LICENSEE'S EXHIBIT 2

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judge
Peter B. Bloch

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

AFFIDAVIT OF DR. SUSAN M. LANGHORST
REGARDING NUREG-1140 AND
INTERVENORS' DISPERSION CONCENTRATIONS

I, Susan M. Langhorst, being duly sworn, hereby state as follows:

1. I am Manager of Reactor Health Physics at the University of Missouri-Columbia Research Reactor Facility ("MURR"), a position I have held since April 16, 1987.

2. I received a B.S. in Nuclear Engineering (Summa Cum Laude) from the University of Missouri-Rolla in 1976, an M.S. in Nuclear Engineering (Health Physics Option) from the University of Missouri-Columbia in 1979, and a Ph.D. in Nuclear Engineering (Health Physics Option) from the University of Missouri-Columbia in 1982. My research projects for M.S. and Ph.D. were devoted to developing and improving airborne monitoring methods for tritium and radioactive iodines at the MURR. My resume is attached as Attachment 1.

3. I have been employed full-time at the MURR since 1980, in the positions of Research Scientist (1980 to 1987) and Manager, Reactor Health Physics (1987 to present).

4. In the foregoing positions I have had a variety of responsibilities of progressive importance under the NRC licenses relating to the MURR held by the Curators of the University of Missouri ("Licensee"). For more than five years (1977 to 1982) my graduate research was devoted to developing and implementing improved monitoring methods for the measurement of airborne concentrations of tritium and radioactive iodines. For five

years (1980 to 1985) my job responsibilities at the MURR were principally that of reactor chemist. As such, my group was responsible for all chemistry quality assurance measurements as required by Reactor License No. R-103, Materials Licenses No. SNM-247, No. 24-00513-32, and No. 24-00513-34, and the Technical Operating Specifications. I was responsible for establishing the formal written procedures for the Reactor Chemistry Group. During this period of time, and afterwards, I have conducted, supervised and published research related to the reactor chemistry function. For two years (1985 to 1987) my job responsibilities were that of evaluating and developing the information and analyses necessary in support of an Environmental Report for a possible power upgrade of the MURR. In this position, I gathered and reviewed site-specific data, i.e., meteorological data for Columbia and the MURR, and made site-specific analyses, i.e., dispersion calculations for MURR and offsite dose projections. For more than three years (1987 to present) my responsibilities as Reactor Health Physics Manager have been to direct research, training, and monitoring programs at the MURR in order to protect the public and reactor personnel from radiation hazards and to assure compliance with federal, state and University regulations. The characteristic duties, as described in the University's Classification Specification for this job title (Code: 6186), are:

- Consult with faculty and staff investigators on radiation safety problems.
- Perform radiation and contamination surveys on all reactor laboratories in which radioactive materials are used and leak test surveys on sealed sources of radioactive materials.
- Control the procurement of radioactive materials by approving all orders and receiving and delivery of each shipment.
- Complete various forms required by the federal government concerning storage, use and transfer of radioactive materials, authorized users and experimental programs currently being conducted and those being planned.
- Supervise radiation monitoring personnel and direct monitoring of reactor areas and worksites.
- Maintain storage facility for all radioactive wastes and provide for final disposition of such wastes.
- Interpret federal regulations and develop procedures to ensure adherence to regulations.
- Evaluate potentially hazardous situations and recommend corrective action.
- Consult with federal authorities on the Reactor's radiation safety program.
- Instruct and advise support staff on methods and procedures.

5. I also hold a faculty appointment of Assistant Professor

in the Nuclear Engineering Program at the University of Missouri-Columbia (1983 to present). In this capacity I have conducted, supervised graduate students, and published research related to health physics and medical physics. I am also responsible for teaching in graduate level courses on radiological protection and am Co-Director for the UMC "Workshop on Nuclear Science and Engineering for Secondary School Teachers" held each summer.

6. I have been a Certified Health Physicist 1/ since September 1985. I am currently serving (1988 to present) as a member of the ABHP's Panel of Examiners, which is responsible for constructing, conducting, and grading of the annual ABHP certification examination. As a Health Physicist, I have also received additional special training related to radiological protection: "Internal Dosimetry--Principles and Practice", Health Physics Society Summer School, June 1983; "Practical Statistics for Operational Health Physics", Health Physics Society Summer School, July 1987; and "Radiological Emergency Response Training for State and Local Government Emergency Prepared Personnel" 2/, Federal Emergency Management Agency, September 1989. My training has included radiological protection associated with alpha, beta, gamma, and neutron radiation sources.

7. I have reviewed the Written Presentation of Arguments of Intervenors and Individual Intervenors ("Intervenors' Written Presentation") (October 15, 1990) including Exhibits 1-19 thereof, and other relevant materials, including Intervenors' Renewed Request for Stay Pending Hearing ("Renewed Stay Request") (October 15, 1990).

8. In the Intervenors' Written Presentation, they contend that NUREG-1140, "A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licenses" (January 1988), "offers no refuge for MURR" in that any reliance on NUREG-1140 "undercuts" the Licensee's use of 10^{-6} release fraction and that the amendment for 25 Ci of Am-241 is "outside the range of concern of" NUREG-1140. Intervenors furthermore contend that the release fractions used in NUREG-1140 underestimate realistic release fractions and that standard NRC dispersion regulatory

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1/ Certification is through the American Board of Health Physics ("ABHP"). The total number of Active Certified Health Physicists in the United States as of August 1990 was 871.

2/ I am currently a member of the Missouri Nuclear Emergency Team ("MoNET") which is under the responsibility of the State of Missouri, Department of Public Safety, Office of the Adjutant General, Emergency Management Agency. I have participated in the State's emergency drills for the Callaway Nuclear Power Plant.

guides produce substantially higher dose estimates than those reported in NUREG-1140. Intervenors' Written Presentation at 5.

9. As has been shown in previous and current Licensee's affidavits, the assertions of the Intervenors are incorrect and are based on claims and partial statements made by the Intervenors' Review Panel in the "Declaration of the TRUMP-S Review Panel" (Intervenors' Exhibit 1). This affidavit will respond to the claims and misstatements of the Intervenors' Review Panel by demonstrating the following:

1.) NUREG-1140 is an important, reliable document in that it was relied upon by the NRC in establishing additional emergency planning requirements and describes a highly conservative method acceptable to the NRC for calculating potential offsite doses, as well as factors that can be considered in calculating potential offsite doses at a specific location.

2.) The factors utilized in the NUREG-1140 dispersion model are conservative, and therefore overestimate offsite doses.

3.) Intervenors recognize only a narrow view of NUREG-1140 and misrepresent Licensee's purpose in discussing the relevance of NUREG-1140.

4.) Intervenors and Intervenors' Review Panel are misleading in their contention that Licensee has one of the most hazardous licenses.

5.) Intervenors' Review Panel has misrepresented plutonium concentrations in their release analysis.

6.) Intervenors' Review Panel has misapplied the use of emergency action levels.

<u>NUREG-1140: Basis for NRC Regulations</u>

10. Credible accident analyses are used to assess the specifications for safety equipment, procedures and emergency preparedness needed to respond to an accident. The accident analysis which was performed for NUREG-1140 evaluated the need for NRC rulemaking to impose <u>additional</u> emergency preparedness requirements on licensees. (Emphasis added.) As stated in NUREG-1140 (pp. 3-4):

"The questions is <u>not</u> whether licensees should have any emergency preparedness. That question was addressed long ago. The NRC has long required licensees to be prepared to cope with emergencies. The question is whether there should be additional requirements. For example, should NRC require formal written state and local government plans for coping offsite with serious radiation accidents? Such plans might include provisions for early evacuation by the public or notifying them to take shelter indoors.

The question is also <u>not</u> whether State and local governments should have emergency preparedness capabilities for dealing with radiation accidents. Police departments, fire departments, state radiological health departments, and other agencies that are routinely prepared to cope with emergencies already exist. This rulemaking is intended to assure that, where needed, there exist emergency procedures for mitigating and coping with offsite releases."

