discussed in § 57 (Id.)-- are available  
36 in ample supply to create a situation where all of the actinide  
37 inventory becomes airborne. Neither of the Panel's assumption  
38 is correct, nor is its conclusion.

39 42. In § 59 (Int. Exh. 20), the Panel submits that "in the  
40 real world...release of many tens of percent must be assumed".  
41 Licensee not only disagrees with how the "real world" is to be  
42 defined insofar as the Alpha Laboratory and the MURR TRUMP-S  
43 experiments are concerned; but also, Licensee will point out that  
44 the Panel ignores "real world" accidents. For example, the  
45 release fraction from the 1969 "real world" fire at the Rocky

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46 21/ Misnumbered as § 59 by the TRUMP-S Review Panel.



1 Flats plutonium plant --which did have multiple fuel components  
2 including both Pu and other combustibles-- was not 50%, 10 % or  
3 even 1%. It was  $10^{-6}$  % (release fraction of  $10^{-8}$ ), or less (§ 53  
4 below).

5 43. This tactic of improperly using weight loss data to  
6 represent release fractions was used before by the Panel. It did  
7 the same thing with the Schwendiman 22/ report. Licensee has  
8 already discussed this fraudulent approach in Licensee's Exhibit  
9 3, at §§ 25-32. Licensee recently (January 8, 1991) provided the  
10 Presiding Officer a copy of the Schwendiman paper. Referring to  
11 Table I of that report and §§ 28-31 (Id.), one can see how the  
12 Panel arrived at the fictitious release fraction of 2.6%.

13 44. In summary, in all three of its declarations, the  
14 TRUMP-S Review Panel has, with very little reluctance,  
15 misrepresented authorities that have reported and reviewed  
16 release fraction data.

#### 17 Inappropriate Comparisons to the Alpha Laboratory

18 45. The nature of the TRUMP-S research at Missouri is  
19 reviewed in § 7 above. As explained, the scale of the MURR  
20 experiments is orders of magnitude below the threshold of  
21 quantities of practical interest. Likewise the benign nature of  
22 the experiments --i.e., a non-combustible salt mixture, in a non-  
23 aqueous system, in a purified inert atmosphere -- contribute  
24 significantly to the overall safety of the project.

25 46. The TRUMP-S Review Panel tends to ignore these  
26 attributes and places no limits on what it will present for  
27 comparison. Chernobyl and the burning B-52 bomber are but the  
28 most glaring mismatches as compared to the MURR research. The  
29 other examples also fail in their comparison to the actinide work  
30 at the MURR for one reason or another. Frequently the reason is  
31 that large amounts of combustibles or flammable solvents are  
32 involved in these examples. As I mentioned in Lic. Exh. 3 at §  
33 22, and Krueger in Lic. Exh. 6 at § 16, the critique supplied by  
34 Warf does not support the Intervenors' claims that percentage  
35 release fractions, ranging from single to double digits, apply to  
36 the research at MURR. These irrelevant comparisons have been  
37 repeated in Int. Exh. 20. See §§ 57 and 88. For example, the  
38 large release fractions require that finely divided plutonium  
39 compounds be burned on tissue paper, or some other ash-producing  
40 combustible. Not surprisingly, the buoyant ash carrying the

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41 22/ Schwendiman LC, et.al., "Airborne release of particles in  
42 overheating incidents involving plutonium metal and  
43 compounds", Battelle Northwest Laboratory, BNWL-SA-1735,  
44 August 1968.

1 plutonium is entrained in large quantities. This artificial  
2 condition does not exist in the Alpha Laboratory; however, even  
3 if it did, plutonium entrained in this manner is not respirable.  
4 In ¶ 88, the Panel quoting Mishima states that half of the  
5 actinide should be considered to be entrained as a conservative  
6 approximation if burned with ash-producing substrates. A careful  
7 reading of the paper clearly shows that by entrained, the author  
8 does not mean released or respirable.

9 47. Other experiments cited by the Panel at ¶¶ 57 and 88  
10 producing percentage release fractions also depend on one or more  
11 conditions --for example burning with flammable liquids or  
12 mechanical pre-entrainment-- that do not exist in the experiments  
13 being conducted in the MU TRUMP-S project.

14 48. The TRUMP-S Review Panel has also alleged that the  
15 literature demonstrates that the release fraction increases with  
16 the increasing burning time. This is also a misrepresentation of  
17 the literature. See conclusion 1, ¶ 36 above. Given a more or  
18 less constant release fraction, it is obvious that the integrated  
19 total material released will increase with the quantity in the  
20 source term. Likewise the size of the source term may affect the  
21 release fraction if it contributes significantly to the chemistry  
22 of the fire, i.e., if the source term were a significant fuel.  
23 Hence, scale must be considered. If the experimental quantity is  
24 small, as is the case of the MURR TRUMP-S experiments, it cannot  
25 be a significant fuel. As has been shown in this affidavit and  
26 also in Lic. Exh. 3 at ¶ 42, the TRUMP-S experiments at MURR do  
27 not involve amounts of the actinides, in the right chemical form,  
28 in an oxidizing atmosphere, sufficient to credibly propose that  
29 the actinide itself can serve as the fuel of a serious fire.  
30 Given this, the minimal fire loading both in and around the Alpha  
31 Laboratory, excellent fire prevention, a facility manned at all  
32 times, and trained emergency response assures that any fire in  
33 the Alpha Laboratory --however unlikely that event might be--  
34 would certainly be of very short duration. Likely the release  
35 fraction, due to any credible fire in the Alpha Laboratory, would  
36 be immeasurably small. Certainly there is no reason to believe  
37 that it is going to increase with time. The value,  $10^{-6}$ , used by  
38 Licensee is conservative.

39 49. It is difficult to know how to respond to Attachment B  
40 of Int. Exh. 20. This attachment was apparently prepared by Warf  
41 for incorporation by some means or another. In the first  
42 paragraph of Attachment B, Warf states:

43 "What would be the result of an accident in which the  
44 molten salt phase is exposed to air, or in which an  
45 explosion throws some of the melt into the air? There seems  
46 to be no literature on this topic, so only an inference can  
47 be made, based on a general knowledge of the chemistry of

1 plutonium and other actinides. In this short discussion the  
2 fission products are not taken into account."

