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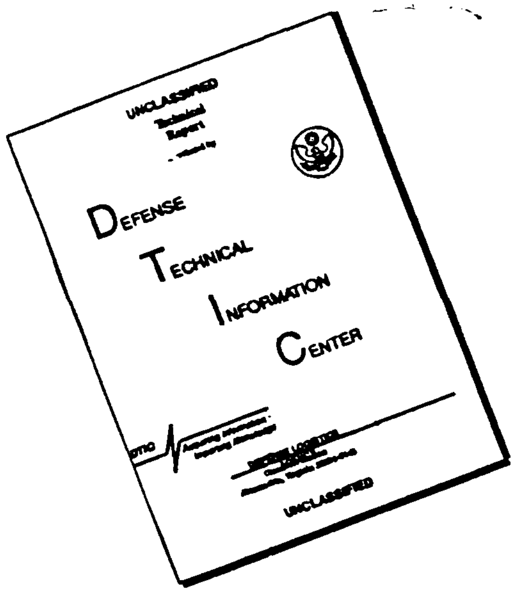

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A scoping study risk assessment was performed to determine a basis for selection of emergency planning zones (EPZ) for DoD nuclear weapons capable fixed facilities. Three classes of facilities were defined and EPZ radii were calculated for each by applying probabilistic risk analysis. This approach considers not only the potential radiological consequences of several accident scenarios, but also evaluates their probability of occurrence.

For Class I facilities (e.g., Alert aircraft, naval staging facilities) an EPZ of 10 Km is suggested; for Class II facilities (e.g., missile facilities and equivalent) an EPZ of 2 Km is suggested; and for Class III (e.g., storage, etc.) an EPZ distance of less than 1 Km might prove to be adequate.

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SECTION 1

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INTRODUCTION

1.1 Background

The U.S. Department of Defense (DoD) has developed and implemented several policies and procedures to respond to potential, but highly unlikely, accidents involving nuclear weapons.[1] While nuclear weapons accidents that could result in accidental detonation with a nuclear yield are considered essentially impossible, the detonation of high explosive component of nuclear weapons under certain accident conditions can and has occurred. In such an event, the dispersion of toxic plutonium and/or other radioactive materials is a likely occurrence. Emergency response plans for dealing with such accidents have considered the consequences of plutonium dispersion to the environment and have recommended appropriate precautionary measures.[2] Among these measures was the recommendation for establishing emergency planning zones (EPZ). EPZ's define areas surrounding Department of Defense weapons capable facilities within which emergency planning is considered prudent. These are analogous to EPZ's required by the Nuclear Regulatory Commission at nuclear power plants.[3,4]

Basically, the EPZ is an area within which to plan timely actions to be taken by DoD, civil authorities, and the general public to minimize the effects of cloud passage or subsequent resuspension of contaminants by either wind action or movement of personnel and vehicles. The EPZ can be geometrically described as a circle with the nuclear facility (potential source of contamination) at its center and can be defined in terms of its radius. At specific sites, deviations from this geometric definition can be made depending upon terrain features, demography, and other relevant considerations.

1.2 Review of Previous Work

In a previous study,[2] a methodology for determining EPZ's at DoD nuclear weapons capable fixed facilities was determined. Operations at

[redacted]

[redacted]

these facilities could include: storage, movement, and maintenance of weapons as well as installation and removal from various delivery systems (e.g., aircraft, missiles, warships, etc.).

Such routine operations result in no environmental release of plutonium or other hazardous materials. Only under unplanned accidental conditions can a release occur. The nature of the release and quantity of material released, given an accident has occurred, will not only depend on the nature of the initiating event, but will also be affected by other factors including the quantity of plutonium present and the accident environment. To characterize the source term, transport conditions, and dose consequences under such a potentially diverse set of circumstances, the methods of probabilistic risk assessment have been applied. The most notable previous application of PRA was in the nuclear reactor safety study (WASH-1400) or the so-called Rasmussen Report.[5] Insights from WASH-1400 were considered in determining the required EPZ's for nuclear power plants. Although the systems and conditions in a nuclear power reactor are considerably different from those of nuclear weapons systems, the basic principles of accident evaluation (i.e., accident sequence identification, probability determination, consequence analysis, etc.) are still applicable. The net result of such assessment not only provides useful insights into the possible consequences of the spectrum of potential accidents, but also into the likelihood for their occurrence.

As a result of this study, the probabilistic relationship between dose and distance show on Figure 1-1 was determined. As can be seen in this set of graphs, to be comparable in risk to that of the 10 mile EPZ at nuclear power plants, a reasonable EPZ distance from DOD nuclear weapons fixed facilities would be somewhere between 3 and 10 km. However, as stated in the conclusions:

> "The results of this study indicate that a reaonsable distance for a generic EPZ for DoD nuclear weapons fixed facilities would be within the range of 2 to 6 miles. It must be noted however that this suggestion is based upon a generic assessment which includes evaluation of a wide spectrum of facilities, operations, and inventories. Necessarily the assessment was of a scoping nature in which the most risk significant scenarios had a dominant influence

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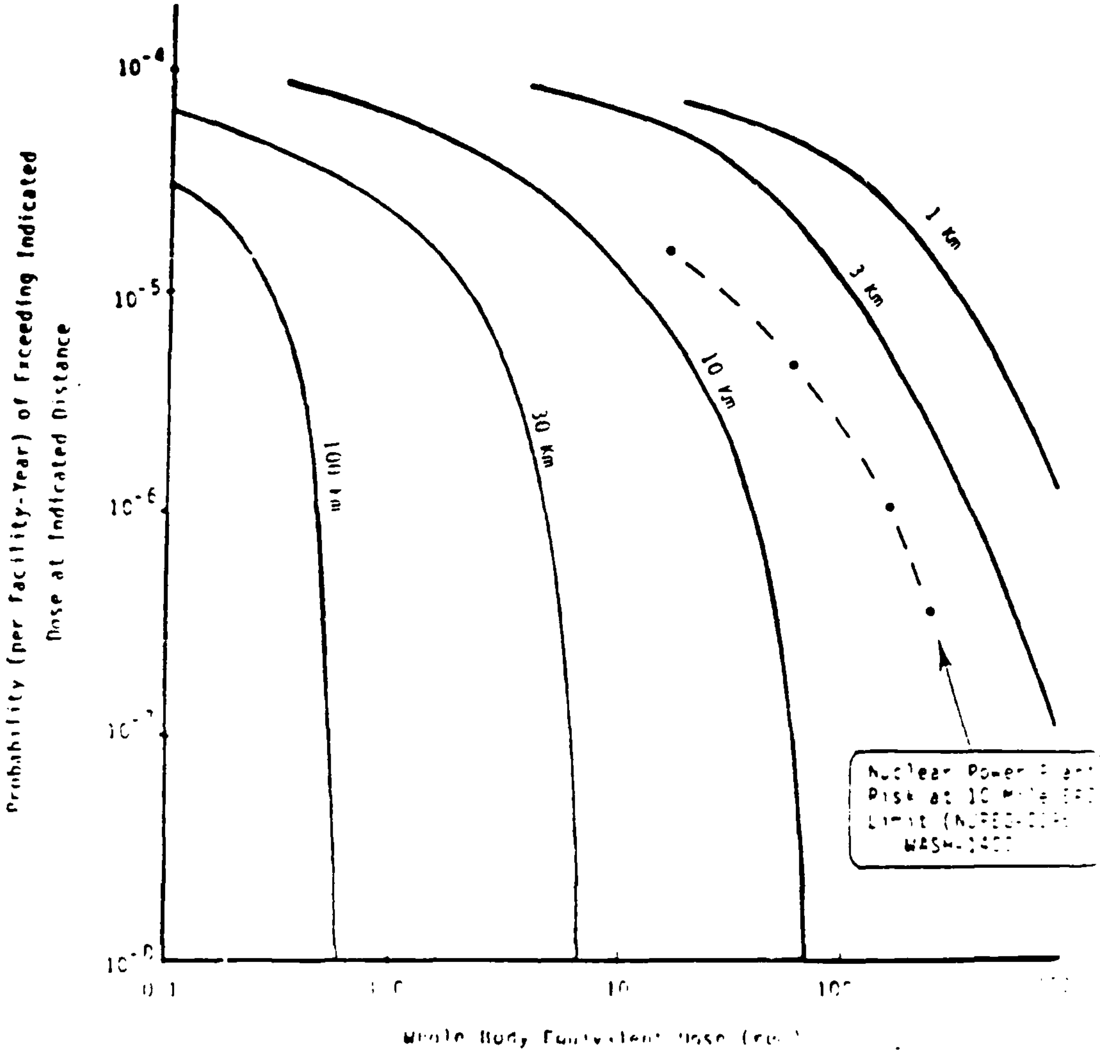

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FIGURE 1-1

[redacted] POTENTIAL RADIOLOGICAL RISK FROM ACCIDENTS AT DoD NUCLEAR WEAPONS FIXED FACILITIES

[redacted]

upon the results. The major implication is that site-specific risk assessments at individual facilities would likely indicate less restrictive EPZ requirements for the majority of facilities. Considering the time and expense of establishing EPZ's, such site specific assessments would likely prove to be a prudent exercise."

1.3 Problem and Approach

The generic assessment performed in the previous study was necessarily very general in scope. A detailed probabilistic risk assessment considering failure modes and probabilities on all components of the overall system would have required many man-years of effort. However, for purposes of determining a generic EPZ within the constraints of funding level and time available could be considered reasonable for an initial effort. Evaluation of EPZ's on a site-specific basis requires a greater degree of detail.

To evaluate the problem of determining site specific EPZ,s requires an assessment of variation in activities and operations at individual facilities as well as a review and assessment of more recent data on such facilities. Since it was initially determined that: (1) a complete assessment at each of the several facilities would be a formidable task requiring extensive time and funding, and (2) various types or classes of facilities maintained relatively similar operations, it would be adequate to determine EPZ's at 3 classes of facilities.

To accomplish this evaluation, data on operations at DoD nuclear weapons capable facilities are reviewed to establish the three generic classes of facilities. Each of these classes are then evaluated using PRA methods as in the previous study.

1.4 Objectives

The objectives of the current study are summarized in the following:

1.4.1 Review recent data on operations and activities at DoD nuclear weapons capable fixed facilities. This review includes recent assessments conducted at Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratory (SNL).

1.4.2 By applying existing data (and new data where relevant) calculate EPZ is for three (3) classes of facilities utilizing previously developed PRA methodology.

1.4.3 Conduct a peer review of the entire approach and methodology for determining EPZ's of DoD nuclear weapons capable fixed facilities. Peer reviewers are to be recognized experts in the areas of nuclear weapons operations and health physics.

1.4.4 Prepare and edit a manual on guidance for preparing and evaluating radiological emergency response plans in support of DoD nuclear weapons fixed facilities.

1.5 Peer Review

The peer review group discussed in 1.4.3 was convened in November 1983 and was chaired by Dr. Robert E. Yoder, Director of Health, Safety and Environment for the Rockwell International Inc., Rocky Flats Plant. Other members included: Dr. William A. Mills (US NRC), Dr. Marvin Rosenstein (US Dept. of Health and Human Services), and Mr. George P. Dix (consultant, and former official in the USAEC).

In its review, the peer group determined that there was no fault with the technical approach (probabilistic risk assessment) used in the study, or in the reasonableness of the methods. Recommendations for improvement of the methodology included:

1.5.1 To seek better insights on fractional release quantities of plutonium than can be found in the Roller Coaster test series data.