11. The conclusion reached in NUREG-1140 is to suggest additional emergency preparedness of licensees whose license limits exceed the isotope quantities listed in Table 13. 3/ The additional preparedness proposed is an appropriate emergency plan where the "approach more closely follows the approach used for research reactors than for power reactors." (see ¶ 26, below). It is important to note that the quantities listed in Table 13 are not upper limits, but rather indicate the license quantity that might theoretically deliver an effective dose equivalent of 1 rem calculated by assuming that the most exposed member of the public is standing at 100 meters and inhales a fraction of 10^{-6} of those materials. In fact, NUREG-1140 makes additional statements concerning licensees authorized for larger quantities and the appropriate actions levels associated with these larger quantitie. (See ¶ 29, below)

12. The final conclusions reached in NUREG-1140 on this proposed rulemaking are of particular interest in evaluating the public health and safety in regard to accidental offsite releases of these materials (Emphasis added.):

"For a licensee possessing <u>5 times the amount of</u>

3/ Table 13. "Quantities of Radioactive Materials Requiring Evaluation of the Need for Offsite Emergency Preparedness. (Based on 1 rem effective dose equivalent outside the building.)"

The quantities listed in Table 13 are calculated based on the assumption that the exposed individual is at a distance of 100 meters on the plume centerline, atmospheric stability is class F with 1 m/s wind speed, release duration is 30 minutes, building size is 10 m by 25 m, no other obstructions are available to spread the plume, and the plume does not rise due to buoyancy.

material in Table 13, we conclude that protective actions in an urban area might save up to 0.00000002 lives per year per facility. Perhaps about 20 to 30 licensees have a possibility of such an accident or worse. For these facilities we recommend there should be notification of local authorities. However, no special facilities, equipment, or other resources for responding are considered necessary.

For a licensee with 50 times as much releasable material as in Table 13, we conclude that protective actions in a built up area might save up to 0.0000004 lives per year per facility. There may be 2 or 3 licensees with a capability of an accident this severe.

The cost of this preparedness may not be justified in terms of protecting public health and safety. Rather we would justify it in terms of the intangible benefit of being able to reassure the public that if an accident happens local authorities will be notified so they [may] take appropriate actions. (pp. 111-112)

13. NRC chose to include the recommendations from NUREG-1140 in the requirements established in 10 CFR 30.32(i) and 10 CFR 70.22(i). Evaluations in meeting the requirements set forth in 30.32(i) or 70.22(i) are reviewed by NRC in light of the methods used in NUREG-1140 (see ¶ 22, below). Due to the recognized conservative nature of the NUREG-1140 analysis used to obtain the values given in § 30.72 Schedule C, 4/ the NRC provided licensees the option to demonstrate that a plan is not needed because of site-specific factors, i.e., § 30.32(i)(1)(i) and § 70.22(i)(1)(i). NRC recognizes the conservatism of this proposed regulation [54 FR 14054, column 2, ¶3):

"The table of radionuclides in the proposed regulations was developed using conservative, pessimistic, or 'worst-case' assumptions. Each assumption is possible at some 'generic' facility, but may not be realistic for an actual facility. Thus the licensee is given the option [of] analyzing accidents for the actual existing facility and determining site-specific maximum credible releases."

NRC furthermore provides guidance on factors which may be used in this evaluation, i.e., § 30.32(i)(2) and § 70.22(i)(2).

14. Thus, NUREG-1140 is relevant in that it provided the basis for the additional NRC requirements for emergency plans in

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4/ § 30.72 Schedule C - "Quantities of radioactive materials requiring consideration of the need for an emergency plan for responding to a release."

applications for materials licenses.

Conservatism of NUREG-1140

15. The NRC recognizes the conservative nature of its analysis in NUREG-1140 and states [54 FR 14056, column 3, ¶2]:

> "...The NRC agrees that its dose calculations are very conservative and that doses from an actual accident are likely to be far lower than calculated."

This implies, as can be documented by references in NUREG-1140, that the NRC considers the theoretical releases which generically provide the basis for the table of radionuclides, represent a maximum generic release analysis, such that any applicant using site-specific information would likely find upon analysis, lower release values for its facility. This likelihood of a worst-case release at a specific facility being lower relative to that predicted from quantities of material in Table 13 of NUREG-1140 (§ 30.72 Schedule C) is due to the conservatism in the NRC release model.

16. The release model includes the following conservative factors (see Attachment 2 for copy of NUREG-1140 Section 2.1.5.1 describing each factor):

"1. Entire possession limit assumed to be involved.

2. Worst-case release fractions.

3. No credit for engineered safeguards or response efforts.

4. The exposed individual makes no response.

5. No plume-rise for smoke.

6. Conservative dosimetry.

7. Adverse meteorology.

8. Open-field site assumed.

9. No wind shifts.

10. 8-hour criticality. 5/

5/ This condition is of course only applicable for materials capable of reaching criticality. Ten grams of plutonium are incapable of reaching criticality.

11. There may be no one standing on the plume center line."

The release model in NUREG-1140 also recognized assumptions that may be nonconservative factors in certain instances. These are (description also contained in Attachment 2):

"1. Adult doses.

2. Breathing rates.

3. Site-specific factors not considered."

17. The conclusion with respect to the NRC analysis in NUREG-1140 is that the conservative factors of this analysis greatly outweigh the nonconservative factors and states (p. 19):

> "Any increase in dose due to such factors would not be significant in size by comparison with the sizes of the conservatisms discussed above."

Therefore, the significance of the possession and use of various quantities of material relative to the threshold quantities could be derived by the applicant or NRC staff reviewers without making site-specific calculations.

18. Neglecting any site-specific factors, a generic NUREG-1140 analysis for a quantity of one gram 6/ plutonium like the Licensee's is presented in Attachment 3. The results of this generic analysis show that Pu-239 and Pu-240 are the significant dose contributing isotopes and that a NUREG-1140 type analysis predicts effective dose equivalent to be 0.034 rem at 100 meters for this worst-case generic accident. This dose is 3.4% of the 1 rem protective action guide.

19. The same worst-case generic NUREG-1140 accident

6/ A quantity of one gram is used rather than the license limit of ten grams because of the following commitment stated in the application:

> "Cells have been constructed for the actinide metal measurements so that all measurements can be conducted with less than one gram of actinide metal in the cell." (see License No. SNM-247, Amendment Application, p. 13, ¶ 1)

In addition, as shown in the Affidavit of Dr. J. Steven Morris Regarding Safety Analysis (Licensee's Exhibit 3) at ¶ 40, the possibility of a release of the entire inventory of each material is not credible.

analysis can also be done for one gram 7/ of depleted uranium, neptunium, or americium. The resultant effective dose equivalents from this generic analysis are 0.0000004 rem, 0.0003 rem, and 1.6 rem for depleted uranium, neptunium, and americium, respectively. This highly conservative generic analysis results in a calculated effective dose equivalent somewhat higher than the 1 rem protective action guide. If the site-specific factor for MURR was used to determine dose at the nearest site boundary, the resultant dose equivalents would be about 20% of the generic doses, or 0.00000008 rem, 0.00006 rem, 0.007 rem, and 0.32 rem for depleted uranium, neptunium, plutonium, and americium, respectively. A site-specific evaluation replacing several of the generic factors assumed in NUREG-1140 with justifiable site-specific factors (as permitted by § 30.32(i)(1)(i)) would reduce the effective dose equivalent by several orders of magnitude, i.e., to small fractions of the 1 rem protective action guide. See, e.g., Affidavit of Daniel J. Osetek Regarding Safety of the TRUMP-S Project (Licensee's Exhibit 1 at ¶ 23).

<u>Response to Intervenors' Comments Concerning NUREG-1140</u>

20. The Intervenors state that Licensee's reliance on NUREG-1140 is misplaced (Intervenors' Written Presentation, p. 41). This statement is apparently a restatement of the following statement by Intervenors' Review Panel (Intervenors' Exhibit 1 at 76):

> "...Applicant may try to use NUREG-1140 as a basis of a claim of the safety of its TRUMP-S project, such a claim would be misdirected."

Licensee (not applicant) is not misdirected in using guidance provided by NUREG-1140, "Regulatory Analysis of Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licenses."