3 Warf speculates what chemical species would be formed if air were  
4 to leak into the glove box, and either as a result of that, or by  
5 some other mechanism an explosion could occur. He concludes that  
6 "[o]xide chlorides and oxides would be formed in a state of extreme  
7 subdivision", and that "[t]he fraction of such respirable is  
8 likely to be high." Warf's discussion leaves much to be desired.  
9 It is possible, although not likely, that air could be introduced  
10 into the glove box during an experiment. However, it is not  
11 clear how that would lead to either a mechanical or chemical  
12 explosion. Licensee can postulate no such mechanism, and Warf  
13 did not provide an example of one. Additionally, as Warf states  
14 in § 2 of Attachment B, "[t]he molten LiCl/KCl phase contains  
15 some plutonium." In fact the actinide metal chloride is quite  
16 dilute, ~1 wt.%. Licensee knows of no evidence that supports the  
17 speculation that if air comes in contact with small amounts (~1  
18 gram) of this dilute solution, an explosion would, or even could,  
19 result. In all probability, nothing of consequence from the  
20 standpoint of safety significance would occur if air were to come  
21 in contact with the molten salt solution. As Warf points out,  
22 some  $\text{PuO}_2$  would likely be formed. Licensee agrees, and as a  
23 result this would end the collection of useful data for that  
24 particular experiment. The furnace would be turned off and the  
25 molten salt would cool and solidify, effectively encapsulating  
26 the actinide compounds in the small tantalum reaction tube.

27 50. Other than the intrusion of air into the glove box,  
28 Warf does not provide any other explanation as to what might  
29 cause an explosion, nor does he provide any insight as to the  
30 energy released. Does the explosion cause a loss of confinement  
31 by the glove box and/or the Alpha Laboratory? There is not a  
32 shred of evidence for either. In fact, the chemical system under  
33 study in the Alpha Laboratory is rather benign involving a non-  
34 combustible salt solution, with small amounts (milligrams in  
35 experiments to date) of actinide chloride in a completely inert  
36 atmosphere, circulating through HEPA filters in a closed loop.  
37 In summary, there is not much in the way of argument in Warf's  
38 Attachment B. That which is there is supported by no evidence,  
39 and has no merit.

40 51. In the last sentence of the same paragraph, Warf states  
41 that "fission products are not taken into account". That's  
42 generous, since there are no fission products involved in the  
43 MURR TRUMP-S experiments. Are the members of the TRUMP-S Review  
44 Panel so distant from the work actually being done at Missouri  
45 that they actually believe that it involves fission products, or  
46 that it is "qualitatively comparable" to Chernobyl, or that  
47 congressional testimony regarding a burning B-52 bomber carrying  
48 nuclear warheads could be even remotely related?

1 52. In summary, the TRUMP-S Review Panel has completely  
2 failed to make a case for the application of percentage-level  
3 release fractions to the MURR actinide research. In fact, the  
4 release fraction of  $10^{-6}$  that has been used by Licensee from the  
5 very beginning --and comprehensively discussed in Lic. Exh. 3 at  
6 ¶¶ 33-37-- is both conservative and credible in the context of  
7 the MURR research.

8 53. By comparison, such release fraction of  $10^{-6}$  is orders  
9 of magnitude greater than what actually occurred at the Rocky  
10 Flats fire in 1969. In that fire large quantities of plutonium  
11 were involved. The actual release of plutonium through a damaged  
12 exhaust system was reported as 856  $\mu\text{Ci}$  by one source 23/ and  
13 as 0.003 grams in NUREG-1140 giving a release fraction of  
14  $\sim 10^{-8}$  24/.

15 Licensee's Decision not to Install an Additional HEPA Filter

16 54. The TRUMP-S Review Panel asserts that "The February  
17 design for the glove box exhaust had two DOP-testable HEPAs in  
18 the exhaust line from the glove box, before it connected with the  
19 main exhaust line" and allege that "The University removed one of  
20 these." Intervenors' Exhibit 20, ¶ 47. Licensee assumes that  
21 the reference to the "February design" means the design described  
22 in the February 20, 1990 Application for Amendment to License  
23 No. SNM-247. The design of the glove box exhaust is described  
24 under Equipment Exhaust (p. 9) and depicted in Figure 3, "Alpha  
25 Laboratory Air Flow Diagram". The argon glove box system was  
26 installed in accordance with such description, and no HEPA filter  
27 was removed. There are two parallel sets of double HEPA filters  
28 (previously referred to in this proceeding as HEPA-3 and HEPA-4)  
29 in the "Final Filter Plenum". As committed to on Figure 3, these  
30 filters are "DOP tested in place". The single stage HEPA filter  
31 (previously referred to as HEPA-2) in "Filter Plenum #2," is also  
32 DOP testable in-place even though the application does not so  
33 require. The HEPA filter (previously referred to as HEPA-1) at  
34 the exit of the argon glove box before the Emergency Exhaust  
35 Valve was DOP tested (but is not testable in-place), even though  
36 the application does not so require. Licensee does not

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37 23/ See page 3-53, "Final environmental impact statement, Rocky  
38 Flats Plant Site", DOE-EIS-0064, April, 1980.

39 24/ NUREG-1140, Jan. 1988, at page 44. In Table II-12, "Long-  
40 lived alpha activity released from Rocky Flats", page 55,  
41 the airborne plutonium, over a six day period during and  
42 after the 1969 Rocky Flats fire, was given as 0.2  $\mu\text{Ci}$ .  
43 Therefore the fractional release of respirable plutonium was  
44 likely much less than  $10^{-8}$ .



1 understand the Panel's allegation about removal of a HEPA filter  
2 or the basis for such accusation.

3 55. The Panel and Intervenors raise a number of questions  
4 as to why, how and when Licensee made the decision not to install  
5 the additional HEPA filter recommended by Mr. Steppen. The Panel  
6 asserts that, although Licensee originally "agreed" to add the  
7 HEPA filter recommended by Mr. Steppen, it found out that a  
8 license amendment would be needed and decided to "cut corners"  
9 and go ahead with the neptunium experiments without the filter.  
10 Intervenors' Exhibit 20 at ¶ 47. They also complain that the IUS  
11 minutes (Licensee's Exhibit 8, Attachment 3) "indicate none of  
12 the 'analysis' he [Dr. Morris] later reported;" and allege that  
13 it was a "post hoc rationalization" after the issue was raised in  
14 this proceeding. Id. Intervenors additionally allege that "Dr.  
15 Morris implies that this decision was made prior to commencement  
16 of the experiments on the actinides," that this implication is  
17 belied by the minutes of the IUS meeting at which it was decided  
18 to proceed with neptunium only, and that none of the minutes  
19 reflect "the alleged safety decision." Intervenors' Rebuttal  
20 at 26. They also characterize my previous affidavit as stating  
21 that the decision was made by me "and three others" and they  
22 question what qualifications we had "to overrule Mr. Steppen."  
23 Id. at 26-27. They allege that the decision was made because of  
24 "fear of delay," not through some safety determination. Id.  
25 at 27.