1.5.2 Source term data was strongly weighted toward low probability events. Although it was recognized that this is a reasonable procedure for data encompassing a wide range of operations and sites, the results represent an "upper bound" and can easily be misinterpreted. (Note: a

[redacted]

primary objective (see 1.4.2) of the present study is to assess classes of facilities thereby minimizing this problem.)

1.5.3 Cloud rise calculations should be adjusted to incorporate the results of the "Church equation"[6] and to make improved provision for incorporating fuel content burned for better estimation of heat input.

1.5.4 For comparison of EPZ's with those for nuclear power plants, greater distinction should be made between the short term effects that might occur from nuclear reactor accidents vs. the long term effects from nuclear weapons accidents.

The complete text of the peer review report is presented as Appendix A of this report.

1.6 Guidance Manual

As part of the current work, SAIC has prepared the guidance manual discussed in 1.4.4. The title of this manual is "Guidance for Developing State and Local Radiological Emergency Response Plans and Preparedness in Support of Department of Defense and Department of Energy Facilities." The purpose of this document is to provide draft plans which integrate the responses of facilities with those of state and contiguous local governments. The manual is an effort to coordinate activities of various federal agencies engaged in radiological emergency preparedness. It can also indicate the status of state and local emergency plans and preparedness for the off-site areas around DoD/DoE facilities.

The guidance manual is presented in its entirety as Appendix B of this report.

1.7 Synopsis

Steps to accomplish the objective of defining EPZ's at three classes of facilities are described in the following sections:

Section 2 reviews operations at various DoD nuclear weapons capable fixed facilities with a view toward site classification. A rationale for

[redacted]

[redacted]

classification is determined and probabalistic source terms for each facility class is developed. Previous assessments are augmented with more recently developed data.

Section 3 discusses the characterization of facility classes including operational considerations.

Section 4 presents a "generic" assessment of consequences for facility classes; comparison with EPZ curves for nuclear power plants and implications of this assessment.

Section 5 discusses the sensitivity of the conclusions to various assumptions and presents the summary and conclusions including areas of uncertainty and areas where future study is indicated.

1.8 References

1) DoD/FEMA-065X, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Department of Defense Nuclear Weapons Fixed Facilities," October 1981.

2) Cohen, J. J., D. A. Outlaw, J. F. Tinney, C. F. Smith, J. A. Stoddard, R. A. Belanger, "Development of a Technical Basis for Determination of Emergency Planning Zones at Department of Defense Nuclear Weapons Fixed Facilities," SAI/PL-83-3, Science Applications, Inc. (March 1983).

3) NUREG-0654/FEMA-REP-1 (Rev. 1), "Criteria for Preparation and Evaluation of Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," November 1980.

4) NUREG-0396, EPA 520/1-78-016, "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants," December 1978.

5) "Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," NUREG-75/014, WASH-1400, USNRC, October 1975.

[redacted]

[redacted]

6) Church, H. W., "Cloud Rise From High-Explosives Detonations," SC-RR-68-903, May 1969.

[redacted]

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SECTION 2

[redacted] REVIEW OF ADDITIONAL ACCIDENT INFORMATION

[redacted] 2.1 Introduction

[redacted] The purpose of this chapter is to review the findings of a continued search for additional information and data that could be used to better characterize the accident risks from nuclear weapons capable fixed facilities. The objective of the initial study had been an overall risk evaluation of DoD nuclear weapons operations based on existing risk evaluations for each of the types of operations. Early in that study, we discovered that comprehensive risk evaluations of the type necessary for risk estimation for all operations at typical DoD bases necessary for our EPZ determinations had not previously been done. There had been limited risk assessments performed by or for DNA Field Command of some recent weapons systems but these were generally limited to a particular weapon and delivery vehicle.

[redacted] For example, the study by Clarke et al.1 presents a detailed evaluation of the severities of transportation accidents and contains an excellent data base on truck and railcar accidents. ERDA 77/10 2 presents a complete analysis of C-141 transport accidents. For most of the remaining accident sequences, detailed studies of the accident risks and accident environments have not been completed. For these sequences, overall estimates of the likelihood of accidents with environments severe enough to threaten the more vulnerable of the weapon types were made.

[redacted] There is also a long term risk evaluation of DoD nuclear weapons storage at worldwide fixed storage locations underway at Sandia National Laboratory (SNL). Additional studies are also underway at SNL with the goal of developing a better understanding of the phenomenon of plutonium burning and dispersal in weapons accidents. Our initial study3 had only limited benefit from these SNL studies because of the preliminary nature of their results at the time of the study.

[redacted]

[redacted] One conclusion of the initial accident risk scoping study was that there were several areas where the information available to estimate the risk from certain nuclear weapons activities was quite limited. It was believed that more information might be obtained, including the following:

- [redacted] Other accident sequences that could make significant contributions to the overall risks from a given site;
- [redacted] The behavior of weapons in an accident environment;
- [redacted] A more realistic estimate of the plutonium source term from accidents, particularly with respect to the amounts aerosolized in a high explosive (HE) detonation and the size distribution of plutonium particles that might be respirable (less than 10 microns);
- [redacted] Estimation of the height of the plutonium bearing cloud that might result from a weapons accident;
- [redacted] The accident probabilities for alert aircraft, particularly the B-52 on active alert;
- [redacted] The naval ship transport accident, particularly the probabilities of weapon threatening accidents;
- [redacted] The accident probabilities and severities for naval warships in port;
- [redacted] The accident probabilities and severities for accidents involving tactical missiles;
- [redacted] The accident probabilities and severities for accidents involving storage of nuclear weapons.

[redacted] The results of our investigation into each of these areas is presented in the following.

[redacted]

[redacted] 2.2 Other Risk Significant Accident Sequences

[redacted] 2.2.1 Background

[redacted] The hypothetical accident sequences analyzed in the initial scoping study are listed in Table 2-1.

Table 2-1

[redacted]

Sequence No.	Description
1	C-141 Crash
2	Helicopter Crash
3	Transport Truck Crash
4	Minuteman II or III RV Transport Truck Crash and Fire
5	Railcar Crash
6	Ship Transport Accident
7	Aircraft Crash Into Storage Facility
8	Missile Mating Accident in Maintenance Facility
9	Aircraft Crash Into Maintenance Facility
10	B-52 Fire While on Ground Alert
11	ADC Interceptor Fire While on Ground Alert
12	Minuteman II or III Silo Fire While Mating RV
13	Naval Warship in Port - Missile Loading Accident
14	Naval Warship in Port - Accident Involving Stored Weapons

[redacted]

[redacted]

[redacted] 2.2.2 Findings

[redacted] Reviewers of the initial scoping study were unable to identify any other accident sequences that made a significant contribution to the overall accident risk at any U.S. site.

[redacted] 2.3 Accident Environment

[redacted] 2.3.1 Background

[redacted] The wide variety of nuclear weapons in the U.S. stockpile would exhibit a spectrum of responses in a severe accident environment. Great care has been taken in the design and engineering of today's weapons to reduce the risk of dispersal of plutonium to the environment; even if the weapon were subjected to the harsh environment of a very severe accident. All weapons in the current stockpile are designed to be "one point safe." This means that, if the high explosive surrounding the plutonium is detonated at any one point, the likelihood of a nuclear yield greater than 4 lbs of TNT is less than one in a million. Therefore, in an accident, the likelihood of fission products being generated and released is essentially nil.

[redacted] The primary concern is that the severe environment created in an accident (e.g., a severe impact, an ensuing fire, crashing, puncture or immersion of the weapon or perhaps lightning) could endanger a weapon. These severe accident environments might cause the plutonium in the weapon to burn or the high explosive to detonate thereby dispersing the plutonium to the atmosphere. The greatest off-site consequences would occur if the HE undergoes a very efficient "high-order" detonation. In this case, a large fraction of the plutonium could be aerosolized and possibly dispersed. Less efficient "low-order" detonations, would probably only break the plutonium apart and aerosolize a much smaller fraction. In recent years, weapon designers have succeeded in engineering weapons that are relatively invulnerable in very severe accident environments. One breakthrough has been the development of "insensitive high explosives" (IHE) which are not expected to burn or detonate in anticipated accident environments.[4] Weapons with IHE are currently entering the stockpile.

[redacted]

[redacted] Analysis of the response of each weapon type in the stockpile to a range of accident environments would be a very difficult task.[5] A simpler method would be to categorize all stockpile weapons into classes based on their expected relative vulnerability in accident environments. Such an analysis and categorization was performed by Sandia in "Safety Assessment of ERDA Nuclear Weapons Transport Operations," ERDA 77/102. The results of that safety assessment were used in this and the previous scoping report.

[redacted] Of the six accident environments considered (impact, puncture, fire, crash, immersion, and lightning), only impacts, punctures and fires are significant in categorizing weapon types. Each weapon type was analyzed and its relative vulnerability to impacts, punctures and fires was estimated.

[redacted] The weapons in the inventory vary considerably in their design and amounts of material relevant to this study, particularly plutonium and high explosives. [redacted] All the releases are expressed as multiples of this amount. [redacted]

(b)(1) (b)(3) (b)(3) (b)(3)

[redacted]

(b)(3) (b)(1)

[redacted]

Table 2-2

Weapon Types in Each Category

[redacted]

Weapon Vulnerability Category	Weapon Types
[redacted]	[redacted]
[redacted]	[redacted]

(b)(1)
(b)(3)

[redacted] The fact that weapons could be grouped into categories with similar behavior in accident environments was not unexpected. Weapon types with little standard protection, as in Category 1, would be expected to have high vulnerability to impact and puncture, but, due to the correspondingly small amount of HE confinement, a low vulnerability to fire. The reverse would be expected for weapons with a high degree of structural protection and mitigation, as in Category 3.

[redacted] There is considerable uncertainty in the vulnerability of different weapon types to severe impacts. Experimental tests have shown that the HE exhibits no reaction until a minimum impact threshold velocity is reached and that a very rapid increase in reaction violence occurs with a moderate increase in impact velocity above that threshold. This reaction results in the explosive dispersal of the plutonium involved. It is not possible to convincingly predict the impact velocity threshold for HE in a weapon solely on theoretical grounds. ERDA 77/10 acknowledged this and used several types of empirical information to make judgments on the impact sensitivity for weapons more or less characteristic of the weapons in the four categories identified. Category 1 weapons are assumed to offer relatively little impact protection to their HE. Weapons in this category are the most sensitive to HE detonation in a severe impact accident environment. An HE detonation impact velocity threshold of [redacted] is assumed, with upper and lower bounds of [redacted] Category 2 weapons are relatively insensitive to HE detonation in a severe impact. An impact velocity (b)(3) threshold of [redacted] with upper and lower bounds of [redacted] is assumed. Category 3 and 4 weapons are assumed to offer a high degree of structural protection to mitigate the effects of severe impact environments on the HE. An impact velocity threshold of [redacted] with upper and lower bounds of [redacted] is assumed. Weapons with insensitive high explosives (IHE) are not expected to pose a significant risk of HE detonation due to impacts in any of the impact environments considered.

[redacted] The behavior and consequences of a weapon in a fire environment are very dependent on certain weapon design features, the fire temperature and fire duration. The consequences are very dependent on what type of reaction occurs in the HE. If the HE undergoes a "high order" detonation, equivalent to a one-point detonation, the results of the Roller Coaster experiments[6] indicate that essentially all of the plutonium will be aerosolized and that about 20 percent of the airborne particles will be respirable (less than 10 microns).