21. As discussed above (¶¶ 10 - 14, above), NUREG-1140 is the NRC document that provided the technical basis for the additional emergency preparedness regulations. In adopting 30.32(i) and 70.22(i), the Commission stated:

> "The conservative accident scenarios and dose calculation which formed the technical basis for the proposed rule are described in 'Regulatory Analysis of Emergency Preparedness

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7/ The same commitment to restrict experiments to less than one gram holds true for each of the actinide materials (see License No. 24-00513-32, Amendment Application, p. 13), as well as the release of the entire inventory of each material not being credible.

for Fuel Cycle and Other Radioactive Material Licenses,' NUREG-1140." 54 Fed. Reg. 14052 (April 7, 1989)

The Commission acknowledged that NUREG-1140 was the source of the Schedule C quantities of § 30.72 as follows:

"The table of quantities in Part 30 that would require evaluation of the need for an emergency plan was taken from 'A Regulatory Analysis of Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licenses,' NUREG-1140. The table lists quantities that might theoretically deliver an effective dose equivalent of 1 rem calculated by assuming that the most exposed member of the public would inhale a fraction of 10^{-6} of those materials... The table also includes all alpha emitters listed on any license for which the quantity to theoretically deliver a 1 rem effective dose equivalent would be less than 2 curies." Id.

22. Furthermore, in response to comment that methods of calculating doses from releases should be published, the Commission provided the following guidance:

"The methods have been published in 'A Regulatory Analysis of Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licenses,' NUREG-1140..." 54 Fed. Reg. 14058. (April 7, 1989)

23. Therefore, Licensee's use of NUREG-1140 is in no way misdirected. Licensee has used the highly conservative NUREG-1140 generic analysis approach to show that even under an incredible worst-case accident the potential offsite doses would be low. Then, by using more realistic site-specific factors of the type contemplated by NUREG-1140 (and the NRC's additional emergency preparedness regulations) Licensee has shown that potential offsite dose from a major fire would be minimal.

24. Intervenors state with respect to NUREG-1140 (Intervenors' Written Presentation, p. 41):

"The analysis was not intended to indicate that assurance was not needed of safe operations, appropriate fire response, and adequate training and equipment and so on for licensees with inventories below roughly estimated levels in the report."

Licensee agrees. However, NUREG-1140 and the NRC implementing regulations did determine that emergency plans of the type prescribed by 30.32(i)(1)(ii) and 70.22(i)(1)(ii) were not warranted with inventories below those specified in the report (without any site-specific analysis) or for inventories above those specified in the report (if justified by site-specific analyses). In this regard, by installing the Alpha Laboratory at a location covered by an established emergency plan, Licensee has provided emergency planning protection beyond what would have been required even if the regulations had been effective when the license amendments were issued.

25. Intervenors also state in reference to NUREG-1140 (Intervenors' Written Presentation, p.41):

> "It was intended merely to estimate for which licensees additional emergency response measures beyond those already required would be cost-effective."

This statement in not correct. In fact the NRC Staff conclusion in NUREG-1140 (p.112) states:

> "Although emergency preparedness for fuel cycle and other radioactive material licensees <u>cannot be shown to be cost effective</u>, the NRC feels that such preparedness represents a prudent step which should be taken in line with the NRC's philosophy of defense-in-depth, to minimize the adverse effects which could result from a severe accident at one of its facilities." (Emphasis added.)

Licensee agrees with NRC that such preparedness represents a prudent step of use of byproduct and special nuclear material at MURR. Licensee does not agree with Intervenors' attempt to summarize NUREG-1140 intent so narrowly and, in fact, incorrectly.

26. Intervenors' Review Panel projects false dangers by stating (Intervenors' Exhibit 1 at 77):

> "NUREG-1140 identifies a threshold over which the quantity of nuclear materials possessed pushes the licensee into an area of such <u>special danger</u> that extra emergency planning requirements would be considered appropriate." (Emphasis added.)

NRC does not recognize such "special dangers" associated with material licenses. NUREG-1140 provides guidelines relating to the scope of emergency preparedness at material license facilities. The executive summary, page v., states:

> "An appropriate plan would (1) identify accidents for which protective actions should be taken by people offsite, (2) list the licensee's responsibilities for each type of accident, including notification of local authorities (fire and police generally), and (3) give sample messages for local authorities including protective action recommendations. <u>This approach more closely follows the approach used for research reactors than for power reactors</u>. The low potential offsite dose

(acute fatalities and injuries not possible except possibly for UF_6 releases), the small areas where actions would be warranted, the small number of people involved, and the fact that the local police and fire departments would be doing essentially the same things they normally do, are all factors that tend to make a simple plan adequate." (Emphasis added.)

Further, the scale of potential emergencies at materials license facilities was discussed by the Commission as follows:

"These radiological emergencies would involve small (not life threatening) doses, small areas, and small numbers of people. The potential risks are much lower than the risk from accidents involving chemical plants or the shipping of hazardous chemicals to which states and local governments routine respond. In other words, the response to radiological accidents at fuel cycle and other radioactive materials licensees can and should be handled by state and local governments as part of their normal emergency response capability without additional resources... The NRC intentionally did not establish emergency planning zones, deciding instead to define the offsite response in terms of when offsite response organizations should be notified." 54 Fed. Reg. 14057 (April 7, 1989)

27. NUREG-1140 also provides the following general guidance in the event of emergencies at licensed materials facilities regarding protective actions (p. 102):

"The appropriate protective actions for an airborne release are: (1) sheltering in buildings with the windows closed, and (2) leaving the immediate vicinity. Sheltering with windows closed should provide, on the average, roughly a factor of three protection against the inhalation of radioactive materials. Inhalation is the dominant exposure pathway for all the radioactive materials of concern. A factor of three protection will result in a substantial dose reduction and will meet the EPA's objective of reducing dose for those people who would receive doses exceeding the protective action guides. Ad hoc respiratory protection could reduce exposures by an additional factor of three. Ad hoc respiratory protection means breathing through cloth such as a towel, a crumpled handkerchief, a bed sheet, or a blanket.

Leaving the vicinity can result in the complete elimination of exposure if it can be done before the release starts. The later the movement starts, the less the benefit. This action should not be confused with evacuation to great distances. The movement could be as little as 50 to 100 yards in a cross wind direction to get out of the direct downwind plume."

28. Intervenors' Review Panel (Intervenors' Exhibit 1 at 78) try to characterize Licensee's description of these conservative factors in the release model of NUREG-1140, used at a meeting to brief the media, as a "very dangerous attitude." Licensee <u>never</u> stated that there was no risk of using these radioactive materials, Licensee was <u>only</u> describing the conservative factors in the NUREG-1140 model that show that open field burning of 2 curies of plutonium or americium, without any engineered safety features, would not be likely to result in a person 100 meters from the burning to receive dose in excess of the lower limit of EPA protective action guides. Licensee most certainly does not propose to do an open field burning of this material, and does not have a "very dangerous attitude" about the use of these materials. Licensee's laboratory equipment, procedures and presence of an emergency plan to respond to emergencies attest to Licensee's high regard for the safety precautions appropriate for using these materials.

29. Intervenors' Review Panel (Intervenors' Exhibit 1 at 77 and 79) falsely portray the Licensee as having one of the most dangerous nuclear materials licenses in the entire country. NRC does not come to the conclusion that any of the country's material licenses are dangerous to the public. <u>8</u>/ The NRC acknowledged that there were numerous licensees with authorized quantities in excess of the quantities specified in NUREG-1140 and Schedule C of § 30.72, and obviously contemplated that additional licenses of this type would be considered. The limited potential offsite hazard presented by such licensed activities is emphasized by the guidance provided by NUREG-1140 regarding appropriate emergency response depending on the quantity of material (pp. 103-104):

<u>8</u>/ In reviewing a history of accidents involving all Part 30, Part 40, and Part 70 licensees (about 9000 NRC non-reactor licensees and another 12,000 Agreement state non-reactor licensees with combined experiences of approximately half a million licensee-years) the NRC found "no evidence that any accidental release of radioactive material from facilities of these types has ever caused an effective dose equivalent to any individual off-site exceeding even 1% of the EPA's 1-rem protective action guide," (NUREG-1140, p. 6) and "...[t]hus, no emergency protective actions have <u>ever</u> been necessary to protect people off-site from airborne releases of radioactivity." (<u>Id</u>., p. 70)

"Appropriate action distances are suggested below, keeping practicality in mind. It is considered impractical to bse distances on measurements of source terms and meteorological conditions. There would not be nearly enough time, nor is such assumed precision necessary or appropriate.

Thus, we will base estimated distances on assumed releases. It would not be practical or appropriate to assume a very-worst case conservative release. The Commission's policy is that, 'Emergency planning should be based on realistic assumptions regarding severe accidents.' (U.S. Nuclear Regulatory Commission Policy and Planning Guidance - 1985, NUREG-0885, Issue 4, 1985, page 6.)