26 56. The only substantive issue, of course, is whether the  
27 decision not to install the HEPA filter was sound. The soundness  
28 of that decision has been amply demonstrated in previous  
29 affidavits (Licensee's Exhibits 7 and 8) and is buttressed by Mr.  
30 Eschen's current response to the relevant portions of  
31 Intervenors' Rebuttal (Licensee's Exhibit 18). Although the  
32 peripheral questions raised by Intervenors are truly without  
33 safety significance, I cannot let their allegations and  
34 innuendoes go unanswered.

35 57. As I have previously testified, I participated in the  
36 decision with four (not three) members of the TRUMP-S working  
37 group, who are the MURR managers principally responsible for  
38 infrastructures such as design, engineering, operations and  
39 health physics, i.e., Dr. Susan Langhorst, Mr. Chester Edwards,  
40 Mr. Walter Meyer and Mr. Charles McKibben. Licensee's Exhibit 8  
41 at ¶ 8. Each of us have filed an affidavit in this proceeding  
42 that contains our resume. Our collective qualifications include  
43 two Ph.D's in science/engineering, two licensed professional  
44 engineers, one certified Health Physicist, three NRC Senior  
45 Reactor Operator licenses, and, collectively, a century of  
46 experience working with radioactive materials and reactors. Our  
47 collective backgrounds and intimate knowledge of the Alpha  
48 Laboratory and MURR Facility eminently qualified us to make this  
49 decision. I never "implied" that the decision was made prior to

1 commencement of experiments with actinides. I testified that the  
2 decision was made on or around August 9, 1990 (August 23 Morris  
3 Affidavit at ¶ 5), which was after uranium experiments were begun  
4 and before neptunium experiments had begun, as Licensee had  
5 informed the Presiding Officer and Intervenors. The minutes of  
6 the August 15 IUS meeting discussed only the decision to proceed  
7 with the neptunium experiments because those were the only  
8 experiments to be considered by the IUS at that time. Contrary  
9 to Intervenors' assertion, the "safety decision" was discussed at  
10 the meeting, including the fact that "multiple failures" would be  
11 required before a backflow condition could occur. Licensee's  
12 Exhibit 8, Attachment 3, p. 1. There are no detailed minutes  
13 reporting the decision not to install the additional filter  
14 because it was made by those managers (all members of the TRUMP-S  
15 working group), as listed above, who have responsibility for the  
16 Alpha Laboratory at MURR, not the IUS. No formal recording is  
17 required for a decision not to change a design that complies with  
18 a license application that has been approved by the NRC.  
19 Finally, Licensee had never "agreed" to install the additional  
20 HEPA filter, and did not "cut corners" in deciding not to install  
21 it. As I previously testified, the HEPA filter was immediately  
22 ordered so that one would be available in case it was decided to  
23 install it. August 23 Morris Affidavit at ¶ 5. Detailed review  
24 demonstrated that the additional filter was not needed for safety  
25 reasons (Id.), and that a license amendment might be needed to  
26 revise the existing approved filtration scheme (Licensee's  
27 Exhibit 8 at ¶ 8). The NRC Staff has confirmed that no  
28 additional HEPA filter was required (Adam Affidavit, August 21,  
29 1990), and an expert engineer has testified that the additional  
30 filter is not necessary (Licensee's Exhibit 7 at ¶ 8). Licensee  
31 acted prudently in its review, its decision was based on safety  
32 considerations and not "fear of delay," and no corners were cut.

33 58. Finally, Intervenors allege that it is "extraordinarily  
34 strange" that Licensee has filed no affidavit from Mr. Steppen,  
35 and, in their customary snide fashion, imply that Licensee  
36 "searched for, and found a witness who would say" what the  
37 Licensee wanted. Intervenors' Rebuttal at 28. Intervenors seem  
38 to have forgotten the arguments that they themselves raised in  
39 Intervenors' Written Presentation to which Licensee was  
40 responding. A basic thrust of Intervenors' arguments was that  
41 the design of the argon glove box exhaust system did not satisfy  
42 standard nuclear engineering standards and did not comply with  
43 DOE Order 6430.1A (Int. Exh. 1 at ¶ 86), and, as a result, the  
44 Presiding Officer expressed some concerns as to whether the  
45 Licensee's exhaust system conformed to industry practice  
46 (Memorandum and Order (Grant of Temporary Stay) at III.A.3, p.9,  
47 October 22, 1990). Intervenors may believe it to be "strange"  
48 that, under these circumstances, Licensee would seek the views of  
49 an engineering expert on the design of plutonium glove box  
50 ventilation and exhaust systems; but to Licensee this seemed the  
51 obvious and rational choice for responding to those arguments and

1 concerns. Licensee continues to appreciate and respect Mr.  
2 Steppen's expertise in the handling of actinide elements  
3 (Licensee's Exhibit 8 at ¶ 11), but he is not an engineering  
4 expert on the design of exhaust and ventilation systems. As for  
5 Intervenor's insinuations regarding Mr. Eschen's testimony, it is  
6 apparent that Intervenor's belief is that only their witnesses  
7 are unbiased. Based upon a witness' background and experience  
8 and upon the contents and support for his/her testimony, the  
9 Presiding Officer can well judge a witness' integrity and  
10 motivation, as well as the value of his/her testimony.

#### 11 Response to Wallace Declaration

12 59. Mr. Wallace, in the last paragraph of section 27 of  
13 Int. Exh. 21, in referencing my description of credible accident  
14 circumstances in the Alpha Laboratory and glove box (Lic Exh. 3,  
15 ¶¶ 38-50), has ignored what is possible and invoked instead that  
16 which is incredible. Smoke from a credible fire in the Alpha  
17 Laboratory would not exit the MURR unfiltered, at ground level.  
18 As I have already stated, fire, with a loss of  
19 containment/confinement, is not a credible accident and therefore  
20 any release of actinides from a fire would be filtered through  
21 the stack. Lic. Exh. 3, ¶ 43. I discussed the most serious  
22 hypothetical accident and associated fire that could take place  
23 in the argon glove box, showed that the HEPA filters would  
24 neither burn nor be clogged, conservatively assumed that only one  
25 HEPA filter remains functional, and provided calculations  
26 demonstrating that the dose levels at 100 meters would be  
27 negligible. *Id.* at ¶¶ 44-52. I also showed that even if the  
28 "worst-case" fractional release factor (.001) in NUREG-1140 were  
29 used and no credit were taken for any HEPA filter or for  
30 deposition in the laboratory or ventilation system, calculated  
31 doses from releases through the stack are still less than the 1  
32 rem EPA Protective Action Guide. *Id.* at ¶ 53. My analysis did  
33 not address ground level releases, because I showed that such  
34 releases are not credible. *Id.* at ¶ 43; n.35 on p. 21. Thus,  
35 Mr. Wallace's claims are not credible, not substantiated, and do  
36 not rebut my analysis. In fact my analysis is now buttressed by  
37 the additional testimony of Mr. Meyer, Lic. Exh. 20 at ¶¶ 37-40,  
38 and Mr. Purington, Lic. Exh. 19 at ¶ 6 at p. 16. However, I  
39 should note that even Mr. Wallace's unsupported assumption of an  
40 incredible severe fire resulting in a ground level release has  
41 already been taken into account in one of the analyses presented  
42 by Licensee. *See* Lic. Exh. 2 at ¶ 18, Lic. Exh. 2, Attachment 3,  
43 and, Lic. Exh. 21 at ¶ 7.