[redacted] On the other hand, if the weapon HE simply burns, no more than 1-2 percent of the plutonium released will be potentially respirable.[7-9] For weapons with [redacted] ERDA 77/10 concluded that no plutonium (b)(3) release would be expected; even if the HE burned. This is because [redacted] would not be expected to melt either in a fuel fire (with a maximum mean

[redacted]

fire temperature of about 1000oC) or due to the burning of the HE. Thus the plutonium in these weapons is protected from burning. Only a few types of weapons are vulnerable to their plutonium being aerosolized by burning in a fire without a detonation.

[redacted] Determination of the likelihood of HE detonation due to a fire environment is much more complicated10. In some weapons, [redacted] In this case, a runaway exothermic reaction of the HE begins at some depth within the HE [redacted] and the self containment of the explosive results in a true detonation. Another HE detonation process that can occur in some weapon types involves the initiation of burning on the outer HE surface which, if the HE is strongly confined by high melting point [redacted] can build into an actual detonation. This second process is referred to as deflagration-to-detonation transfer (DDT). (b)(3)

[redacted] Therefore, the behavior of the weapon is very dependent on the effective temperature of the fire environment and the fire duration. For a weapon in a fuel fire, the HE might burn. However, [redacted] Weapons of moderate *vulnerability to detonation* in a fire environment were assumed in ERDA 77/10 to be typical for Category 2 weapon. Category 3 weapons were found to be much more sensitive to detonation in a fire environment. It is generally accepted that [redacted] At the same time, [redacted] Category 1 weapons are relatively unsusceptible to detonation in a fire environment. These weapons generally have [redacted] They, therefore, offer a minimal threat of detonation due to a fire because [redacted] Table 2-3 summarizes the relative vulnerability of weapons in each category to fire and impact. (b)(3)

[redacted]

[redacted]

Table 2-3

[redacted] Vulnerability Categories

[redacted]

Category	Relative Vulnerability to Fire	Relative Vulnerability to Impact
1	Low	High
2	Medium	Medium
3	High	Low
4	Very Low	Very Low

[redacted] Puncture accident environments will generally not be severe enough to contribute to the overall accident risk. [redacted] ERDA 77/102 assumed that [redacted] into the HE would be [redacted] HE for Category I, II, and III weapons. Since Category I weapons generally [redacted] Clarke[1] has analyzed puncture environments in truck and railcar accidents and calculated the velocity and probe radii joint probability distributions in severe accidents. It is assumed in this report that [redacted] Puncture environments are [redacted]

(b)(3)

[redacted] Other accident environments encountered in these accidents, such as crush, immersion and lightning, were generally not severe enough to be a significant contributor to the overall risk.

[redacted]

[redacted]

[redacted] 2.3.2 Findings

[redacted] In our discussions with personnel at DOE Headquarters, DNA, SNL, and LLNL, we have found no information to indicate that the assumptions on accident environments used in the scoping study, which were based on ERDA 77/10, are still not the best available assumptions. Although several reviewers questioned the release fractions in high-order detonations, preliminary experimental results at SNL [11] apparently do not significantly contradict earlier assumptions.

[redacted] 2.4 Plutonium Source Term and Particle Size Distribution

[redacted] 2.4.1 Background

[redacted] In the earlier study, the following conclusions were drawn from the literature on the distribution of plutonium particle sizes that would likely result from a weapon detonation:

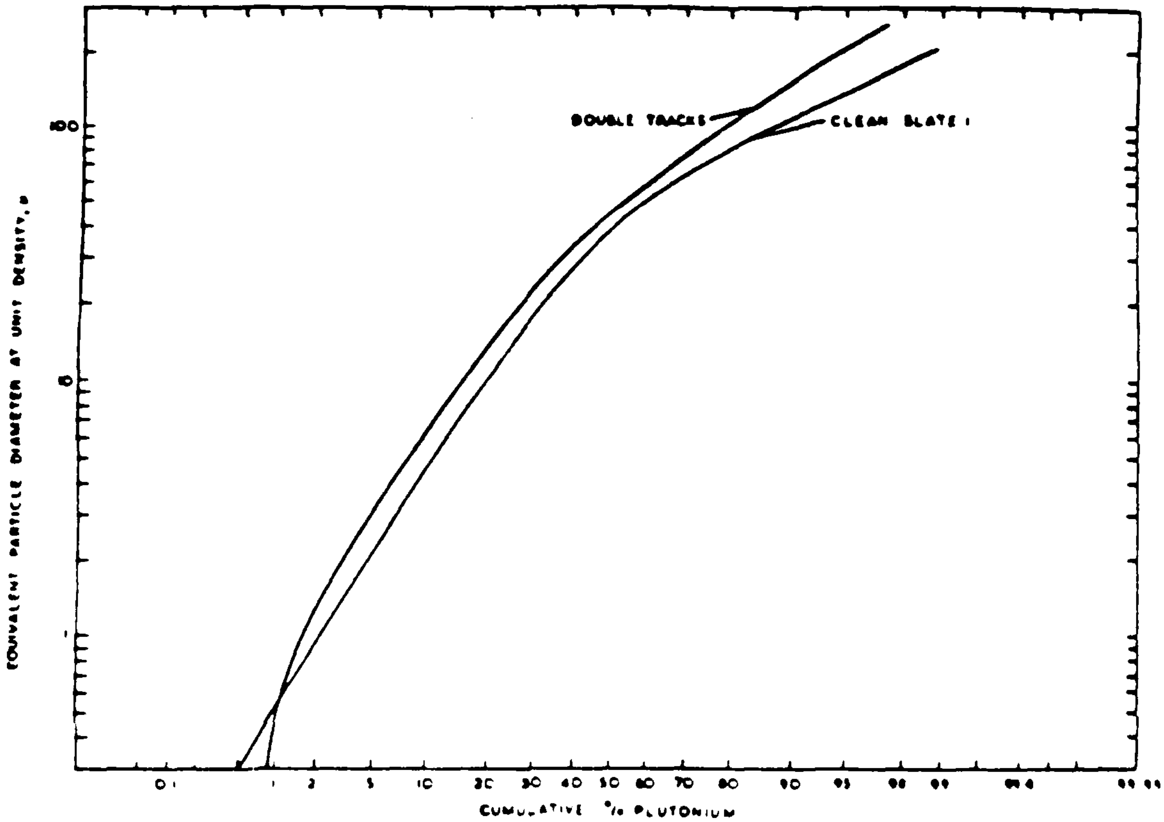
[redacted] A primary source of information related to the inertial characteristics of plutonium which might be dispersed in a nuclear weapon accident can be found in the results of the Roller Coaster series of experiments. Project Roller Coaster[6,12] was planned and executed in the early 1960's to provide better data on the consequences of low order (non-nuclear) detonations of nuclear weapons. In Roller Coaster, four experiments were performed. Two of these (Double Tracks and Clean Slate I) were detonated in the open. Elaborate sampling was performed at these experiments to determine deposition isopleths, inhalation dosage isopleths, size distribution, and activity as a function of cloud height as well as data from animal exposure.

[redacted] Data on the particle size distribution was obtained by means of cascade impactors and special particulate studies consisting of autoradiography, microscopy, and radiochemical analysis of selected particles from impactor slides and deposition collectors.

[redacted] Figure 2-1 represents the overall size distribution of particles sampled in the indicated experiments. Particle size is given in terms of equivalent (or aerodynamic) diameter. The aerodynamic diameter can

[redacted]

[redacted]



[redacted]

FIGURE 2-1

[redacted] OVERALL PARTICLE SIZE DISTRIBUTION

[redacted]

[redacted]

be defined as the diameter of a unit density sphere where terminal velocity (fall rate) is equivalent to that of the particle being evaluated. The Roller Coaster results indicate that the particle size distribution in an aerosol cloud resulting from a low order detonation of a nuclear weapon is not log-normal as might be expected, but rather appears to be skewed. It should be noted that the size distribution in Figure 2-1 represents only those particles associated with plutonium. Therefore, the inertial properties of the airborne plutonium (fall rate, respirability, etc.) would be expected to behave accordingly.

[redacted] Table 2-4 presents a particle size fractionation derived from the Roller Coaster data which is assumed to be a reasonable representation for predicting atmospheric dispersion and ground deposition of an aerosol cloud resulting from a nuclear weapon accident. It is recognized that for specific accidents, depending upon the nature of the detonation as well as various factors in the accident environment, significant differences in the size distribution might occur. Nonetheless, for purposes of a generic assessment of accident consequences, the distribution represented in Table 2-4 should provide an adequate characterization.

TABLE 2-4

[redacted] ASSUMED PARTICLE SIZE DISTRIBUTION FOR NUCLEAR WEAPON ACCIDENTS

[redacted]

Size Range Aerodynamic Diameter (μ)	Fraction of Total Plutonium Aerosol in Indicated Size Range
<1.0	0.02
1.0 - 3.0	0.04
3.0 - 10.0	0.12
10.0 - 30.0	0.24
30.0 - 100	0.42
>100	0.16

[redacted]

[redacted] 2.4.2 Findings

[redacted] The assumptions regarding percent of the plutonium that might be aerosolized and the fraction of that which would be respirable in a high-order detonation were questioned by many of the reviewers of the scoping study, including the authors. The assumptions were based on the Roller Coaster data and are the standard assumptions used by SNL and others in weapons accident analyses. An experimental program is underway at SNL to try to verify as many of these assumptions as feasible. Our discussions with SNL personnel indicate that these assumptions are still reasonable.

[redacted] 2.5 Cloud Heights

[redacted] 2.5.1 Background

[redacted] In the earlier study, the following conclusions were drawn from the literature on the heights to which clouds containing respirable plutonium would likely rise in the event of a detonation:

> [redacted] To predict the dispersal of the contaminant cloud resulting from a nuclear weapon accident, it is necessary to estimate the potential height of the initial cloud. A knowledge of cloud height is required for calculation of both dispersivity and depletion rates due to fallout and other factors.
>
> [redacted] Essentially all accidents which might result in a release of plutonium will be accompanied by a release of heat. The heat will create a buoyant effect in the cloud of released material causing it to rise in the atmosphere. In a nuclear weapon accident, the resultant height to the top of the released cloud will depend on several factors. These include:
>
> [redacted] o The mass of explosive (HE) involved in the detonation or fire, as well as its burn rate.

[redacted] o The presence or absence of other combustible material such as jet fuel.

[redacted] o The accident environment which might direct or mitigate the released energy.

[redacted] o The atmospheric stability (wind speed, temperature, inversion conditions, etc.) at the time of cloud formation.

[redacted] Studies have been performed to assess the potential cloud rise under potential accident conditions.[13,14] Although all factors affecting cloud height may not have been considered in these studies, they can provide a reasonable basis for cloud height predictions under most accident conditions. The primary factor affecting cloud height is the quantity of HE involved.

[redacted] 2.5.2 Findings

[redacted] Estimated cloud heights were reevaluated following the guidance of the peer review group as discussed in Section 4.2 of this report. The revised assumptions used (the unaltered "Church formula" but did not significantly change the calculational results. The close in (<10 Km) doses were only slightly reduced compared to those using the modified formula.

[redacted] 2.6 Active Alert Aircraft

[redacted] 2.6.1 Background

[redacted] In the earlier scoping study, the accident parameters for hypothetical alert aircraft accidents were analyzed as follows:

[redacted] Air Force B-52's on alert with bombs or SCRAM missiles onboard would pose a significant accident risk. These planes, while on the taxiway on alert, would be fully fueled and ready to takeoff. Accidents could occur while taxiing, fueling, or maintenance, or in collisions with other planes. Such accidents, however, would be unlikely due to the stringent safety procedures followed. Accident data on ground operations for other types of aircraft provide little basis for

[redacted]

estimating the accident probability for a B-52 on alert status. While accidents have occurred with B-52s, none have occurred during ground alert status. Thus we have about 7,000 plane-years without a weapon-threatening ground-alert accident. If one accident had occurred, then the historical expectation would be about 2E-3 accidents per squadron-year (or site-year for most bases with 1 squadron). Since no such accidents have occurred, it is assumed for the base case in this report, that the likelihood of an accident with a B-52 on ground alert status, which results in a significant weapon-threatening fuel fire, is about 5E-4 significant accidents per site-year.