For an accident involving a quantity of material 10 times the amount requiring a plan we recommend a response distance of about 100 meters.

The 100-meter distance is selected based on the following factors:

1. Isolation areas of this size are commonly used by emergency personnel.

2. Doses exceeding the lower end of the protective action guide range would generally not be expected beyond this distance for the largest plausible releases and average meteorology (D, 4.5 m/s) or for adverse meteorology (F, 1 m/s) with releases of more likely size (one-tenth the assumed maximums).

3. The upper end of the protective action guide range is unlikely to be exceeded beyond that distance even under very adverse but realistic circumstances (i.e., considering plume buoyancy, people not likely to remain in smoke, possible wind shifts, or other factors that may occur).

If the quantity of material involved in the accident is about 100 times the quantity requiring a plan the appropriate distance would be about 500 meters. The 500-meter distance is selected based on the following factors:

1. A 500-meter distance is still a practical size area for providing a reasonable response.

2. A distance of 500 meters provides approximately a factor of 10 dilution in concentration compared to 100 meters. (See Figure 1 curves for D, 4.5 m/s wind speed

and F, 1 m/s wind speed.)

> 3. For most accidents, the lower end of the protective action guide range would not be exceeded beyond that distance.
>
> 4. For worst-case accidents the upper end of the protective action guide range is unlikely to be exceeded under realistic circumstances."

30. If an appropriate site-specific evaluation of off-site doses is made, pre-planning of off-site response would not be required. But, on a generic basis, the foregoing quotations show that even for 10 times the amount of material requiring a plan (20 curies of plutonium or 20 curies of americium-241) the NRC recommends a response distance of only 100 meters. This coincides with the MURR EPZ of 100 meters. The quotation further shows that for a quantity of material involved in an accident 100 times the amount of material requiring a plan (200 curies of plutonium or 200 curies of americium-241) that the appropriate response distance is 500 meters. The MURR Emergency Procedures (SEP-5, Partial Site Area Evacuation Procedure) provide for evacuation of personnel to a distance of approximately 400 meters. Any reasonable linear or exponential curve drawn between 10 times 2 curies and 100 times 2 curies would show that for Licensee's authorized amount of americium-241 (12.5 times 2 curies) the 400 meters distance would amply satisfy the recommendation of NUREG-1140.

31. Finally, the conclusion of NUREG-1140 puts into true perspective NRC's assessment of hazards to the public from accidents and the cost-benefit of emergency plans for fuel cycle and other radioactive material licensees (pp. 111-112):

> "The conclusion of this Regulatory Analysis is that accidents at fuel cycle and other radioactive material licensees pose a very small risk to the public. Serious accidents are infrequent and would generally involve relatively small radiation doses to few people located in small areas.
>
> This is not to say that radiation doses large enough to exceed guides for taking protective actions cannot occur. It may be possible to have an accident at some licensed facilities which would cause offsite doses exceeding protective action guides. However, offsite radiation doses large enough to cause an acute fatality or even early injury from an airborne release are not considered plausible.
>
> For a licensee possessing 5 times the amount of material in Table 13, we conclude that protective actions in an

urban area might save up to 0.00000002 lives per year per facility. Perhaps about 20 to licensees have a possibility of such an accident or worse. For these facilities we recommend there should be notification of local authorities. However, no special facilities, equipment, or other resources for responding are considered necessary. (Emphasis added.)

For a licensee with 50 times as much releasable material as in Table 13, we conclude that protective actions in a built up area might save up to 0.00000004 lives per year per facility. There may be 2 or 3 licensees with a capability of an accident this severe.

The cost of this preparedness may not be justified in terms of protecting public health and safety. Rather we would justify it in terms of the intangible benefit of being able to reassure the public that if an accident happens local authorities will be notified so they may take appropriate actions."

32. In summary, Intervenors' are incorrect in their narrow interpretation of NUREG-1140 and are misleading in their contention that Licensee has one of the most hazardous licenses.

Review of Review Panel's Dispersion Concentrations

33. It is abundantly clear from a knowledgeable and professional scrutiny of the Intervenors' Written Presentation and Intervenors' Exhibit 1 prepared by the Interveners' Review Panel (Warf, et.al.) that their alleged concerns for public health and safety are based on "analyses" using incorrect methods, unknown assumptions, and misapplied data. Further, the Intervenors repeatedly wave the flag of false dangers based on their incorrect assessments. The dispersion analysis prepared by Warf, et.al. (Intervenors' Exhibit 1), is reviewed below, along with a previous filing containing the Intervenors' dispersion analysis (Declaration by Hirsch and Warf, dated June 11, 1990 at 11-12).

34. Warf, et.al., have provided a table of numbers described as resulting from their calculation of estimated concentrations of plutonium released in the case of a fire in the Alpha Laboratory at MURR. 9/ While Warf, et. al., provide some of the assumptions used to construct these numbers, the lack of description for the dispersion model used and the associated weather conditions assumed show either a lack of understanding on how to do a simple

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9/ See Intervenors' Exhibit 1, Table III.

dispersion calculation or a deliberate omission in an attempt to deflect criticism of their false claim of high concentrations of plutonium being released from a fire. To show the incredible nature of these numbers, the "missing" bases for Warf's, et. al., professed calculation must be evaluated in the presence of reality.

35. The examination of the Warf, et.al., concentration estimates is summarized in Attachment 4. Warf, et.al., state that their calculations are based on a 1 hour release of 1 gram of Pu, which they describe as containing 0.08 Ci, and assuming a release fraction of 0.03. Their release rate is therefore calculated to be $Q = 6.7 \times 10^{-7}$ Ci/sec. (See Attachment 4, ¶ 1)

36. I have then calculated and compared the X/Q values associated with the Warf, et.al., numbers to the most conservative X/Q values given in NUREG-1140. 10/ (See Attachment 4, ¶ 2) This comparison is made for the X/Q values given in NUREG-1140 at distances of 100 m and greater. It is not possible from the lack of information provided to determine how Warf, et.al., constructed numbers for distances less than 100 m. This is of little concern since public access is limited in case of emergency to distances well beyond 100 m from MURR. As shown in Attachment 4, Warf's, et.al., "model" for dispersion overestimates X/Q values by factors ranging from <u>30</u> to <u>90</u> times those associated with the most conservative values given in NUREG-1140.

37. To further examine the bases for these numbers, a simpler, and more conservative dispersion model is applied to the Warf, et.al., numbers. The Pasquill-Gifford model 11/ describing the ground level concentration at the centerline of a plume containing particulates and released at ground level is used to determine the wind speed. The prerequisite wind speeds required to produce the Warf, et.al., concentrations are calculated and these wind speeds range from 0.041 m/sec to 0.095 m/sec. This corresponds to at most a 0.2 mph wind speed needed to reconstruct Warf's, et.al., numbers. At this wind speed, <u>hours</u> are available to instruct the public at 500 m and beyond to seek shelter, or evacuate.

10/ NUREG-1140, Figure 1, Class F,1 m/s, no buoyancy assumption.

11/ Cember,H., <u>Introduction to Health Physics</u>, 2nd Edition, Equation 11.7 on p. 351.

It is surmised that Warf, et.al., assumed the plume contains particulates since they state that they ignored resuspension (Note 2 in Warf, et.al., Table III).

In fact, people standing 600 m away could do as little as walk about 300 feet cross wind to get out of the plume!

38. Of course these types of conjectures, like Warf's, et.al., "concentrations", are incredibly far from reality. In reality, the smoke from a fire would rise in such calm wind conditions which would decrease the concentration in the plume. In reality, the plume in such calm wind conditions would meander (change wind directions) which would limit the time a person is exposed to the plume. In reality, weather conditions are seldom this adverse and any change in Stability Class or increase in wind speed would decrease the concentration in the plume (see Attachment 3 at ¶ 4).

39. Other aspects of Warf's, et.al., analysis are equally incredible. The Alpha Laboratory is located in the basement of the MURR laboratory building where the only non-HEPA filtered, ground release route 12/ out of the building is through a portion of the basement with a volume of greater than 1400 m^3. Release of plutonium from a fire in the Alpha Laboratory would naturally mix in this volume, and, even using Warf's, et.al., incredible release assumptions, would result in a concentration of 1.7×10^{-6} Ci/m^3. Warf, et.al., claim the concentration is <u>26 times higher</u> than this concentration "at 1 meter distance from TRUMP-S Bldg" (Intervenors' Exhibit 1, Table III). It is not clear what Warf, et.al., mean by "distance from the TRUMP-S Bldg." If they mean distance from the Alpha Laboratory, then they are obviously misapplying whatever atmospheric dispersion model they are using to hold true inside a basement! If they mean distance from the outside wall of the MURR laboratory building, then one must assume their model somehow magically and insidiously concentrates the airborne plutonium as it leaves the building! Intervenors' claims of incredibly high concentrations of plutonium being released from a fire are completely without merit.