#### 44 Isotopic Composition of Plutonium

45 60. In Int. Exh. 20, ¶¶ 9, 12 and 13 the TRUMP-S Review  
46 Panel revisits its allegations concerning the plutonium content  
47 specified in the subject amendments. Licensee realizes that the  
48 Presiding Officer has already ruled on these matters, but, as



1 long as the Panel's allegations are in the record, it cannot  
2 leave them unanswered. Basically these paragraphs ignore the  
3 facts and attempt to divert the Presiding Officer from the  
4 reality that Licensee properly followed the guidance in RG 10.3  
5 in preparing the subject amendment applications. The correctness  
6 of Licensee's approach has been sustained by the filings of NRC  
7 Staff. See Affidavits of Drs. Glenn (December 4, 1990) and Adam  
8 (December 5, 1990).

9 The TRUMP-S Review Panel state in ¶ 9:

10 "We find it therefore somewhat amusing for the  
11 Applicant to accuse us of relying on "library research"  
12 in our discussion of the typical isotopic composition  
13 and total curie content of weapons-grade and reactor-  
14 grade plutonium in our effort to --correctly, we might  
15 add-- point out that the application's claims about  
16 isotopic composition and total curie content of the  
17 material they themselves had requested were in  
18 error,...."

19 Licensee does not find the Intervenors' misrepresentation of this  
20 issue amusing. It has added significantly to the time, effort  
21 and funding that must be dedicated to this litigation. This  
22 issue was given considerable weight in the Presiding Officer's  
23 October 20, 1990, Order staying the TRUMP-S research at MU. See  
24 Memorandum and Order (Grant of Temporary Stay), October 20, 1990,  
25 at p. 3-4. This stay caused significant harm to Licensee from  
26 which it still has not fully recovered.

27 61. In the SNM-247 Amendment Application at p. 1, Licensee  
28 correctly reported the major constituents of the subject  
29 plutonium to be 94.42 wt.% <sup>239</sup>Pu and 5.58 wt.% <sup>240</sup>Pu. The small  
30 amounts of <sup>238</sup>Pu, <sup>241</sup>Pu, <sup>242</sup>Pu and <sup>241</sup>Am were not reported because they  
31 do not contribute significantly to dose relative to <sup>239</sup>Pu and <sup>240</sup>Pu.  
32 The TRUMP-S Review Panel ignored this information and asserted in  
33 Int. Exh. 1, i.e., at ¶¶ 17, 18 and 20, that the isotopic content  
34 of <sup>241</sup>Pu was between 0.44 and 11%. Obviously a <sup>241</sup>Pu content  
35 anywhere in this range would not be consistent with the  
36 composition stated by Licensee in its application, even when some  
37 reasonable uncertainty is applied to these data. Without regard  
38 for the stated facts or any showing to the contrary, the TRUMP-S  
39 Review Panel in ¶ 23 of Int. Exh. 1, state:

40 "It would appear likely that Rockwell had some reason  
41 to believe the sample was 5.8 25/ wt.% Pu-240, and

---

42 25/ Presumably the TRUMP-S Review Panel means 5.6 wt.%, or  
43 perhaps they have spirited up still another fictional  
44 interpretation of the data in Licensee's application.



1 assumed that the rest must be Pu-239, neglecting to  
2 consider the -241 and -242. Apparently the researchers  
3 at the University of Missouri, who should have known  
4 better and caught the mistake, uncritically assumed the  
5 sample was indeed just Pu-239 and Pu-240, without  
6 inquiring how that could be." (Emphasis added by the  
7 TRUMP-S Review Panel)

8 Indeed Rockwell and the University did "[have] some reason to  
9 believe the sample was 5.6 wt.% Pu-240". This was the knowledge  
10 that the subject plutonium was an aliquot of Certified Reference  
11 Material CRM-127. Hence both Rockwell and the University had  
12 great confidence that the isotopic composition was precisely what  
13 it was reported to be by New Brunswick Laboratory, from which it  
14 was obtained. Licensee has shown in its October 30, 1990,  
15 filing, beyond any doubt, that the isotopic composition of NBL  
16 CRM-127 is accurately known and correctly reported as per RG 10.3  
17 by Licensee in its application. See Morris Affidavit "Regarding  
18 Plutonium Content", October 30, 1990 at ¶¶ 10-16 and Attachments  
19 1, 1B, 2-4, 6, 7 and 9-12.

20 62. Now, the TRUMP-S Review Panel in ¶¶ 12 and 13 of  
21 Intervenors' Exhibit 20, continue their misrepresentation of the  
22 facts. They no longer insist that the true <sup>241</sup>Pu content ranges  
23 between 5 to 120 curies as they did in ¶ 27 of their October 15,  
24 1990, Declaration. Mercifully, this indicates there is some  
25 limit to the degree to which they will misrepresent the facts.  
26 Instead they would like for the Presiding Officer to believe that  
27 Licensee, in its SNM-247 Amendment Application, was applying for  
28 0.71 curies of plutonium, period. In fact page one of the  
29 application clearly shows that the 710 millicuries pertains only  
30 to the <sup>239</sup>Pu and <sup>240</sup>Pu isotopes, and then for the specific isotopic  
31 composition of 94.4 and 5.6 wt.%, respectively.

32 63. The Panel continues on, restating its arguments in Int.  
33 Exh. 20, ¶¶ 29 through 46, frequently repeating itself in an  
34 apparent attempt to put some distance between the position it now  
35 takes on the subject of isotopic composition --especially <sup>241</sup>Pu--  
36 compared to its position as espoused in Int. Exh. 1 back in  
37 October.