[redacted] A B-52 fuel fire poses one of the highest risks of plutonium release. The probability of a significant fuel fire on an alert status B-52 with nuclear weapons onboard is estimated to be 5E-4 per year per Strategic Air Command (SAC) base with one B-52 squadron. The plane is assumed to be loaded with 8 SRAM air-to-ground missiles and 5 randomly selected bombs. It is acknowledged that the actual mix of missiles and bombs can vary considerably. There would be sufficient fuel onboard an alert B-52 to cause fires of sufficient duration to endanger Category I and II weapons as well as the most vulnerable Category III weapons.

[redacted] Air Defense Command F-106 and F-4 aircraft squadrons can carry Genie air-to-air nuclear missiles to intercept enemy bombers. One of these planes on active ground alert would pose a hazard similar to that posed by B-52s. Determination of the weapon-threatening accident probability for a ground alert ADC interceptor poses the same problem as with the B-52; namely insufficient data. It is assumed for the base case in this report that the likelihood of a weapon-threatening accident to an ADC interceptor squadron on active ground alert is the same as that for the B-52 squadron, about 5E-4 significant accidents per squadron-year.

[redacted] The probability of a significant fuel fire on an alert status Air Defense Command (ADC) F-106 or F-4 interceptor is expected to be about the same as that of the B-52, about 5E-4 per year per ADC base with one interceptor squadron. Each plane is assumed to have 1 Genie air-to-air missile with a W-25 warhead.

[redacted]

[redacted]

[redacted] 2.6.2 Findings

[redacted] Since the risk from these accidents is higher than many of the other accidents, several reviewers thought it appropriate to evaluate these accidents in more detail. In particular, it was questioned whether better accident statistics might be available. A search was made of several databases, including the Defense Technical Information Center (DTIC), the National Technical Information Service (NTIS), and DIALOG, for analyses of accidents that might be relevant to our problem. No reports directly relevant to alert aircraft fires were found. Aircraft accident databases compiled by the U.S.Air Force, U.S.Navy, the National Transportation Safety Board, and others were reviewed. Serious accidents resulting in substantial fuel fires involving large aircraft on the ground are extremely rare.

[redacted] National Transportation Safety Board aircraft accident data[15] indicate that an annual average of about 1.6 accidents per year occur that result in fire and explosion to aircraft on the ground in the U.S. air carrier fleet. About 3.5 percent of all the accidents occur on the ground and result in fire or explosion. About 5.5 accidents per year occur to aircraft on the ground that do not result in fire and explosion. This implies that the probability of any one of approximately 2100 operational U.S air carrier aircraft having an on-the-ground accident resulting in fire and explosion is about 7.7 E-04 per plane-year.

[redacted] If we applied this accident probability to a squadron of 15 B-52s, this would imply a probability of a fire or explosion to one plane in the squadron while on alert of about 1.1 E-02 per year. Fortunately, B-52 aircraft on active alert would operate with severe safety constraints that should make their operation somewhat safer than the U.S air carriers. It seems reasonable to expect that the safety precautions taken with alert aircraft would reduce the likelihood of an accident while on alert to the value assumed in the scoping study. Based on no better information, we will therefore continue to use the earlier value. Tables 2-5 and 2-6 present our best estimate of the source terms for bases with these two types of alert aircraft.

[redacted] Table 2-5 presents the details of the B-52 fire accident evaluation. The evaluation of any of the accident sequences identified is a step

[redacted]

[redacted]

Table 2-5

[redacted] **Accident Sequence 10: B-52 Fire While on Ground Alert**

[redacted]

Accident Sequence 10	B-52 fuel fire while on ground alert status. Weapons on board: 8 SRAM-W66(1); 5 bombs; random mix of stockpile B28, B43, B53, B57, B61.
Initiating Event Probability	5E-4/squadron-year (in a fuel fire)
Accident Environment	
P(Fire)	1
P(other)	small
Releases | Accident Environment	
Pu burning | fire	1 for Type A
HE detonation | fire	0.1 for Type I, II 0.76 for Type III 10-3 for Type IV

Summary

Release Mode	Probability of Release X per site yr	Release Quantity X (Grams Respirable Pu)
Pu Burn | Fire	5E-4 x P(1,2,3,.. of Type A)	1 F, 2 F, 3 F,...
HE Det. | Fire	5E-5 x P(1,2,3,.. of I or II)	
Total	5.6E-5	1 F
	2.9E-6	2 F
	7.4E-8	3 F
	9.5E-10	4 F
	5.0E-5	80 F
	8.0E-6	90 F
	1.4E-5	100 F
	1.6E-5	110 F
	8.0E-6	120 F
	1.5E-6	130 F

[redacted]

[redacted]

Table 2-6

[redacted] Accident Sequence 11: ADC Interceptor Fire While on Ground Alert

[redacted]

Accident Sequence 11	ADC interceptor fuel fire while on ground alert. One Genie air-to-air missile is on board (W-25).
Initiating Event Probability	5E-4/squadron-year (in a fuel fire)
Accident Environment	
P(Fire)	1
P(other)	small
Releases | Accident Environment	
Pu burning | fire	1 for Type A
HE detonation | fire	0.1 for Type II

Summary

Release Mode	Probability of Release X per squadron-yr	Release Quantity X (Gram Respirable Pu)
Pu Burn | Fire	5E-4	10 F
HE Det. | Fire	5E-5	10 F

[redacted]

[redacted]

process. The first step is to identify the probability of the initiating event. In this case the probability of a major fire to 1 of a squadron of 15 B-52s is about 5 E-04 per year.

[redacted] The next step is to determine the conditional probability that, given the initiating event occurs (a major fire), each of several weapon threatening accident environments could occur. In this case, the conditional probability of a fuel fire occurring given a major fire is assumed to be about 1.0, and of a severe impact accident environment is small. The probability of other accident environments (e.g., crash, puncture, immersion, etc.) being severe enough to threaten the weapons is small enough that the risk to the weapons is dominated by only the fire threat.

[redacted] The third step is to determine the likelihood of plutonium releases in respirable form for each of the accident environments identified in step 2. In doing this, detailed consideration must be given to the severity of the particular accident environments. For this example, the fire environment is estimated to be severe enough that any Type A weapons in the shipment would be subjected to some plutonium burning. Detailed evaluations of the response of each of the categories of weapons to the fire and impact environments of this accident were made in ERDA 77/10. That report concluded that the probability was about 0.76 that the HE in a Category (Type) III weapon would detonate and disperse plutonium due to the fuel fire, but that it was only a one in ten chance that the fire duration would be long enough to cause detonations of the Category I or II weapons. (Category III weapons are the most susceptible to fire.)

[redacted] The next step is to compute the probability per major fire of releasing X grams of respirable plutonium from each of the event trees in the accident sequence. In this example, plutonium releases can primarily occur through two event trees or sequences: (1) a major fire followed by plutonium burning in type A weapons, and (2), a major fire, and HE detonation due to the fire in Category III weapons or the less suceptible Category I or II weapons. In the case of plutonium burning in Type A weapons, a release of about F (see Section 2.3.1 fo the defnition of "F") grams of respirable plutonium per weapon is assumed. Therefore, the probability of a release of F grams per major fire by this sequence is (5E-4) x (1.0) x (1.0) x (probability of having exactly 1 Type A weapon onboard). Similarly, the

[redacted]

[redacted]

probability of a release of 2F grams from 2 Type A weapons is (5E-4) x (1.0) x (1.0) x (probability of 2 Type A). The assumed respirable plutonium release if the HE detonates is 10F grams. Therefore, the probability per takeoff of a release of 10 F grams due to the detonation of 1 Type III weapon in a fire is (5E-4) x (1.0) x (0.76) x (probability of exactly 1 Type III). Similar results follow for sequences involving 2 to 5 Type III weapons in a fire and 1 to 5 Type I or II weapons due to fire.

[redacted] The final step is to combine the results from the various release modes, taking into account multiple release modes for some weapon types, probability of both fires and impacts occurring, etc., as appropriate. The combined results are presented in a tabular basis, presenting columns for the probability of releasing X per fire, and the release quantity X where X is expressed in grams of respirable plutonium. Results are later combined to present the complementary cumulative distribution function, i.e., the frequency per event or year that X or more grams of respirable plutonium will be released due to a weapons accident for the particular initiating event, accident sequence, or facility.

[redacted] Details of the major fire accident consequences is presented in Table 2-5. The plutonium releases in the 1F-3F gram range are due to plutonium burning in Type A weapons, while the higher releases are due to HE detonation and aerosolization of the plutonium due to fires for Type III weapons and, to a lesser extent, from Type I and II weapons.

[redacted] 2.7 Ship Transport Accidents

[redacted] 2.7.1 Background

[redacted] In the earlier scoping study, the accident parameters for ship transport accidents were as follows:

[redacted] Naval ships can transport nuclear weapons. It was estimated that the accident frequency for these ships is about 2E-6 per km. The only accident environment likely to pose a threat to weapons is a severe fuel fire, which has an estimated probability of 0.005 given a serious ship accident. The probability of the fuel fire being of sufficient duration to detonate Category III weapons is estimated to be 0.02.

[redacted]

[redacted]

[redacted] 2.7.2 Findings

[redacted] The initial study suffered from a lack of primary data on the accident risks associated with ship transportation of nuclear weapons. Although no direct data associated with weapons transportation was available, tanker casualty statistics from the U.S. Coast Guard[16] indicate that the probability of a fire or explosion given a tanker casualty varies from 0.05 (in harbor) to 0.16 (at pier) to 0.19 (at sea). Although these numbers are somewhat higher than the 0.005 assumed earlier, safety precautions associated with nuclear weapons transport should assure that all but the most serious of the fires or explosions that might occur do not threaten the weapons. For that reason we have retained our earlier estimates. Table 2-7 presents our best estimate for the source term for accidents involving ship transport accidents.

[redacted] 2.8 Naval Warships in Port

[redacted] 2.8.1 Background

[redacted] In the earlier scoping study, the accident parameters assumed for Naval warships in U.S. ports were:

> [redacted] Naval submarines and warships at U.S. Naval bases are expected to offer a mixed range of weapons accident hazards. Most of the accident risk appears to be due to the actual loading of weapons or missiles with attached warheads onto the ships. Once on the ships, nuclear weapons are typically stored under stringent safety conditions. Safety records are excellent for all naval nuclear weapons, and indicate that there have been no weapon-threatening accidents once the warheads are mated to the missiles (that accident is covered under maintenance accidents).
>
> [redacted] For the base case in this report, it is assumed that the likelihood of a missile-handling accident, while loading or unloading onto a Naval warship, is about 1E-4 weapon-threatening accidents per site (port)-year. It is assumed that the likelihood of a weapon-threatening accident to weapons onboard U.S. warships in a Navy port is 1E-6 per port-year.