40. The level of contamination associated with airborne release of materials is directly dependent on the concentration of that material in air. Since Warf's, et.al., plutonium concentrations have been shown to be incredible, Intervenors' claim that "a substantial area could be contaminated to levels not permitted for release for unrestricted use, pursuant to Reg. Guide 1.86," 13/

12/ As described in the incredible scenario given in Hirsch/Warf Declaration.

13/ Regulatory Guide 1.86: "Termination of Operating Licenses for Nuclear Reactors," July 1974, Table I.

(Hirsch/Warf Declaration , June 11, 1990 at 12) is equally without merit. The same guidance on acceptable contamination levels is found in RG 10.3, Section 4.6.3.4:

> "Acceptable limits of fixed and removable contamination for facilities and equipment in unrestricted areas and for release for unrestricted use should be set. For example, after reasonable effort to remove all residual contamination, if maximum alpha levels are 300 dpm/100 cm^2 or less, and the average is 100 dpm/100 cm^2 or less, unrestricted use is permissible, provided that removable alpha contamination does not exceed 20 dpm/100 cm^2. These guidelines apply to all special nuclear material except mixtures of the naturally occurring isotopes of uranium (U-234, U-235, U-238) for which the levels may be a factor of 5 higher."

Based on the factors used in the site specific evaluation (See Affidavit of Daniel J. Osetek Regarding Safety of the TRUMP-S Project, Licensee's Exhibit 1), the highest contamination levels due to release of plutonium or americium external to the MURR building would not exceed the RG 10.3 contamination guide for unrestricted use.

41. Additionally, Warf, et.al., misapply the emergency action level associated with classifying an emergency as an Unusual Event. The description of how to apply the action level of 10 MPC is given in Table I of ANSI/ANS-15.18-1982, a copy of which was attached to Intervenors' Exhibit 1. The action level specifically says:

> "Actual or projected radiological effluents at the <u>site boundary</u> exceeding 10 MPC when averaged over 24 hours..." (Emphasis added.)

The nearest site boundary defined for MURR <u>14</u>/ is at approximately 400 meters. Warf, et.al., inappropriately calculate their imaginary factor above the emergency action level for all distances in their Table III. Warf, et.al., state (Intervenors' Exhibit 1 at ¶ 66):

> "We should note that the dispersion calculations that had been attached to the Warf/Hirsch declaration of 11 June were based on MURR's claim that 3800 MPC was required for declaring emergency response; we have now revised the calculations to take into account the true

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<u>14</u>/ MURR Emergency Plan - 9.11 Definition of <u>Nearest Site Boundary</u>. Intervenors were supplied a copy of MURR's Emergency Plan on June 26, 1990.

emergency threshold and certain other factors."

The action levels for declaring an Unusual Event at MURR are given in Licensee's Emergency Plan, Table I which states:

"3) Concentration of airborne radioactivity *at the stack monitor* exceeding 3800 MPC when averaged over 24 hours.

4) The projected concentration of airborne radiological effluents *at the distance corresponding to the nearest site boundary* exceeding 10 MPC when averaged over 24 hours." (Emphasis added.)

Warf, et. al., are correct that 10 MPC is an action level at MURR, but this level applies only at the site boundary. Licensee's use of 3800 MPC is also a true action level, but only when applied at the point of stack release. Warf, et. al., misapply the use of the 10 MPC action level at distances different than the MURR site boundary.

42. In summary, Intervenors' claims of danger to the public and widespread contamination are completely without merit. Their claims are based on an accident "analysis" which states no reference to justify use of an incredible dispersion model, and which misuses emergency action levels to incorrectly imply the need for mass evacuation at great distances.

Summary

43. Thus, Licensee has comprehensively shown that:

1.) NUREG-1140 is relevant to Licensee in that it is the basis for NRC's regulations for additional emergency preparedness.

2.) The NUREG-1140 dispersion model is conservative in its estimation of off-site doses and is considered by the NRC to estimate the upper dose limit as the generic worst-case accident analysis.

3.) Intervenors are incorrect in recognizing only a narrow view of NUREG-1140 and misrepresent Licensee's purpose in discussing the relevance of NUREG-1140.

4.) Intervenors and Intervenors' Review Panel are misleading in their contention that Licensee has one of the most hazardous licenses.

5.) Intervenors' Review Panel has misrepresented plutonium concentrations and the emergency actions required in their release analysis.

Subscribed and sworn before me in

Boone County, Missouri this 13th day of November 1990

Susan M. Langhorst
Susan M. Langhorst
Manager,
Reactor Health Physics

Sharon Wesselman
Notary Public

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

My Commission Expires

2-21-91

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EDUCATION:

Ph.D., Nuclear Engineering/Health Physics Option, University of Missouri-Columbia, 1982

M.S., Nuclear Engineering/Health Physics Option, University of Missouri-Columbia, 1979

B.S., Nuclear Engineering, University of Missouri-Rolla, 1976

PROFESSIONAL EXPERIENCE:

Manager, Reactor Health Physics, Research Reactor, University of Missouri, April 1987 to present

Responsible for radiation safety program at 10 MW research reactor and work performed under all material licenses at the reactor.

Certified Health Physicist, American Board of Health Physics, September 1985 to present; Member of the Panel of Examiners, August 1988 to present

Assistant Professor, Nuclear Engineering Program, University of Missouri-Columbia, August 1983 to present; Graduate Faculty Senator, August 1986 to present; Graduate Faculty Senate Secretary, August 1989 - August 1990.

Research Scientist, Research Reactor, University of Missouri, September 1980 to April 1987

Responsible for evaluation and development of analyses in support of an environmental report for power upgrade at MURR, June 1985 to April 1987.

Leader of Reactor Chemistry Group responsible for radioactive materials monitoring via gamma and beta spectroscopy in support of measurements required by reactor and material licenses, September 1980 to May 1985.

Instructor, Nuclear Engineering Program, University of Missouri-Columbia, August 1982 to August 1983.

Graduate Student, Nuclear Engineering Program, University of Missouri-Columbia, August 1976-August 1982

Graduate and Professional Opportunities Program Fellow, September 1979 to August 1980
Graduate Research Assistant, Research Reactor, September 1978 to August 1979
Gregory Fellow, September 1977 to August 1978

Engineering Assistant, Nuclear Engineering: Union Electric, St. Louis, Missouri, May 1975 to August 1975 and May 1976 to August 1976

Clerk, Quality Assurance: Union Electric, St. Louis, Missouri, May 1974 to August 1974

HONORS AND AWARDS:

Woman of Achievement in Energy, Missouri Women in Energy, 1990

Listed in Outstanding Young Women of America, 1982 & 1985

Who's Who Among Students in American Colleges and Universities, 1978 & 1979

Bachelor of Science, Summa Cum Laude, University of Missouri-Rolla, 1976

Nuclear Honor Society, University of Missouri-Rolla

Phi Kappa Phi

Tau Beta Pi

Curator Scholar, University of Missouri-Rolla, 1972-1976

PROFESSIONAL ORGANIZATIONS:

American Nuclear Society: Secretary of Student Branch, Univ. of Missouri-Columbia, 1976-77; Governor of Student Branch, Univ. of Missouri-Columbia, 1977-79; Governor of Central/Eastern Missouri Section, 1985-87

Health Physics Society: Councilperson for Mid-America Chapter, March 1989 to present.

Women In Energy, Inc.: State Treasurer-Missouri, 1980-82; National Treasurer, October 1983 to September 1984; Vice Chairman, Mid-Mo Chapter, October 1984 to September 1985

ADDITIONAL TRAINING:

"Internal Radiation Dosimetry," Health Physics Society Summer School, University of Maryland at Baltimore County, June 12-17, 1983.

"Practical Statistics for Operational Health Physics," Health Physics Society Summer School, Idaho State University, July 12-17, 1987.