38 64. The Panel characterizes the University as admitting to  
39 having 1.2 Ci of <sup>241</sup>Pu and <sup>241</sup>Am. Int. Exh. 20 at ¶ 31. This  
40 characterization carries a negative connotation and belies the  
41 fact that the Licensee felt compelled to carefully document the  
42 isotopic composition of its plutonium for the record of this  
43 proceeding, even though not required to do so by regulations, in  
44 order to dispel the careless, irresponsible and totally  
45 inaccurate claims made by the Panel in Int. Exh. 1.

1 65. The Panel quotes from 10 CFR 70.22(a)(4), ¶ 33, Int.  
2 Exh. 20, and from RG 10.3 in ¶ 35. Those quotes will not be  
3 repeated here as they have been called out at least once by all  
4 parties. The Intervenor's point apparently is that they do not  
5 agree with the position jointly held by Licensee, Region III NRC  
6 Staff, and Headquarters NRC Staff, that <sup>241</sup>Pu and <sup>241</sup>Am are not  
7 significant contaminants (major dose-contributing contaminants)  
8 in the NBL CRM-127 plutonium standard possessed by Licensee. The  
9 Panel's position is presented in numerous paragraphs, among them,  
10 ¶¶ 32, 34, and 39-44. Simply put, the Panel's argument is that  
11 <sup>241</sup>Pu accounts for nearly 4% of the dose of the sample (¶ 39), <sup>241</sup>Am  
12 accounts for 10% of the dose of the sample (¶ 39), and together  
13 they account for 15%, (¶ 43). The Panel concludes that 15% is  
14 greater than the 1% it has visited on these proceedings to define  
15 what is meant by significant contaminant (major dose-contributing  
16 contaminant). This argument has no merit because it is based,  
17 not on regulation or regulatory guidance, but on the ad hoc  
18 definition arbitrarily selected by the Intervenor to suit their  
19 purpose.

20 66. The Panel states that "Dr Morris says they didn't  
21 include the content of the other isotopes in the application  
22 because it takes a lot of calculation which they did after we  
23 raised the issue" (*Id.* at ¶ 45). This is utter fabrication.  
24 Statements such as this should raise doubts in the mind of the  
25 Presiding Officer regarding the honesty with which the TRUMP-S  
26 Review Panel approaches this proceeding.

27 67. The Panel, at ¶ 45, claims that failure to include  
28 specific information concerning <sup>241</sup>Pu and <sup>241</sup>Am leaves the NRC staff  
29 with "no way of assessing the safety and precautions of the  
30 Applicant's proposed activity." This is absolutely wrong.  
31 Licensee disclosed the isotopic composition of the plutonium  
32 requested in its amendment application as being 94.42% <sup>239</sup>Pu and  
33 5.58% <sup>240</sup>Pu as specified by the supplier, New Brunswick  
34 Laboratory. This data clearly indicates that any contaminants  
35 must be present at very low concentration.

36 68. Finally, the Panel argues that "[t]he University  
37 currently has more plutonium than it is legally licensed for, and  
38 possesses isotopes for which it has no license", at ¶ 46. The  
39 opposite is true as testified to by Drs. Glenn (Affidavit of John  
40 E. Glenn, December 4, 1990) and Adam (Affidavit of William J.  
41 Adam, December 5, 1990).

#### 42 Available Information

43 69. The Intervenor and the TRUMP-S Review Panel have  
44 complained without justification throughout their rebuttal  
45 documents (*See*, e.g., Int. Exh. 20, ¶¶ 6-8) --as they had  
46 previously in their Written Presentation-- that the information

1 needed to conduct their review is not available. Such complaints  
2 are mistaken and misrepresent the facts. Not only have  
3 Intervenor had the hearing file to which they were entitled  
4 under the NRC regulations, but extensive additional information  
5 that had been provided by Licensee.

6 70. Typical of Intervenor's misrepresentations is the  
7 following statement taken from ¶ 8 of Int. Exh. 20:

8 "We find it extremely frustrating to attempt a review  
9 of the proposed TRUMP-S project at MURR when so little  
10 relevant documentation either exists or is publicly  
11 available for such a review. We are forced to guess,  
12 for example, based on fragmentary statements made by  
13 University representatives at public meetings and bits  
14 and pieces of documents not contained in the  
15 application, what assumptions the University would have  
16 included in a safety analysis or emergency plan had it  
17 included one in the application."

18 71. The statement implies that some requirement for  
19 submitting a safety analysis as part of the application has not  
20 been met. This is not the case. No Safety Analysis Report was  
21 required or needed. Furthermore, it is clear from the discussion  
22 in the applications along with the schematic drawings that the  
23 Alpha Laboratory design far exceeds all NRC requirements for the  
24 type of experimentation and amounts of materials for which  
25 license authorization was sought.

26 72. Likewise, an emergency plan was not required to be  
27 submitted as part of the application. Nevertheless the MURR has  
28 such a plan that was developed for the entire facility. The MURR  
29 Facility Emergency Plan has been tested in concert with outside  
30 emergency response agencies including the Columbia Fire  
31 Department. It has been accepted and inspected by the NRC. It  
32 is germane to the TRUMP-S project. The MURR Facility Emergency  
33 Plan was voluntarily made available to the Intervenor by the  
34 Licensee in June 1990, and supplied as part of the hearing file  
35 on or around August 17, 1990. Intervenor may not like the  
36 Emergency Plan, that is their prerogative; however it is pure  
37 deceit to state: "We are forced to guess, for example, based on  
38 fragmentary statements made by University representatives at  
39 public meetings and bits and pieces of documents not contained in  
40 the application, what assumptions the University would have  
41 included in a safety analysis or emergency plan had it included  
42 one in the application."

1           73. Furthermore, one has but to peruse Intervenor's Exhibit  
2 19 26/ accompanying Intervenor's Written Presentation (October  
3 15, 1990) to find that the Licensee has provided extensive  
4 TRUMP-S materials to the Intervenor. The first 18 pages (a  
5 through r) of Intervenor's Exhibit 19 is a listing of documents  
6 compiled by Licensee in categories defined and prioritized by the  
7 Intervenor. This search and compilation represents an  
8 exhaustive good-faith effort made by MURR staff in the hope that  
9 what was intended to be an informal hearing, which specifically  
10 prohibits discovery, could be expedited. To see this effort  
11 described by the TRUMP-S Review Panel as: "We find it extremely  
12 frustrating to attempt a review of the proposed TRUMP-S project  
13 at MURR when so little relevant documentation either exists or is  
14 publicly available for such a review", should not be countenanced  
15 by the Presiding Officer.