[redacted]

[redacted]

[redacted] Accident Sequence 6: Ship Transport

[redacted]

Accident Sequence 6	Naval transport ship ferrying weapons in a port, random mix of 5 weapons
Initiating Event Probability	2E-6
Accident Environment P(Fire)	5E-3
Releases | Accident Environment	
Pu burning | fire	1 for Type A
HE detonation | fire	0.02 for III

<u>Summary</u>

Release Mode	Probability of Releasein X per km	Release Quantity X (Grams Respirable Pu)
Pu Burn | Fire	1E-8 x P(1,2,3,.. Type A)	1 F,2 F,3 F5, . .
HE Det. | Fire	2E-10 x P(1,2,3,.. Type III)	10 F, 20 F, 30 F,...
Total	1.1E-9	1 F
	5.8E-11	2 F
	1.5E-12	3 F
	8.1E-11	10 F
	3.6E-11	20 F
	7.8E-12	30 F
	8.6E-13	40 F

[redacted]

[redacted] For an accident while loading Navy missiles onto a surface ship or submarine, severe impact environments, due primarily to rocket propellant ignition, are assumed to occur 10% of the time in major fires. Half the operations are assumed to involve single warhead ASROC, SUBROC or Terrier missiles, and half are assumed to involve multiple warhead (assumed to be 10) Trident and Poseidon missiles.

[redacted] An accident involving weapons stored on an operational Navy warship while in a U.S. Naval base is assumed to have an expected frequency of no more than 1E-6 per port year. Because of severe restrictions, procedures on handling and storing weapons, it is likely that a fire could be of sufficient duration to threaten most weapons. However, if one weapon detonates, it is expected that the probability of all of the rest in the compartment, assumed to total about 5 weapons, detonating is 0.9. Only one compartment is assumed to be involved because of the difficulty of involving large quantities of fuel to feed a fire.

[redacted] 2.8.2 Findings

[redacted] Naval port accident sequences are of concern because of the nearness of population centers. Since serious accidents that could provide a better estimate of the probabilities involved have not occurred, accident estimates are quite poor. Several data bases were searched for information that might be useful in determining the likelihood of serious ship accidents in ports. These databases included DTIC, NTIS, DIALOG, the U.S. Coast Guard, and others.

[redacted] Tanker casualty statistics indicate that an average of about 56 tanker casualties a year out of about 4133 tankers are the result of fires and/or explosions[19]. About 18.3 % of these occur at the pier. This implies that the probability of a casualty occurring on a tanker due to a fire or explosion is about 1.35 E-02 per tanker-year.

[redacted] U.S. Navy ships reported 1,346 fires from January 1969 to August 1977. Of these, 66 were considered major and resulted in over $100,000 damage to each ship. Seventeen major fires occurred on aircraft carriers, 47 on other surface ships, and 2 on submarines[20]. Thus the probability of a major fire onboard one of the 13 (as of January 1980[21]) aircraft carriers is 0.15 per year, onboard one of 122 submarines is 1.9 E-03, and onboard one of the other surface ships is 1.7 E-02. per ship-year. Carrier fires are due predominantly to flight operations which do not occur in port. We expect that the likelihood of major fires while in port is similar to that for other surface ships.

[redacted] If we assume that a typical U.S. Navy port has an average of 10 surface ships in port that have nuclear weapons onboard in storage at any time during the year, then the probability of having a major ship fire among one of the ten in any year is about 1.7 E-01. Most major fires are not expected to significantly threaten any nuclear weapons that might be onboard. We estimate that because of the safety precautions taken, the likelihood of a weapon-threatening fire given that a major fire has occurred is 1 E-03. Thus the probability of a weapon threatening fire is about 1.7 E-04 per port-year. Tables 2-8 and 2-9 present our best estimate for the source term for accidents involving naval warships in port.

[redacted] 2.9 Tactical Missile Accidents

[redacted] 2.9.1 Background

[redacted] In the earlier scoping study, the accident parameters for tactical missile accidents were analyzed as follows:

> [redacted] The likelihood of an accident severe enough to threaten the weapons at a weapons maintenance facility on a fixed U.S. site is extremely remote. Safety procedures for all operations in these buildings are stringent. Two sequences initiated with accidents in a maintenance facility are assumed to have the potential for creating accident environments that could threaten nuclear weapons.
>
> In most operations carried out in maintenance facilities, there are no materials available to create a credible fire, impact, puncture, crash or other accident environment of sufficient magnitude to endanger a weapon. In one type of operation, the mating of a warhead to a missile, the introduction of the rocket propellant into the maintenance facility makes the possibility of a severe accident credible. This operation is done for several types of Air Force and Navy weapon

Table 2-8

[redacted] Accident Sequence 13: Naval Warship in Port - Missile Loading Accident

[redacted]

Accident Sequence 13	Serious accident resulting in a fire while loading Navy missiles onto surface ship or submarine. Possible missiles include SUBROC, ASROC, Terrier, Poseidon or Trident.
Initiating Event Probability	1E-4 per port-year
Accident Environment	
P(Fire)	1
P(Impact)	0.1
Releases | Accident Environment	
Pu burning | fire	1 for Type A (none)
HE detonation | fire	0.76 for III 0.1 for I, II 10-3 for IV
HE detonation | impact	0.7 for I 0.3 for II, III

<u>Summary</u>

Release Mode	Probability of Release X per port-year	Release Quantity X (Grams Respirable Pu)
HE Det. | Fire	7.6E-5 x P (Type III)	10 F (ASROC)
	1.0E-6 x P (Type I)	10 F (SUBROC or Terrier)
	1.0E-6 x P (Type II)	100 F (Poseidon or Trident)
HE Det. | Impact	7.0E-5 x P (Type I)	10 F (SUBROC or Terrier)
	3.0E-6 x P (Type III)	10 F (ASROC)
	3.0E-6 x P (Type II)	100 F (Trident or Poseidon)
Total	1.5E-5	10 F
	2.0E-6	100 F

[redacted]

[redacted]

[redacted] Accident Sequence 14: Naval Warship in Port - Accident Involving Stored Weapons

[redacted]

Accident Sequence 14	Accident onboard a Naval warship in port resulting in fire and damage to stored weapons - random mix of weapons involved.
Initiating Event Probability	2E-4 per port-year
Accident Environment	
P(Fire)	1
Releases | Accident Environment	
Pu burning | fire	1 for Type A
HE detonation | fire	0.76 for III 0.1 for I, II 10-3 for IV

Summary

Release Mode	Probability of Release X per port-year	Release Quantity X (Grams Respirable Pu)
Pu Burn | Fire	2.2E-5	1 F
	1.2E-6	2 F
	3.0E-8	3 F
HE Det. | Fire	8.6E-5	50 F

[redacted]

[redacted]

systems, including the Air Force's Short Range Attack Missile (SCRAM), Genie Air-to-Air Missile, and the Navy's SUBROC Submarine-Launched Anti-Submarine Nuclear Missile, ASROC Ship-Launched Anti-Submarine missile, Terrier Surface-to-Air Anti-aircraft missile and Poseidon and Trident SLBM. These operations could occur in an onshore maintenance facility, or in some cases onboard a Navy tender in a U.S. Naval port.

[redacted] The likelihood of an operational accident related to weapon maintenance is difficult to estimate. Historically, there has been one accident that resulted from the separation and dropping of a Terrier missile from its booster. In that case, there was weapon damage but no HE detonation or plutonium contamination. Given one serious accident in about 60,000 warhead-missile-years of experience with those seven weapon systems plus the Polaris A-3 SLBM, the historical likelihood of an operational accident while mating a warhead to one of these missiles is about 1E-3 weapon-threatening accidents per site-year.

[redacted] A missile mating accident is assumed to occur at either an Air Force or Navy maintenance facility. For the Air Force facilities, SRAM and Genie missiles are assumed to be involved. For the Navy facilities, either SUBROC, ASROC or Terrier missiles or multiple warhead Trident or Poseidon missiles are assumed to be involved. No more than 1 multiple warhead missile or 4 single warhead missiles are assumed to be involved.

[redacted] Reviewers questioned whether there might be better accident probability data for these types of accidents.

[redacted] 2.9.2 Findings

[redacted] Although the accident probabilities were of concern to some reviewers, we were unable to find better accident statistics within the time, funding and other limits of this study. Table 2-10 presents our best estimate for the source term for accidents involving missile mating operations in a maintenance building.

[redacted]

[redacted]

Table 2-10

[redacted] Accident Sequence 8: Missile Mating Accident - Maintenance Facility

[redacted]

Accident Sequence 8	Missile mating accident at either an Air Force maintenance facility, with SRAM or Genies involved, or at a Navy shore maintenance facility or in-port tender, with SUBROC, ASROC, Terrier, Poseidon and Trident missiles involved. Propellant on at least 1 rocket is assumed to ignite, creating fire and impact environment.
Initiating Event Probability	1E-3/site-year
Accident Environment	
P(Fire)	.5
P(Impact)	.5
Releases | Accident Environment	
Pu burning | fire	1 for Type A
HE detonation | fire	.7 for Type III .1 for Type I, II 10-3 for Type IV
HE detonation | impact	.7 for I, for 1 missile; .1 for remaining .3 for II, III for 1 missile; .05 for remaining

Summary

Release Mode	Probability of Release X per site-year	Release Quantity X (Grams Respirable Pu)
Pu Burn | Fire	5.0E-5 x P(1,2,3,... Type I or II)	10 F, 20 F, 30 F, ...
	3.5E-4 x P(1,2,3,... Type III)	10 F, 20 F, 30 F, ...
HE Det. | Fire	3.5E-4 x P(1 Type I)	10 F
	5.0E-5 x P(2,3,4,... Type I)	10 F, 20 F, 30 F, ...
	1.5E-4 x P(1 Type II or III)	10 F
	2.5E-5 x P(2,3,4,... Type II or III)	10 F, 20 F, 30 F, ...
Total	2.8E-4	10 F
	6.4E-5	20 F
	3.0E-5	30 F
	1.0E-5	100 F

[redacted]

[redacted] 2.10 Storage Facility Accidents

[redacted] 2.10.1 Background

[redacted] In the earlier scoping study, the accident parameters for storage facility accidents were:

> [redacted] The likelihood of an accident that could create an accident environment severe enough to threaten the weapons at a storage facility in the U.S. is extremely remote. Most nuclear weapons storage facilities are [redacted] Safety procedures for storing nuclear weapons are similar to, but more stringent than, those for storing conventional munitions. Thus, the probability that an operational accident will create an accident environment severe enough to threaten stored weapons is very small (probably less than 10^{-9} per storage facility-year). Discussions with people knowledgeable in weapons storage procedures and facilities indicate that the dominating risk to the stored weapons is from external influences, predominantly the crash of a heavy airplane into a storage facility. (b)(3)

[redacted] Most weapon storage facilities at fixed U.S. sites are located, for operational reasons, near a military airfield. The likelihood of an aircraft crashing or skidding into a storage facility depends on a number of factors, including the number of annual aircraft operations from nearby runways and flight paths, the effective storage facility structural area, the facility location relative to air activity, and the accident rate on takeoff, landing, or inflight for the types of aircraft flown in the area. These factors vary widely among the fixed U.S. sites. Some sites have a large number of operations while some have few. Some have storage facilities close to runways, and others do not.

[redacted] For example, the weapons storage areas for SAC weapons at six U.S. bases average about 20,000 ft^2 per base (not counting other possible nuclear weapon storage areas on site). Assuming a probability of 4E-8 fatal crashes per square mile per aircraft movement (based on USAF statistics compiled by Eisenhut[22] for crashes within 2 miles of the end

[redacted]

of Air Force runways), and 200 operations per day, there is an annual probability on the order of 2E-6 for a fatal U.S. Air Force plane crash into one of the SAC weapons storage facilities.