"Air Transportation of Dangerous Goods Seminar/Workshop," Federal Express Corporation, Kansas City, MO, March 8-9, 1988.

"Radiological Emergency Response Training for State and Local Government Emergency Preparedness Personnel," Federal Emergency Management Agency/Reynolds Electrical & Engineering Co., Inc., U.S. Department of Energy Nevada Test Site, September 20-29, 1989.

Member of the Missouri Nuclear Emergency Team (MoNET) under the Emergency Management Agency, Office of Adjunct General. Missouri Department of Public Safety.

PUBLICATIONS:

Langhorst, S. M., J. S. Morris, and S. R. Bull, "Tritium Monitoring Methodology and Application at a Research Reactor," Health Physics, Vol. 40 (June 1981).

Langhorst, S. M., J. S. Morris, and W. H. Miller, "Investigation of Charcoal Filters Used in Monitoring Radioactive Iodine," Health Physics, Vol. 48 (March 1985).

PUBLICATIONS continued:

Spate, V. L., S. M. Langhorst, and A. M. DuChemin, "Excretion of S-35 from Two Contaminated Workers," Health Physics, Vol. 49 (July 1985).

Widmer, D. J., K. W. Logan, S. M. Langhorst, and W. L. Kennedy, "Gamma Camera Measurement of Accidental Internal Radionuclide Deposition: Ir-192 and Sm-153," Health Physics, Vol. 51 (September 1986).

Spate, V. L. and S. M. Langhorst, "A Comparison of the Counting Characteristics of Opti-Fluor® and Aquasol-2®: Liquid Scintillation Cocktail," Health Physics, Vol. 51 (November 1986).

PAPERS AND PRESENTATIONS:

Langhorst, S. M., J. S. Morris, and S. R. Bull, "Tritium Monitoring Methodology Using a Desiccant and Application to a Research Reactor Facility," American Nuclear Society Transactions, Vol. 32 (1979).

Spate, V. L., J. S. Morris, and S. M. Langhorst, "Argon-41 Monitoring at a Research Reactor," American Nuclear Society Transactions, Vol. 39 (December 1981).

Langhorst, S. M. , J. S. Morris, and W. H. Miller, "Analysis of Loading Iodine onto Charcoal Filters," American Nuclear Society Transactions, Vol. 39 (December 1981).

DuChemin, A. M., S. M. Langhorst, J. S. Morris, and V. L. Spate, "Tritium Monitoring at the University of Missouri Research Reactor," Ninth Biennial Campus Radiation Safety Officers Conference (June 1983).

Spate, V. L., S. M. Langhorst, and A. M. DuChemin, "Internal Dose Determination for S-35 Contamination," Ninth Biennial Campus Radiation Safety Officers Conference (June 1983).

Langhorst, S. M., J. S. Morris, and W. H. Miller, "Investigation of Iodine Loading onto Charcoal Filters Used in Air Sampling Equipment," 28th Annual Meeting of the Health Physics Society, Baltimore, MD (June 1983).

Spate, V. L. and S. M. Langhorst, "Evaluation of a Gamma Ray Analysis Procedure for Pool and Primary Water at a Research Reactor," 29th Annual Meeting of the Health Physics Society, New Orleans, LA (June 1984).

Langhorst, S. M., "Analyses of Charcoal Filters Used in Monitoring Radioactive Iodines," 18th DOE Nuclear Airborne Waste Management and Air Cleaning Conference, Baltimore, MD (August 1984).

Langhorst, S. M. and J. S. Morris, "Panel Discussion on Iodine Release from the Three Mile Island Accident: MURR Analyses of Samples," Dosimetry Workshop sponsored by the Three Mile Island Public Health Fund, Philadelphia, PA (November 1984).

Spate, V. L. and S. M. Langhorst, "New Generation Liquid Scintillation Cocktail: Could We Switch to Pitch?" 30th Annual Meeting of the Health Physics Society, Chicago, IL (June 1985).

Elam, J. M., S. M. Langhorst, and M.D. Glascock, "Thermoluminescence Glow Curve Characterization and Sourcing of Ancient Ceramics: Comparison and Control with Neutron Activation Analysis," American Nuclear Society Transactions, Vol. 53 (Nov 1986).

PAPERS AND PRESENTATIONS continued:

Schuh, J. M., S. M. Langhorst and V. L. Spate, "Calibration and Utilization of TLD600/700 Thermoluminescent Dosimeter Pairs for the Determination of Absorbed Dose to the Biological Shield of the University of Missouri Research Reactor," Health Physics Society Annual Meeting, Boston, MA (July 1988).

Slaback, L., S. M. Langhorst, "Impact of New Part 20 on Operations," TRTR Annual Meeting, State College, PA (October 1990).

GRANT PROPOSAL ACTIVITY

Podzimek, J., M. Straka, S. Loyalka, S. Langhorst, and R. Warder, "Use of Neutron Activation Technique for the Study of Scavenger Collection Efficiency," Funded by UMC Weldon Spring Endowment Fund (March 1986): $24,000.

Loyalka, S. K., S. M. Langhorst, and R. Warder, "Characterization of Radioiodine and Particulate Transmission Through Air Sampling Lines at the Callaway Nuclear Power Plant," Proposed to Union Electric Company (June 1986). Requested 1 year funding $42,964. Funding to date: $5,000 via UMC Student Training in Engineering Problem Solving Program.

Miller, W. H. and S. M. Langhorst, "Summer Workshop on Nuclear Science and Engineering for Secondary School Teachers," Funded by Union Electric. $15,000 for 1990. Funded for past ten years.

Storvick, T. S., P. Sharp, L. Krueger, C. McKibben, and S.M. Langhorst, "Engineering, Chemistry and MURR Program Support of the Rockwell International TRUMP-S Project," Funded by Rockwell International (January 1990): $490,000.

CONSULTING:

Dow Chemical Company, May 1986 to present

Radiation safety assessment of procedures and equipment, and health physics training.

2.1.5.1 Conservative Factors

1. Entire possession limit assumed to be involved. In calculating the quantities of radioactive material for which an emergency plan would be needed, this analysis generally assumed that the licensee's entire or nearly entire possession limit would be involved. In actuality, most licensees at any particular time possess much less material than they are legally authorized to possess. In many cases the possessed material will be located at different locations and will not all be subject to release during a particular accident. For example, the National Institutes of Health is authorized to use and store licensed material in more than 1,000 different laboratories.

2. Worst-case release fractions. The release fractions due to fires (the accidents with highest potential release) were determined from experiments designed to maximize releases. In such experiments a finely powdered material is typically placed on top of a large amount of combustible material. Having the entire licensed inventory unenclosed on top of a large quantity of combustible material would be most unusual. Radioactive materials are usually within shielded "pigs" and kept in metal safes or well shielded hot cells or glove boxes. Amounts of combustible materials present are generally kept low.

3. No credit for engineered safeguards or response efforts. No credit is generally given for design or operating features that could reduce releases. No credit is given for sprinkler systems designed to stop fires. Generally, no credit is given for filter systems during a fire. No credit is given for fire fighting efforts to stop the fire before it reaches radioactive materials. Little or no credit is given for holding up the release of the material by means of deposition or plateout. For UF_6 releases outdoors, no credit is given for knocking the uranium out of the air using fire hoses.

4. The exposed individual makes no response. In the case of fires and UF_6 releases, the dose is calculated for a person who stands directly on the plume centerline for 30 minutes. Such a person would be standing in dense smoke or irritating acid fumes. Realistically, people can be expected to move from such positions to avoid smoke inhalation. People close in would only have to move about 20 meters to get completely out of the plume.

5. No plume-rise for smoke. Even where the assumed accident is a large fire no credit is given for plume rise due to buoyancy in calculating the quantities of radioactive material for which an emergency plan would be needed. The smoke is assumed to be released at and remain at ground level.

6. Conservative dosimetry. The material is assumed to have the solubility which would result in the highest dose per curie inhaled. Particulates are generally assumed to have a size of 1 micron making them highly respirable and transportable.

7. Adverse meteorology. Quantities of radioactive material for which an emergency plan would be needed were calculated for atmospheric stability class F with a 1 m/s windspeed. These conditions result in minimal dilution and high plume centerline doses, but also very narrow plumes. It is probable that the actual weather would cause lower doses. For example, doses during a moderately sunny day with average winds would be a factor of 50 times smaller than the doses calculated for the analysis.