16           74. Among the documents made available to the Intervenor  
17 --they had but to request copies from the list-- were the TRUMP-S  
18 Actinide Measurement Procedures (TAMS). See documents 162  
19 through 195 listed on pages j through l of Intervenor's Exhibit  
20 19. These are the detailed procedures by which vital aspects of  
21 the TRUMP-S project are conducted. Yet curiously, Intervenor  
22 only requested copies of TAMS 62, 80 through 89, and 91. See  
23 pages j through l, Intervenor's Exhibit 19 for descriptive  
24 titles. Of these, only TAM-62 was discussed by the TRUMP-S  
25 Review Panel, and then it was in a contrived context as explained  
26 in Licensee's Meyer Affidavit (October 30, 1990). For example,  
27 the following documents were made available to the Intervenor,  
28 but apparently were of no interest and hence were not included in  
29 Intervenor's Exhibit 19 or discussed by the TRUMP-S Review Panel.

- 30           TAM-01: "Alpha Laboratory General Description", rev 0  
31           TAM-10: "Alpha Laboratory Entry/Exit", rev 0  
32           TAM-11: "Frisking of Personnel and Packages", rev 0  
33           TAM-12: "Glove Box Transfers", rev 0  
34           TAM-13: "Working in a Glove Box", rev 0  
35           TAM-14: "Bagging Material in and out of a Glove Box", rev 0  
36           TAM-20: "Receipt of Actinides", rev 0  
37           TAM-21: "Transfer of Actinides", rev 0

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38           26/ Intervenor's Exhibit 19 contains some but not all of the  
39 documents made available to Intervenor by Licensee. See  
40 Intervenor's Written Presentation at p. 6.



- 1 TAM-22: "Actinide Sample Subdivision and Storage", rev 0  
2 TAM-23: "Inventory Control of Actinides", rev 0  
3 TAM-24: "Quality Assurance", rev 0  
4 TAM-30: "Bioassay", rev 0  
5 TAM-31: "Airborne Monitoring", rev 0  
6 TAM-32: "Solidification of Aqueous Residue", rev 0  
7 TAM-33: "Bag Out Material", rev 0  
8 TAM-34: "Survey of Alpha Lab", rev 0  
9 TAM-35: "Transfer of Actinide Metal into the Glove Box",  
10 rev 0  
11 TAM-60: "Loss of Glove", rev 0  
12 TAM-61: "Loss of Facility Argon Supply", rev 0  
13 TAM-63: "Response to MURR Emergency Evacuation Alarm", rev 0  
14 TAM-70: "Alpha Laboratory Fire" (names and telephone numbers  
15 are obliterated from step 10), rev 0  
16 TAM-71: "High Airborne Radioactivity" (names and telephone  
17 numbers are obliterated from step 7), rev 0

18 75. Licensee suggests that the fact that no mention --good,  
19 bad or indifferent--is made by the TRUMP-S Review Panel of the  
20 operating procedures by which the TRUMP-S project is conducted  
21 can only mean that their statements in ¶ 8, i.e., --"We find it  
22 extremely frustrating to attempt a review of the proposed TRUMP-S  
23 project at MURR when so little relevant documentation either  
24 exists or is publicly available for such a review"--are nothing  
25 more than hollow rhetoric.

26 Epidemiology

27 76. In Intervenor's Rebuttal at pages 35 and 36,  
28 Intervenor's quote portions of the written opinions of John Gofman  
29 (Committee for Nuclear Responsibility). No evidence is cited in  
30 support of these opinions or their relevance to the subject  
31 amendments. Taken at face value, under the pretense of human  
32 epidemiology, the incorrect inference --that any radiation  
33 exposure can be shown to result in "excess fatal cancer"-- could  
34 be made. These kind of statements have contributed significantly  
35 to misunderstandings by some members of the general public  
36 concerning the magnitude and origin of the risk of radiation-

1 induced cancer. Fortunately, a long-term epidemiological  
2 study 27/ has recently been published (July 1990) which  
3 addresses the risk of cancer associated with proximity to a  
4 nuclear facility.

5 77. In this study conducted by the National Cancer  
6 Institute, a total of 62 nuclear facilities in the US were  
7 studied. This constitutes all the nuclear facilities that went  
8 into service prior to 1982, that are either commercial power  
9 reactors or DOE facilities engaged in nuclear fuel reprocessing  
10 and other activities involving radioactive materials. A case-  
11 control study design was used. The cases were the 900,000 cancer  
12 deaths that occurred between 1950 through 1984 in the 107  
13 counties in which the 62 nuclear facilities studied, reside, and  
14 certain other counties that are in close proximity. The controls  
15 were the 1,800,000 cancer deaths from the control counties which  
16 were regionally matched to the "case" counties. The overall  
17 conclusion of this study was that: "[t]here was no evidence to  
18 suggest that the occurrence of leukemia or any other form of  
19 cancer was generally higher in the study counties than in the  
20 control counties". Emphasis added. This general conclusion  
21 cited for the entire study also applies to such facilities as  
22 Rocky Flats, where plutonium fires are known to have occurred. A  
23 copy of the Abstract and Summary of the study is enclosed as  
24 Attachment 1. This work has been extensively reviewed by outside  
25 scientists and, to date, must be considered the definitive U.S.  
26 study relating cancer risk and residential proximity to a nuclear  
27 facility. The null finding may reflect that there is truly no  
28 effect at the very low radiation doses that result from these  
29 facilities, or perhaps the effect is too small to be observed.  
30 In either case, this study credibly refutes the statement: "we  
31 prove beyond reasonable doubt that no safe dose or dose-rate  
32 exists with respect to radiogenic cancer" (Intervenors' Rebuttal  
33 at page 35).

#### 34 Conclusions

35 78. This affidavit has addressed a number of Licensee's  
36 concerns in reading and trying to understand statements made in  
37 Intervenors' Rebuttal and Intervenors' Exhibits 20-23. These  
38 concerns are summarized as follows:

- 39 a. With respect to release fractions, the TRUMP-S  
40 Review Panel has made statements that are

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41 27/ Jablon S, Hrubec, Z, Boice, JD and Stone BJ. "Cancer in  
42 Populations Living Near Nuclear Facilities", National Cancer  
43 Institute, Division of Cancer Etiology, Epidemiology and  
44 Biostatistics Program, U.S. Department of Health and Human  
45 Services, Public Health Service, National Institutes of  
46 Health, NIH Publication No. 90-874, July 1990.