[redacted] Actual nuclear weapons storage areas at fixed U.S. facilities range from a few thousand square feet to over 235,000 ft^2. Most of the larger storage buildings are [redacted] (b)(3)

[redacted] In computing actual site specific crash probabilities, effective facility areas, building heights, and flight angles from the airfield would have to be taken into consideration. Aircraft crash rates vary also. Between 0 and 1 miles from the runway, the crash rate for the Air Force is 5.7E-8, and for the U.S. Navy and Marine Corps, 8.3E-8 fatal air crashes per mi^2 per aircraft movement. Distances of storage sites from runways, as well as angles relative to flight paths, vary considerably at U.S. bases.

[redacted] Each of these factors has the capability of raising or lowering the probability of a heavy aircraft crash into a weapons storage facility at a specific U.S. military base by factors ranging from 2 to 10. In considering all the factors, it is unlikely that the probability of a crash of a heavy aircraft into a weapons storage igloo or multicubicle magazine at a fixed U.S. base is much lower than 1E-7 per site-year or much higher than 1E-5 per site-year. This report will assume for its base case analysis a probability of 1E-6 per site-year for a heavy aircraft crash into a weapons storage building on a "typical" fixed U.S. site. Preliminary results of a Sandia study that examines the probability of aircraft crashing into weapons storage facilities at U.S. military installations indicate that these previously estimated probabilities are reasonable.[23]

[redacted] By way of comparison, in an estimated 5,000 site-years of operation at U.S. military facilities with nuclear weapons storage, there has been one aircraft crash into a storage facility. This implies a frequency of about 2E-4, or about a factor of 200 higher than the estimated value of 1E-6. This illustrates the wide range in probabilities that exist with this accident sequence.

[redacted]

[redacted] Storage facilities are typically located near airfields. The only restrictions on distances from runways and taxiways are based on the quantity/distance rules, in which the concern is an explosion in a magazine damaging other structures, airplanes, or property. Using these rules, a small storage facility (with 1300 lbs of HE) could be as close as 1,000 ft. to a runway, and 320 ft. to a taxiway if there are barricades between the two, and 750 ft. to a taxiway if no barricades are in place[24,25].

[redacted] [redacted] (b)(3)

[redacted] [redacted] (b)(3)

[redacted] Two accident situations are considered, (1) a crash into a [redacted] building, and (2) a crash into a [redacted] igloo. In both cases, a typical military aircraft is assumed to crash approximately directly into a facility. In the case of the [redacted] igloo, its low profile and [redacted] cover is expected to offer substantial protection to the interior structure and weapons unless the impact is directly into the uncovered door end of the structure. Given that an aircraft impacts an igloo, we have assumed a 15% chance of impacting the door end, and a 40% chance of a fire environment following a crash into the door end. Crashes directed into other portions of the structure are assumed to result in partial collapse of the structure but no substantial fire environment in the vicinity of the weapons. (b)(3)

[redacted]

[redacted] Behavior of the weapons in this accident environment is difficult to predict[27-32]. The main design goal, as well as the basis for HE and plutonium limits [redacted] has been to ensure that if the [redacted]

(b)(3)

[redacted] Similar assumptions are made for [redacted] except that less credit is taken for the structural protection provided by the roof and walls to direct hits. We have assumed that a crashing aircraft has a 70% chance of penetrating the structure, and a 40% chance of a fire environment.

[redacted] 2.10.2 Findings

[redacted] We were unable to find better accident statistics than those presented in the scoping study. Table 2-11 presents our best estimate for the source term for accidents involving weapons in storage buildings.

[redacted]

[redacted]

Table 2-11

[redacted] Accident Sequence 7: Airplane Crash Into Storage Facility

[redacted]

Accident Sequence 7	Crash of a heavy military aircraft into a weapon storage facility - [redacted]
Initiating Event Probability	1E-6 per site-year
Accident Environment	
P(Fire)	0.7 x 0.4 for [redacted] 0.15 x 0.4 for [redacted]
Releases | Accident Environment	
Pu burning | fire	1 for Type A
HE detonation | fire	0.1 for I, II 0.76 for III

(b)(3)

Summary

Release Mode		Probability of Releases X per site-year		Release Quantity X (Grams Respirable Pu)
Pu Burn | Fire	[redacted]	8.1E-8		1 F
		7.6E-8		2 F
		4.8E-8		3 F
		2.2E-8		4 F
		8.1E-9		5 F
	[redacted]	1.7E-8		2 F
		1.6E-8		4 F
		1.0E-8		6 F
		4.7E-9		8 F
		1.7E-9		10 F
HE Det. | Fire	[redacted]	2.1E-7	1	50 F
		1.5E-7	8	400 F
		1.5E-8	15	750 F
	[redacted]	4.6E-8		100 F
		3.2E-8		800 F
		3.2E-9		1500 F

[redacted]

[redacted]

[redacted] 2.11 Probabilistic Source Terms

[redacted] Several accident scenarios considered to be the most risk significant have been addressed. The sequences of events were evaluated for probability for occurrence and the potential quantity of plutonium released.

[redacted] A summary of the results of the assessment is tabulated in Table 2-12 and displayed in Figure 2-2. For each accident scenario, the outer boundary of these data represents the area of greatest risk significance due either to the relatively high probability for occurrence or the severity of consequences. The probabilistic source term can be represented in graphic form by a line encompassing (or bounding) this data.

[redacted] It should be noted that the overall risk from all types of DoD fixed facilities appears to be dominated by potential accident sequences related to SAC Air Force bases. Potential plutonium releases from other types of facilities appear to be significantly less serious. For example, if these other facilities were separately assessed, the probabilistic release curve would likely be much lower. The possibility of classifying fixed facilities according to their potential risk and prescribing emergency plans accordingly might result in significant advantage.

[redacted] The data represented in Figure 2-2 provide a required input to the total probabilistic risk assessment which will consider probable dispersive mechanisms and will probabilistically determine the potential radiation dose to man at various distances from the point of release. Additional source information required for such assessment includes the potential cloud height of released material and its inertial characteristics (particle size distribution).

[redacted] The source term assessment described in this report has required extensive consideration of classified data and information. However, a planning basis for the determination of EPZ's may be unclassified when a multitude of parameters are factored into the assessment.

[redacted]

Table 2-12

[redacted] Probability Per Facility-Year That Indicated Quantity X or Greater Will be Released Due to a Nuclear Weapon-Related Accident Involving That Activity

[redacted]

Release Quantity X (Grams of Respirable Plutonium)	1 C-141 Crash	2 Heli-copter Crash	3 Truck Crash	4 Minuteman Transport Crash	5 Railcar Crash	6 Ship Accident	7 Storage Aircraft Crash	8 Maintenance - Missile Mating	9 Maintenance - Aircraft Crash	10 Alert B-52 Fire	11 Alert - Interceptor Fire	12 Minuteman Silo Fire	13 Warship Missile Loading	14 Warship Weapon Fire
1 F	1.2E-5	1.3E-6	6.6E-7		1.0E-6	5.1E-7	3.6E-7		3.4E-8	1.6E-4	5.5E-4			1.1E-4
2 F	1.1E-5	6.3E-7	2.2E-7		6.0E-7	7.4E-8	3.2E-7		2.9E-8	1.0E-4				8.6E-5
3 F	1.1E-5	6.0E-7	2.0E-7		5.7E-7	5.1E-8	2.8E-7		2.9E-8	9.8E-5				8.6E-5
4 F							2.5E-7			9.8E-5				
5 F							2.3E-7							
6 F							2.3E-7							
8 F							2.2E-7							
10 F	1.1E-5	6.0E-7	2.0E-7	1.8E-8	5.7E-7	5.0E-8	2.2E-7	2.8E-4	2.9E-8		5.0E-5	2.6E-6	1.7E-5	
20 F	4.4E-6	2.5E-7	1.1E-7	7.8E-9	2.1E-7	1.8E-8		6.4E-5	1.3E-8			1.1E-6		
30 F	1.0E-6	6.1E-8	2.9E-8	2.6E-9	4.6E-8	3.5E-9		3.0E-5	4.0E-9			3.7E-7		
40 F	1.6E-7	8.2E-9	4.1E-9		5.6E-9	3.6E-10			9.7E-10					
50 F	2.2E-8	4.8E-10	2.3E-10		3.8E-10	1.5E-11	2.2E-7		1.4E-10					8.6E-5
80 F										9.8E-5				
90 F										4.8E-5				
100 F							1.2.E-7	1.0E-5		4.0E-5			2.0E-6	
110 F										2.6E-5				
130 F										9.5E-6				
400 F							9.3E-8							
750 F							2.5E-8							
800 F							1.8E-8							
1500 F							1.6E-9							

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[redacted]

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(b)(1); (b)(3)

[redacted]

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SECTION 3

[redacted]

CLASSIFICATION OF FACILITIES

3.1 Rationale

From a review of accident frequency data and source term prediction as discussed in SAI/PL 83-3 and reevaluated in the previous section, it appears that the establishment of a single overall EPZ for DoD nuclear weapons capable fixed facilities would be excessively restrictive for the majority of sites. To evaluate this assumption, classes of facilities can be developed according to similarities in operations and/or quantities of plutonium at risk at any given time. With this approach, it is possible to determine probabalistic source terms for each class of sites and subsequently to calculate EPZ's for site classes. From an examination of accident source term data (Figure 2-3), it appears reasonable to classifiy sites as:

3.1.3 Class I - Alert Aircraft, Naval Station, and Equivalent - Class I sites have the highest accident probability and/or quantity of plutonium at risk.

3.1.2 Class II - Missile Sites and Equivalent - Class II sites show an intermediate level of accident probability and/or quantity of plutonium.

3.1.3 Class III - Storage sites and equivalent are facilities with minimal operations and present the least chance for accident.

3.2 Class I Sites

Class I sites encompass those having the highest risk due to high probability of accident and/or high potential release quantities. This class notably includes sites having one or more alert aircraft loaded with weapons. Such aircraft are vulnerable to ground level accidents primarily due to impact from crashing aircraft or ground vehicles. They would also be most vulnerable to impact by various projectiles released accidentally or

[redacted]

[redacted]

intentionally. A major source of risk in this class is the possibility of severe fire due to ignition of large fuel supplies.

From a consideration of the total inventory at risk as well as the probability for an accident resulting in accidental release of plutonium to the atmosphere as may be noted in Figure 2-3, it is apparent that a group of facilities encompassing air bases, naval staging ports, and equivalent constitute that class of facilities with the highest accident potential. Additionally, given the occurrence of an accident at such facilities, it is possible to release substantial quantities of plutonium.

3.3 Class II Sites

Class II sites encompass these facilities with intermediate risk levels. Examples of facilities in this class would include: missile sites where potential accidents could occur during loading or maintenance, operations involving cargo type aircraft (where the total plutonium inventory is limited) and equivalent operations. The determination of classification for individual sites into this category would be based upon a consideration of specific operations, and potential release quantities.

3.4 Class III Sites

Facilities with the lowest level of risk fall within Class III. Any nuclear weapons capable facility used primarily for storage of weapons or sites with equivalent risk are those exhibiting the lowest potential for accidents. Although the total inventory of plutonium at these facilities may be relatively high, the low accident probability (generally due to minimal transport and maintenance operations) indicates that such facilities will have the least restrictive EPZ based upon the risk criteria.

3.5 Evaluation

Based on an assessment of the data shown in Figure 2-3 and a review of the facilities associated with the types of accident events evaluated, a reasonable definition of the three facility classes is shown in Figure 3-1.