8. Open-field site assumed. A rural open-field site is assumed. Greater atmospheric dispersion and thus lower doses would occur at an urban or suburban site. Buildings, trees, or other obstacles in the plume path would broaden the plume. Heat sources would increase the plume height.

9. No wind shifts. Doses are calculated only on the plume centerline. It is assumed that no wind direction shifts occur during the accident. In addition, correction factors for plume meander are conservative; the factors were selected to envelope the experimental data. Normally greater plume meander would be expected.

10. 8-hour criticality. The source term assumes a pulsating criticality with a total of 48 bursts occurring over 8 hours (see Section 2.2.5.2). This is a highly conservative source term.

11. There may be no one standing on the plume centerline. The doses are calculated for single point, and they fall off rapidly as one moves away from the point. Even with no protective actions, the highest dose anyone would receive is likely to be well below the assumed dose.

2.1.5.2 Nonconservative Factors

On the other hand there are certain assumptions in the dose calculations that may be nonconservative in certain instances. These factors are discussed below:

1. Adult doses. Doses are calculated for adults rather than children (except for radioiodine doses which are calculated for children). This is because dose conversion factors for children using modern dosimeter models are generally not available. For some inhaled radionuclides a child standing in

the plume may perhaps receive a dose 2 or 3 times higher than an adult standing at the same location.

2. Breathing rates. The breathing rate used in the dose calculations (2.66×10^{-4} m^3/s) represents an average breathing rate. Breathing rates for above average activity would be higher.

3. Site-specific factors not considered. The table of quantities of material for which emergency planning should be considered was based on assumptions (for example building wake) that would usually be conservative, but may not be conservative for all instances. For example, the building wake factor for a particular building could be less than assumed although it would generally be larger. This should be a minor factor. Any increases in dose due to such factors would not be significant in size by comparison with the sizes of the conservatisms discussed above.

2.2 Fuel Cycle Facilities

2.2.1 Uranium Mining

Uranium mining is not considered in this report because the NRC has no regulatory jurisdiction over uranium mining. Uranium mining is regulated instead by the Mine Safety and Health Administration, the Environmental Protection Agency, and the individual states.

2.2.2 Uranium Milling

Uranium mills extract uranium from ore that typically averages about 1 part per 1000 uranium. The mills produce concentrated uranium compounds, which are shipped out in 55 gallon drums, and waste "tailings," which contain radium-226 and thorium-230 not removed from the ore by the mill processes. In late 1984 there were about 10 full-scale uranium mills operating in the U.S. In addition, there are smaller facilities that perform some of the processes found in milling. Roughly half the mills are licensed by the NRC. The others are licensed by Agreement States.

In addition, this section considers "in-situ" solution uranium mining, in which a solution that has leached uranium from the ground is pumped up and uranium extracted from the solution.

ATTACHMENT 3

EVALUATION OF DOSE DUE TO ACCIDENTAL RELEASE OF PLUTONIUM BASED ON GENERIC NUREG-1140 METHOD

Introduction

1. The maximum credible accident which would involve plutonium of the type used in the Alpha Laboratory is considered by the NRC to be a fire. NUREG-1140 describes NRC's generic method of calculating the effective dose equivalent from such a postulated accident to assess the need to take protective actions, i.e., move indoors, evacuate, or move out of the plume. The following describes the evaluation which uses generic NUREG-1140 methods and shows that the maximum dose to a member of the public offsite due to a one hour release of plutonium from a fire would not exceed 1 rem effective dose equivalent for 1 gram of plutonium of the type licensed by Licensee's SNM-247 license.

Release Fraction

2. NUREG-1140 calculations use several conservative factors and as stated (p. 17) in 2. Worst-case release fractions:

> "The release fractions due to fires (the accidents with highest potential release) were determined from experiments designed to maximize releases. In such experiments a finely powdered material is typically placed on top of a large amount of combustible material."

The foregoing worst-case release fraction for plutonium metal is given as 0.001 in NUREG-1140 (p. 76 and in Table 13). The conservative nature of this factor is pointed out in § 70.22(i)(2)(iii):

> "In the case of fires or explosions, the release fraction would be lower than 0.001 due to the chemical or physical form of the material."

For this evaluation, the release fraction is assumed to be 0.001.

Plutonium Material

3. For this evaluation, one gram of the plutonium metal sample is assumed to be involved in a fire. Results are therefore on a per gram basis and can be scaled up or down for evaluation of different masses of plutonium. The isotopic content assumed for the plutonium in this evaluation is based on additional data provided by New Brunswick Laboratory for CRM 127. 1/

1/ LANL letter dated January 20, 1982 to T.E. Gills (NBS) from J.C. Rein and G.R. Waterbury (LANL). (See Affidavit

Dispersion Model

4. The atmospheric dispersion factor (X/Q) versus distance is given in Figure 1 of NUREG-1140 (p. 13). As stated in NUREG-1140 (p. 10):

"The F, with 1 m/s assumptions are those traditionally used by NRC in hazard evaluation and represent very adverse weather conditions. The D, 4.5 m/s assumptions are those traditionally used by DOT in calculating evacuation distances for accidents involving toxic chemicals and represent more typical weather. DOT considers evacuation distances based on D, 4.5 m/s adequate to protect public health and safety as demonstrated by experience with toxic releases."

The computer code used to generate this atmospheric dispersion information is a version of the CRAC2 computer code 2/ which has been used extensively by the NRC for calculations of offsite doses that could result from nuclear power plant accidents. For this evaluation, the X/Q value for the F, 1 m/s, no buoyancy assumption at a distance of 100 meters is used ($X/Q = 3.4 \times 10^{-3}$ sec/m^3). This results in the most conservative estimate (highest value) for concentration of airborne plutonium, or a factor of approximately eight times higher than DOT would reasonably estimate.

Dose Calculation

5. The effective dose equivalent is based on inhalation of the airborne plutonium. External dose due to exposure to plutonium is minimal. Dose conversions factors for each isotope are obtained from Table 13 of NUREG-1140 (p. 80). Breathing rate is assumed to be 2.66×10^{-4} m^3/sec, as stated in NUREG-1140 (p. 11). The individual being exposed is assumed to stand at the point of highest airborne plutonium concentration for the entire release time of one hour. 3/

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of Dr. J. Steven Morris Regarding Plutonium Content (October 29, 1990), Attachment 7)

2/ NUREG-1140 lists reference:

L.T. Ritchie et al., "CRAC2 Model Description," Sandia National Laboratories, NUREG/CR-2552, SAND82-0342, April 1984.

3/ The calculated dose is essentially independent of time as

Evaluation Results

6. The results for this evaluation are summarized in Table 3-1. Descriptions of the calculations are given in the footnotes of the table.

Evaluation Conclusions

7. Using the evaluation method on which the regulatory requirements of 10 CFR 70.22(i) are based, the total effective dose equivalent received by an individual standing at 100 meters downwind of a one hour accidental release from a fire involving one gram of plutonium is calculated to be 0.034 rem.

8. The effective dose equivalent due to Pu-239 is 79% of the total and due to Pu-240 is 17% of the total, which together represent 96% of the total effective dose equivalent. 4/ An additional isotope which builds up due to the decay of Pu-241 is Am-241. The estimated activity of Am-241 in a 1 gram sample of CRM 127 as of September 1990 is less than 0.007 Ci. Using the same method of calculation as described above, the effective dose equivalent due to this amount of Am-241 in a 1 gram sample would be less than 0.003 rem. The plutonium material is indicated to be quite homogenous 5/ and so release of the material through a fire would release the same ratio of isotopes. The effective dose equivalent due to this amount of Am-241 would therefore not significantly contribute to the total effective dose equivalent from the release of the plutonium material.

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long as the individual is exposed to the maximum concentration for the whole time of the release (i.e., wind speed and direction remains constant and the individual does not move out of the plume). This can be explained by noting that the time factor (in this case, 3600 sec) appears in the denominator of the release rate equation (see attached Table 3-1, Note (f)), but is then used again in the numerator of the inhaled activity equation (Id., Note (i)). If the equations were combined into one equation, the time factor for this case would be:

$$\frac{3600 \text{ sec}}{3600 \text{ sec}} = 1$$

Thus for this simple model, the release time can be any value as long as the total breathing time is the same.

4/ Dose due to Pu-241 would be negligible, i.e., 0.0011 rem or 3.2% of the total.