1 factually incorrect, made improper use and  
2 representation of authorities, and applied  
3 incredible conditions relative to the TRUMP-S  
4 research being conducted in the Alpha Laboratory  
5 at MURR. Licensee has demonstrated that its use  
6 of  $10^{-6}$  as the release fraction is both credible  
7 and conservative.

8 b. The ventilation system for the Alpha Laboratory,  
9 including the HEPA filtration units, meets all  
10 regulations for such a facility. An additional  
11 HEPA filter in the room exhaust leg of the  
12 ventilation system is not required nor would it  
13 contribute in any significant way to the safety of  
14 the experimenters or the general public.  
15 Furthermore, the review of the ventilation system  
16 undertaken by the Licensee as a result of Mr.  
17 Steppen's recommendation was both responsible and  
18 comprehensive.

19 c. Accidents do happen, and by their nature they are  
20 unpredictable in some respects. However,  
21 accidents are quite predictable in other respects.  
22 Fires cannot "invent" fuels that are not otherwise  
23 present; nor can their consequences escape the  
24 laws of nature. Licensee has described the  
25 maximum credible accident that can occur. The  
26 Intervenor, their Review Panel and most recently,  
27 Mr. Wallace, have all ignored the facts and  
28 postulated incredible accidents that cannot occur  
29 at the Alpha Laboratory. Furthermore, the  
30 resulting circumstances do not obey the laws of  
31 nature. The latest of these scenarios pictures  
32 the Alpha Laboratory as a blazing inferno in a  
33 'concrete oven' which reaches temperatures of  
34 2000-3000 °F; and yet, the combustion gasses at  
35 these extreme temperatures leave the building at  
36 ground level and do not rise. As Licensee has  
37 shown through the testimony of experts, these  
38 scenarios are utter nonsense.

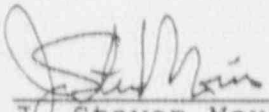
39 d. The isotopic composition of plutonium was  
40 accurately reported by Licensee in its original  
41 amendment application. Intervenor's absurd claims  
42 to the contrary, which at their high-water mark  
43 put the  $^{241}\text{Pu}$  content up to 10 wt.% or greater,  
44 have been completely discredited and essentially  
45 abandoned by the Intervenor. Unfortunately, it  
46 appears that the Intervenor pay no price for  
47 their irresponsible acts. On the other hand the

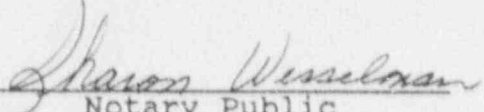
1 University's coinage with the community was  
2 unjustly damaged.

3 e. The Intervenors have misrepresented the  
4 availability of relevant information. For  
5 example, 35 TRUMP-S operating procedures having to  
6 do with training, health physics, emergency  
7 response and maintenance were made available to  
8 the Intervenors. Of these, only one was ever  
9 discussed by the Intervenors or members of the  
10 TRUMP-S Review Panel. They were silent on the  
11 other 34. The Presiding Officer is referred to ¶  
12 74 above and ask to ponder why the procedures  
13 listed there are of no apparent interest to the  
14 Intervenors, and further, how they can credibly  
15 claim such limited access to relevant information.

16 f. The National Cancer Institute, in looking at over  
17 2.7 million cancer deaths in a case-control study,  
18 has concluded that there is no evidence to suggest  
19 that persons living near nuclear facilities in the  
20 U.S. have any higher risk of contracting leukemia  
21 or some other form of cancer than do persons  
22 living greater distances from such facilities.

23 Subscribed and sworn  
24 before me in  
25 Boone County,  
26 Missouri this 28<sup>th</sup> day of  
27 January 1991

  
\_\_\_\_\_  
J. Steven Morris  
Group Leader  
Nuclear Analysis Program

28   
29 Notary Public

30 My Commission Expires  
31 2-21-91

Sharon Wesselman, Notary Public, State of Missouri  
My commission expires February 21, 1991  
Boone County, Missouri



CANCER IN POPULATIONS  
LIVING NEAR NUCLEAR FACILITIES

VOLUME 1 - REPORT AND SUMMARY

Seymour Jablon<sup>1</sup>, Zdenek Hrubec<sup>1</sup>, John D. Boice, Jr.<sup>1</sup>, B.J. Stone<sup>2</sup>

NATIONAL CANCER INSTITUTE  
DIVISION OF CANCER ETIOLOGY  
EPIDEMIOLOGY AND BIostatISTICS PROGRAM

<sup>1</sup> Radiation Epidemiology Branch  
<sup>2</sup> Biostatistics Branch

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
PUBLIC HEALTH SERVICE  
NATIONAL INSTITUTES OF HEALTH

July, 1990

NIH Publication No. 90-874

## CANCER IN POPULATIONS LIVING NEAR NUCLEAR FACILITIES

### ABSTRACT

Recent studies from the United Kingdom have reported increases in mortality from leukemia among young persons, especially under age 10, living near certain nuclear installations. The reasons for this pattern are not clear and there were no corresponding increases in total cancer mortality. Because of concerns raised by these data, a survey of cancer rates was conducted in populations living near nuclear facilities in the United States. The study encompassed all 62 nuclear facilities that went into service prior to 1982, including commercial electricity-generating plants and major Department of Energy facilities engaged in nuclear fuel reprocessing, isotope separation or other activities involving radioactive materials.

Over 900,000 cancer deaths occurring between 1950 through 1984 in 107 counties with nuclear installations and certain adjacent counties in the United States were evaluated. For counties in two states, cancer incidence data were also available and evaluated. Each study county was matched for comparison to three similar "control counties" in the same region. Over 1,800,000 cancer deaths occurred in these control areas. There was no evidence to suggest that the occurrence of leukemia or any other form of cancer was generally higher in the study counties than in the control counties. For childhood leukemia, the relative risk comparing the study counties with their controls before plant startup was 1.08, while after startup it was 1.03. For leukemia at all ages, the relative risks were 1.02 before startup and 0.98 after startup.

The survey results showed that some of the study counties had higher rates of certain cancers, and some had lower rates, either before or after the facilities came into service. The observed comparisons provided no evidence of any cause-effect relationship between particular facilities and cancer occurrence in nearby populations. The study is limited by the correlational approach and the large size of the geographic areas (counties) used, and of course it cannot prove the absence of any effect. However, if any excess cancer risk was present in U.S. counties with nuclear facilities, it was too small to be detected by the methods employed in this survey.