[redacted]

[redacted]

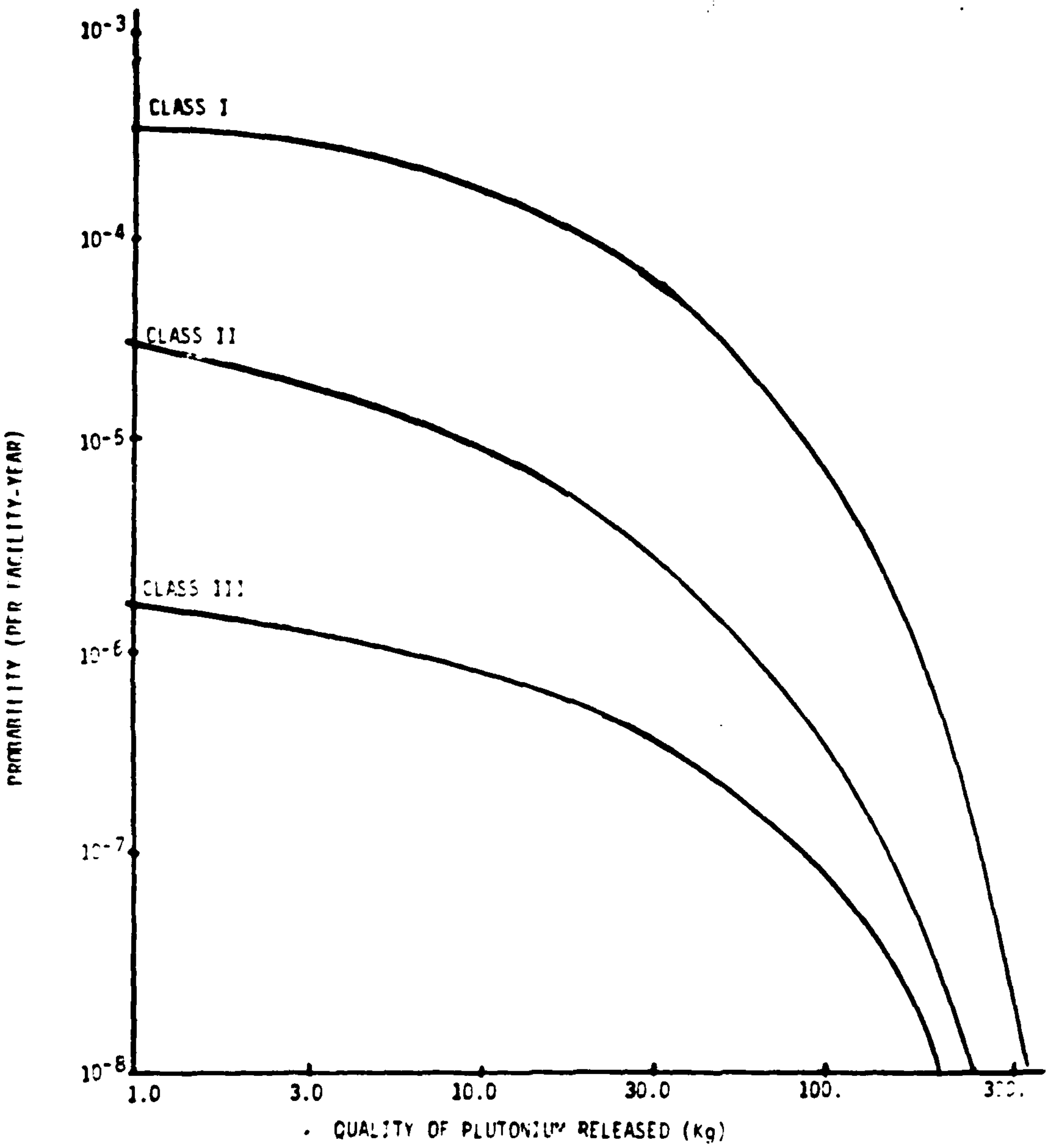

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FIGURE 3-1

[redacted] PROBABILISTIC SOURCE TERM FOR SITE CLASSIFICATION OF NUCLEAR WEAPONS CAPABLE FIXED FACILITIES

[redacted]

[redacted]

The curve for Class I facilities provides a representation of the probabilistic source term for that class of site. Similarly, the Class II and Class III curves represent the same source term vs. probability relationships for those classes of sites.

To determine whether a specific site would fall within a given generic classification will require a probabilistic risk assessment for that facility incorporating an analysis of each operation and/or chain of events that could lead to an accident involving the release of plutonium. From a comparison of the probabilistic source term curve derived from that analysis against the curves in Figure 3-1, a determination on the site classification may be made.

[redacted]

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SECTION 4

[redacted]

DETERMINATION OF EMERGENCY PLANNING ZONES

4.1 Approach

To estimate EPZ radii for the three classes of DoD nuclear weapons capable fixed facilities, the methods developed in SAI/PL-83-3 are applied. In this approach, the probabilistic source terms determined in Figure 3-1 provide input to generic meteorological calculations to estimate probabilistic dose consequences as a function of distance from the source. Generic calculations have been utilized since administrative constraints prevented obtaining site-specific data. Nonetheless, for the site classes discussed in Section 3, the generic approach should provide adequate estimates.

As in the previous study, the probabilistic dose estimates are then compared with those for nuclear power plant EPZ's as determined by the USNRC and USEPA in NUREG-0396.[2] To improve the probabilistic dose estimates, we have reviewed the assumptions used in the calculational models. Of particular importance are the assumptions related to particle size distribution and cloud height estimation.

4.2 Cloud Height

An area of concern and criticism by the peer review group on the approach used in the previous study was the method used to derive cloud height estimates. According to Church,[3] the cloud resulting from an accidental (no fission yield) nuclear weapon explosion can be related to the quantity of high explosive detonated. From a best-fit analysis of experimental data, Church derived the formulation:

$$H = 76W^{0.25}$$

where H is the cloud height in meters and W is the mass of high explosive in pounds. In the previous study, a modified formula of $H = 50W^{0.25}$ was

[redacted]

[redacted]

arbitrarily applied to account for an assumed decrease in cloud buoyancy due to horizontal cloud development when, for example, the blast release emanates from a failed igloo door. Consideration was also given to possible increased buoyancy due to heat input from burning fuel from an aircraft accident. However, the time scale of early cloud development (during which the major fraction of plutonium would be released) precludes a significant contribution from burning fuel relative to that from the high explosive component.

Based on these arguments, the original Church formulation was utilized to develop "best estimates" of the probabilistic cloud height. Accordingly, input to the meteorological calculations assumes the cloud height distribution presented in Table 4-1.

Table 4-1

Cloud Height (m)	Probability, Given a Nuclear Weapon Accident, of Indicated Cloud Height
30	0.2
150	0.6
750	0.2

4.3 Atmospheric Dispersion

The methodology applied in SAI/PC-83-3 was used to calculate atmospheric transport and probabilistic dose consequences. The basic atmospheric transport methodology used is the Gaussian plume model described in Meteorology and Atomic Energy - 1968"[4] and used in a number of computer programs, such as the NRC XOQDOQ code.[5] In the Gaussian plume model, advantage is taken of the fact that natural diffusion in the atmosphere leads to a known (Gaussian) distribution of the pollutants. The analysis methodology includes addition of a term for ground reflection of dispersed maerial, integration over time to yield time-integrated effects, solution at

[redacted]

[redacted]

z = 0 to provide results at the ground interface, and solution at y = 0 to provide maximum (plume centerline) results.

The following data were used to calculate the probabilistic dose as a function of distance from the source:

- o weather (wind speed and direction, atmospheric stability),
- o release quantity,
- o initial cloud size and height,
- o particle size distribution, and
- o breathing rate and dose commitment factor.

A single set of generic weather data was derived from weather data for five locations (Hanford, WA, San Diego, CA, Scranton, PA, St. Louis, MO, Savannah River, SC). For each site, data were obtained which indicated the frequency of occurrence for each combination of wind speed and Pasquill stability category. The frequency for each wind speed/stability category combination was then averaged over the five sites to derive the generic weather data set. The result was a matrix of 42 frequencies for six wind speed classes and seven Pasquill stability categories.

Calculations were performed on the basis of a 1 kg release and then scaled for the probabilistic source term (release quantities and probabilities). For purposes of analysis, clouds were each divided into two disks, with the upper segment containing 67 percent of the released material.

The data in Section 2.4, the particle size distribution is assumed to be characterized by three particle size classes: a small particle size class with an effective aerodynamic diameter of 3 microns (20 percent of total release mass), a medium particle size class with an effective aerodynamic diameter of 30 microns (60 percent of mass), and a large particle size class with an effective aerodynamic diameter of 300 microns (20 percent of mass).

Conversion of air concentrations to inhalation dose commitment required data for breathing rate and a dose commitment factor. A breathing rate of 1.2 m^3/hr was assumed, based on a standard man (adult) undergoing moderate

[redacted]

[redacted]

activity.[6] A dose factor of 2×10^7 rem per gram inhaled was derived from weighted organ dose commitment factor data in ICRP-30[7] for Y class Pu-239. The factor of 2×10^7 is the sum of the ogran dose commitment times the ogran weighting factor for four organs: red marrow, bone surface, lungs, and liver. This sum is referred to as the effective whole body dose equivalent.

Air concentration and deposition calculations (X/Qo and D/Qo) were performed for each combination of weather condition, cloud mix, particle size class, and distance of interest (seven values ranging from 100 m to 100 km). The result was nine sets of data, each containing 7x42 sets of X/Q, D/Q, and weather frequency data. These nine sets of data were then reduced to three sets by combining the particle size classes for each respective weather condition, distance, and cloud size. This was done by multiplying each X/Q and D/Q by the fraction of material in that size class and summarizing. The resulting three were then combined and Complementary Cumulative Distribution Functions (CCDF's) of dose vs. distance vs. probability created.