5/ CRM 127 Certificate

Table 3-1. Generic Worst Case Analysis (NUREG-1140) of Accidental Release of Plutonium

Isotope	$T_{1/2}$ [a] (y)	Atom %[a] at Feb 75	Decay [b]	Atom % [c] at Sep 90	N [d] (atoms/g)	SA [e] (Ci/g)	Q [f] (Ci/sec)	χ [g] at 100 m (Ci/m³)	Inhaled [h] Act (μCi)	DF [i] (rem/μCi)	Dose [j] (rem)	% of Total Dose
Pu-238	87.74	0.0092	0.885	0.0081	2.0×10^{17}	1.4×10^{-3}	3.9×10^{-10}	1.3×10^{-12}	1.2×10^{-6}	460	5.5×10^{-4}	1.6
Pu-239	24119	94.198	1.00	94.198	2.4×10^{21}	5.9×10^{-2}	1.6×10^{-8}	5.4×10^{-11}	5.2x1[illegible]	510	2.7×10^{-2}	79.4
Pu-240	6540	5.53	0.998	5.52	1.4×10^{20}	1.3×10^{-2}	3.6×10^{-9}	1.2×10^{-11}	1.1×10^{-5}	510	5.6×10^{-3}	16.5
Pu-241	14.4	0.245	0.474	0.116	2.9×10^{18}	1.2×10^{-1}	3.3×10^{-8}	1.1×10^{-10}	1.1×10^{-4}	10	1.1×10^{-3}	3.2
Pu-242	387000	0.018	1.00	0.018	4.5×10^{17}	6.9×10^{-7}	1.9×10^{-13}	6.5×10^{-16}	6.2×10^{-10}	490	3.0×10^{-7}	0.0009
											Total = 3.4×10^{-2}	
											Pu-239/240 = 3.3×10^{-2}	

(a) Data on half life ($T_{1/2}$) and atom percents (Atom%) as of February 1975 for CRM 127.

(b) Decay = $e^{-(ln2/T_{1/2})(t)}$ where t = 15.5y (February 1975 to September 1990).

(c) Atom% at Sep 90 = (Atom% at Feb 75)(Decay)

(d) Atomic weight for plutonium = 239.12 g/g mole as per October 1, 1987 Certificate for CRM 127. $\therefore N = \frac{(\text{Atom\% at Sep 90})(6.023\times10^{23}\ \text{atoms/g mole})}{(100)(239.12\ \text{g/g mole})}$

(e) Specify activity: $SA = (ln2/T_{1/2})(N)(3.17\times10^{-8} y/sec)(1\ Ci/3.7\times10^{10} dps)$

(f) Release rate (Q) assuming 1 g plutonium, release fraction = 0.001, and release time = 1 hour. $\therefore Q = (SA)(1\ g)(0.001)/(3600\ sec)$

(g) Concentration (χ) at 100 m where $\chi/Q = 3.4\times10^{-3} sec/m^3$ $\therefore \chi = (Q)(3.4\times10^{-3} sec/m^3)$

(h) Inhaled activity = $(\chi)(2.66\times10^{-4} m^3/$[illegible]$)(3600\ sec)(10^6 \mu Ci/Ci)$

(i) Dose factor (DF) in rem/μCi inhaled from NUREG-1140, Table 13

(j) Effective dose equivalent: Dose = (Inhaled Act)(DF)

ATTACHMENT 4

EXAMINATION OF WARF, ET.AL., DISPERSION CONCENTRATIONS

1. The examination of the Warf, et.al., dispersion concentrations (Intervenors' Exhibit 1, Table III) is summarized in Table 4-1. Warf, et.al., state that their calculations are based on a 1 hour release of 1 gram of Pu, which they describe as containing 0.08 Ci, assuming a release fraction of 0.03. Their release rate is therefore assumed to be:

$$Q = (0.08Ci)(0.03)/(3600sec)$$
$$= 6.7\times10^{-7} Ci/sec$$

2. The X/Q values associated with the Warf,et.al., numbers are calculated and compared to the most conservative X/Q values given in NUREG-1140. 1/ This comparison is made for the X/Q values given in NUREG-1140 at distances of 100m and greater. It is not possible from the lack of information provided to determine how Warf, et.al., constructed numbers for distances less than 100m. The overestimation factor is the ratio of the Warf, et.al., X/Q value to the corresponding NUREG-1140 X/Q value. The Warf, et.al., X/Q values are shown to be 30 to 90 times higher than the most conservative NUREG-1140 X/Q values.

3. For this examination, a simpler, and even more conservative dispersion model is applied to the Warf, et.al., numbers. The Pasquill-Gifford model describing the ground level concentration at the centerline of a plume containing particulates and released at ground level is given by Equation 1: 2/

$$X/Q = \frac{1}{2\pi\sigma_y\sigma_z\mu} \qquad \text{Equation 1}$$

where, X = ground level concentration (Ci/m^3) at a

1/ NUREG-1140, Figure 1, Class F,1m/s, no buoyancy assumption. See Attachment 3 at ¶ 4 for description of conservatism of these assumptions.

2/ Cember,H., Introduction to Health Physics, 2nd Edition, Equation 11.7 on p. 351.

It is surmised that Warf, et.al., assumed the plume contains particulates since they state that they ignored resuspension (Note 2 in Warf, et.al., Table III).

point, x,

x = downwind distance on plume center line (m),

Q = release rate (Ci/sec),

σ_y, σ_z = horizontal and vertical standard deviations of concentration in the plume (m),

μ = mean wind speed at level of plume center line (m/sec).

4. Values for σ_y and σ_z, 3/ which are given in the literature at 100m or more from the source, are listed for the most conservative (worst) weather stability class, F, resulting in the highest estimated concentrations. Substituting these σ_y and σ_z values into Equation 1, the prerequisite wind speeds required to produce the Warf, et.al., concentrations are calculated and these wind speeds range from 0.041m/sec to 0.095m/sec. This corresponds to at most a 0.2 mph wind speed needed to reconstruct Warf's, et.al., numbers.

3/ Cember, H., Introduction to Health Physics, 2nd Edition, pp. 349-350.

TABLE 4-1. Evaluation of Warf, et. al., Dispersion Concentrations for Plutonium

	Warf, et. al.		NUREG-1140	Over-	Stability Class F(f)		
$x^{(a)(b)}$ (m)	$\chi^{(b)}$ (Ci/m^3)	$\chi/Q^{(c)}$ (sec/m^3)	$\chi/Q^{(d)}$ (sec/m^3)	estimation Factor(e)	σ_y (m)	σ_z (m)	$\mu^{(g)}$ (m/sec)
1	4.5×10^{-5}	6.7×10^{1}	-	-	-	-	-
5	2.8×10^{-5}	4.2×10^{1}	-	-	-	-	-
10	1.7×10^{-5}	2.5×10^{1}	-	-	-	-	-
15	1.1×10^{-5}	1.6×10^{1}	-	-	-	-	-
20	8.3×10^{-6}	1.2×10^{1}	-	-	-	-	-
30	4.9×10^{-6}	7.3×10^{0}	-	-	-	-	-
50	2.3×10^{-6}	3.4×10^{0}	-	-	-	-	-
100	2.0×10^{-7}	3.0×10^{-1}	3.4×10^{-3}	90	4.0	1.4	0.095
170	7.6×10^{-8}	1.1×10^{-1}	1.8×10^{-3}	60	7.0	2.6	0.079
300	2.5×10^{-8}	3.7×10^{-2}	9.0×10^{-4}	40	11	4.6	0.085
600	7.6×10^{-9}	1.1×10^{-2}	3.2×10^{-4}	30	22	9.0	0.073
1000	4.0×10^{-9}	6.0×10^{-3}	1.5×10^{-4}	40	36	13	0.057
1600	2.4×10^{-9}	3.6×10^{-3}	5.2×10^{-5}	70	60	18	0.041

(a) Distance from release

(b) Values from Intervenors' Exhibit 1, Table III

(c) Assuming $Q = 6.7\times10^{-7}$ Ci/sec

(d) Values from NUREG-1140, Figure 1, Class F, 1 m/sec, no buoyancy

(e) Overestimation Factor = (χ/Q) Warf, et.al./(χ/Q) NUREG-1140

(f) Cember, H., Introduction to Health Physics, 2nd Edition, pp. 349-350

(g) Prerequisite wind speed to obtain Warf, et.al., χ/Q values, as calculated from Equation 1