## SUMMARY

A survey of mortality from leukemia and other forms of cancer in the environs of 62 nuclear facilities in the United States has been made. More than 2,700,000 certificates of death due to some form of cancer during the period 1950-1984 were analyzed. Included in the survey were 52 commercial electricity-generating nuclear facilities that had gone into service by the year 1981 and ten other facilities that reprocessed nuclear fuel, produced radioactive isotopes, separated isotopes, or carried out other activities involving radioactive materials. Counties in which nuclear facilities were located and certain adjacent counties were designated "study counties". Three "control counties" were matched to each study county for comparison. Over 900,000 cancer deaths occurred in the study counties and over 1,800,000 in the control areas. Cancer incidence data were also obtained for the counties around four facilities in two states.

This survey was initiated following a report published by the British Office of Population Censuses and Surveys (OPCS) on cancer risk in the vicinity of nuclear facilities in England and Wales. The most striking finding of the British survey was the occurrence of excess deaths from leukemia in young persons, especially those under age 10, in the vicinity of one particular fuel reprocessing plant (Sellafield). Overall, however, there was no evidence to support a general increase in total cancer mortality near nuclear installations in the United Kingdom, and the reasons for the elevation of childhood leukemia were not clear.

In the present study, standardized mortality ratios (SMRs) were calculated for sixteen classes of cancer for each study area and for the associated control areas for five-year periods both before and after the startup of the facility in question. For each cancer, both SMRs and relative risks (RRs) were calculated, permitting comparisons between the study and control areas before and after the facilities came into service. Similarly, comparisons of cancer occurrence were made separately for the study and control areas before and after the facilities went into service. Five different age groups as well as all ages combined were examined. The SMRs provided a basis for comparison with rates for the United States as a whole. Relative risks were calculated as ratios of SMRs. Comparisons were made for each facility and also for combined groups of facilities: all Department of Energy (DOE)

facilities; the early electric power plants (those that went into service before 1970); those that started up between 1970 and 1974; and the later plants that started between 1975 and 1981.

Many thousands of comparisons were tested explicitly for statistical significance. Hundreds of the tests turned out to be "significant" in a technical sense, marking comparisons that indicated either excesses or deficits of cancer risk. To help distinguish excesses possibly indicative of adverse health effects attributable to the facilities from those that resulted from mere chance or from variation resulting from other environmental, industrial, or local factors, several questions were asked:

- o Were the differences between study and control areas present before the facility began operations or did they occur only after startup?
- o Was the cancer rate in the study area "significantly" larger than that in the control area only because the control area rate was abnormally low, while the study area rate was not significantly different from the U.S. rate?
- o Was there an increase in the SMR for the study area after the facility began operations? If there were increases in cancers other than leukemias in the study area, did they take place at least ten years after startup as would be expected?
- o Were increases identified for those forms of cancer known to be especially susceptible to induction by radiation (i.e., leukemia, female breast cancer, and lung cancer)?

So many comparisons have been made that even the few "significant" test results that successfully passed these tests of credibility may nevertheless represent chance occurrences. Further, although control counties were matched as closely as possible to the



study counties, differences in other important variables, apart from the presence of a nuclear facility, probably exist that could have contributed to any differences in cancer rates.

Of the nearly 900,000 cancer deaths that were evaluated around U.S. nuclear installations, 350,000 occurred before the plants became operational and 530,000 after startup. These numbers include 37,500 deaths attributed to leukemia. Overall, and for specific groups of nuclear installations, there was no evidence to suggest that cancer mortality in counties with nuclear facilities was higher than, or was increasing in time faster than, the mortality experience of similar counties in the United States. Data on all 1,394 deaths due to leukemia in children below age 10 also did not suggest an overall increased risk in areas with nuclear installations.

On examination of the data for individual facilities, only the incidence data for the area around the Millstone nuclear power plant in New London County, Connecticut, showed a significantly increased RR of leukemia at ages 0-9 years. However, the significance of the difference was largely attributable to very low leukemia rates in the control counties. No other excesses of deaths from childhood leukemia were found that could be linked to any of the nuclear facilities. Further, three study areas (San Onofre, Quad Cities, and Vermont Yankee) were marked by significant deficits in the RR for leukemia deaths at ages 10-19. No excesses in mortality from any form of cancer other than leukemia, or from leukemia in any group over 10 years of age, were identified that could, plausibly, have resulted from the operation of any facility or set of facilities.

Radiation releases from nuclear power stations are reported to be quite low, delivering to any person, at a maximum, less than 5% of the radiation exposure that is normally received from natural background sources, such as radionuclides in the earth and cosmic rays. Such low levels would not be expected to result in detectable increases in childhood leukemia or other cancers. On the other hand, certain facilities, such as Hanford, are known to have released more than average amounts of radiation into the environment.

An apparent excess risk observed around any facility may be a chance observation or, if real, might result from excessive but undetected radioactive emissions from the plant, from exposures to chemical effluents, or from other circumstances that may be peculiar to

individual areas in comparison with their control counties. Mortality from leukemia was examined for populations living near 62 facilities for each of six age groups, so it was not unexpected to find, by chance, one or more "statistically significant" excesses and deficits. Finally, some excesses in risk may result, not from the operation of the facilities themselves, but from the large population movements stimulated by the building of large industrial complexes in rural areas.

The survey, based as it was on existing mortality and incidence data, suffers from a number of weaknesses: for most of the facilities only mortality, not incidence, data were available; data were not available for areas smaller than entire counties; and the causes of death were obtained from death certificates and are, therefore, of variable quality. Although all of the DOE facilities went into service more than 35 years ago, many of the commercial nuclear electric stations began service relatively recently and not enough time may have passed to allow for the expression of cancers that may still have been latent in 1984.

The strengths of the survey include the large number of facilities studied, the selection of control counties for comparison purposes, the evaluation of risks before and after reactor startup, and the availability of 35 years of mortality data for each county included. Further, the method used (correlation analyses of county mortality data) has been successful in the past in pointing to such carcinogenic hazards as arsenical pollution from metal smelters, and asbestos exposures in shipyard workers.

From the evidence available, this study has found no suggestion that nuclear facilities may be linked causally with excess deaths from leukemia or from other cancers in populations living nearby. Studies in the United Kingdom had found increased mortality from leukemia in children near two nuclear fuel reprocessing complexes and two nuclear weapons plants. Examinations of similar installations in the United States failed to find such increases. The study, of course, cannot prove the absence of an effect, and its findings must be viewed in the context of its ecological approach and the relatively large geographic areas (counties) used in the study. It can be said, however, that if any excess cancers have occurred in counties with nuclear facilities, the number has been too small to detect by the methods employed.