4.4 EPZ Estimation

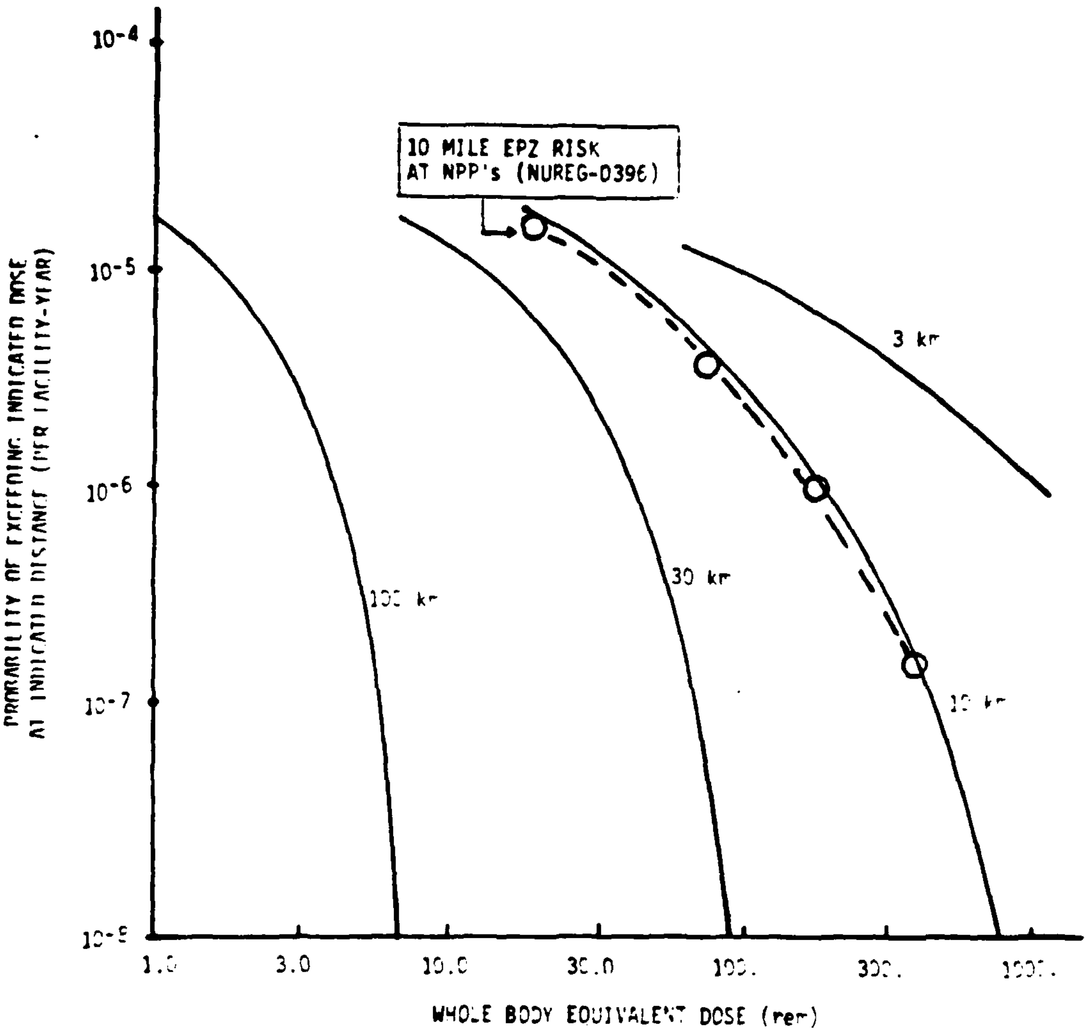
To determine suitable emergency planning zone radii for the classes of facilities designated in Section 3, probabilistic dose estimates were determined as a function from of distance from the release source (accident site). For the three classes, the dose estimates are presented in Figures 4-1, 4-2, and 4-3. For purposes of comparison, the risk curve for the 10 mile EPZ designated for nuclear power plants (NPP) is superimposed (dotted line). From this set of curves, suitable EPZ's can be estimated for the facility classes.

4.5 Discussion

From a review of the calculational results as presented in Figures 4-1, 4-2, and 4-3, it appears that significant advantage could be gained from establishing site classification criteria. For example, Table 4-1 indicates reasonable distances for EPZ's for the various facility classes.

[redacted]

[redacted]



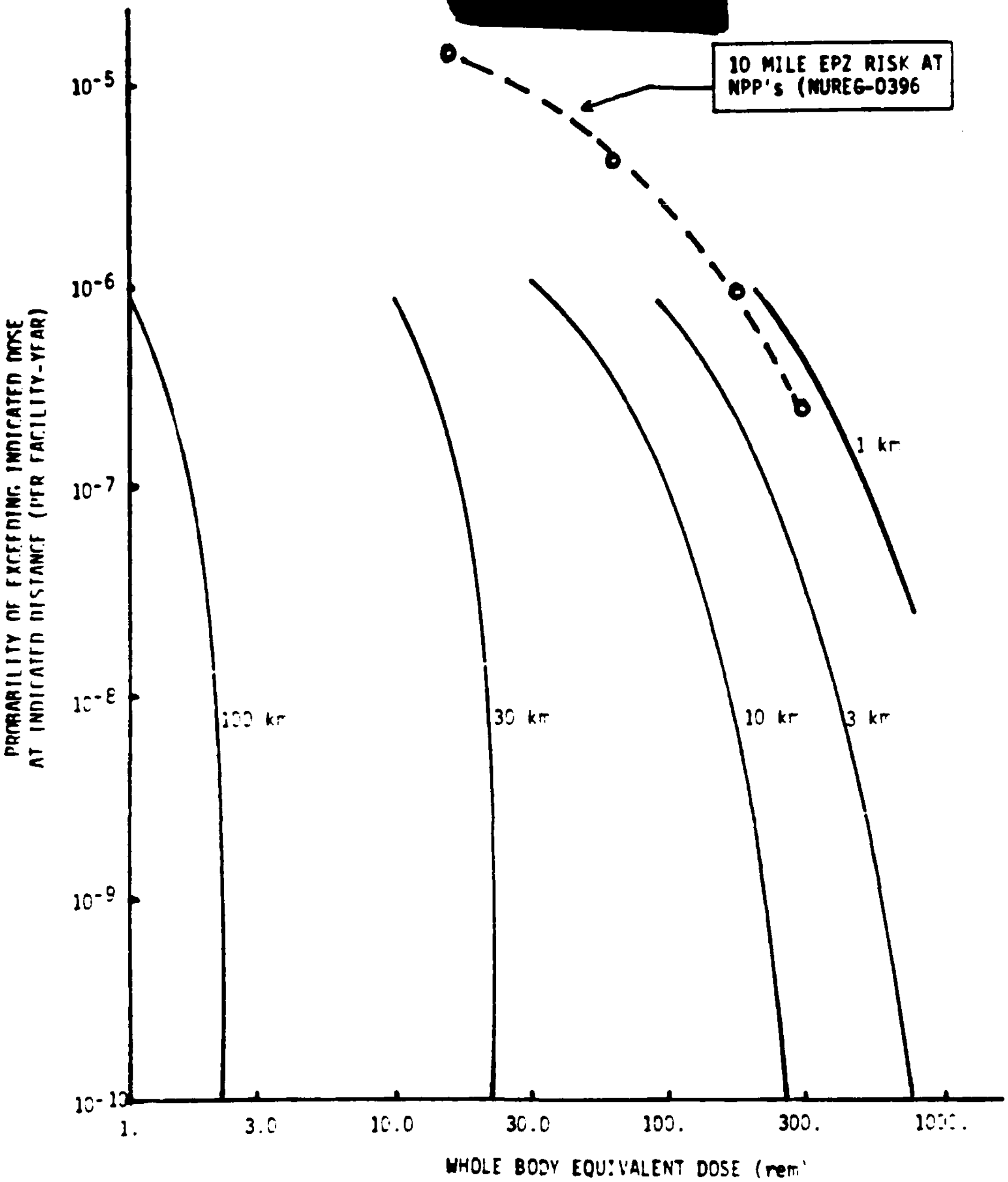
[redacted]

FIGURE 4-1

[redacted] POTENTIAL RADIOLOGICAL RISK FROM ACCIDENTS AT <u>CLASS I</u> NUCLEAR WEAPONS CAPABLE FIXED FACILITIES

[redacted]

[redacted]



[redacted]

FIGURE 4-2

[redacted] POTENTIAL RADIOLOGICAL RISK FROM ACCIDENTS AT <u>CLASS II</u> NUCLEAR WEAPONS CAPABLE FIXED FACILITIES

[redacted]

[redacted]

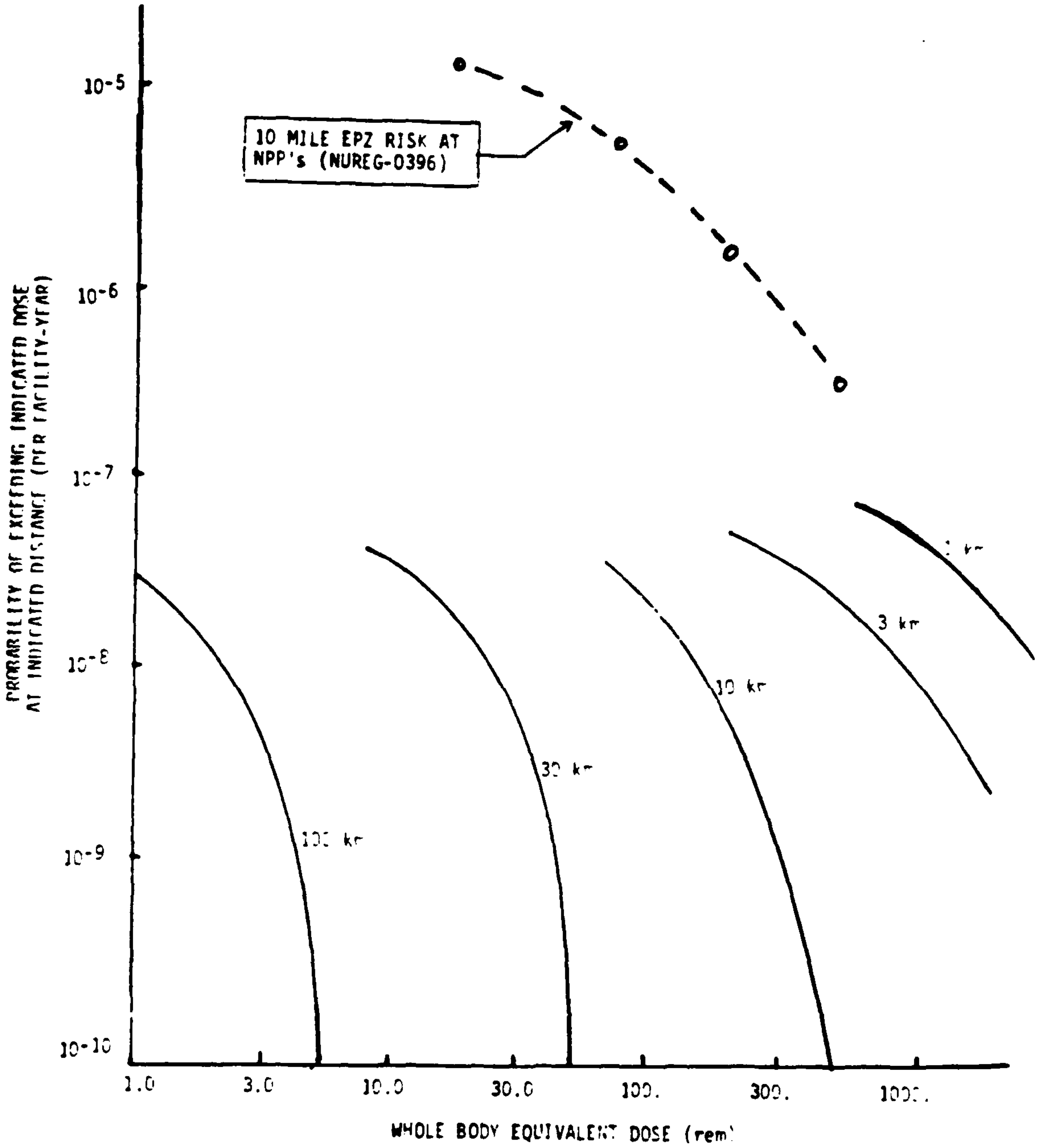


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FIGURE 4-3

[redacted] POTENTIAL RADIOLOGICAL RISK FROM ACCIDENTS AT CLASS III NUCLEAR WEAPONS CAPABLE FIXED FACILITIES

[redacted]

[redacted]

Table 4-1

[redacted] EPZ Distances for Nuclear Weapons Capable Fixed Facilities

[redacted]

Site Classification	Estimated EPZ Distance (Km)	(Miles)
Class I	10	6
Class II	2	1
Class III	< 1	-

Class III facilities which show an estimated EPA distance of less than 1 km could likely contain the entire EPZ area within the designated boundaries of the facility. This would also probably be the case with several Class II facilities. Significant savings in planning efforts could be realized as compared to that for applying a single generic criteria. Determination of classification for individual facilities would require assessment on a site-specific basis.

4.6 References

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SECTION 5

[redacted] ASSESSMENT

[redacted] 5.1 Overview

[redacted] In this report we have estimated EPA distances for three classes of DoD Nuclear Weapons Capable Fixed Facilities. In previous work, a single generic EPZ was calculated for all such facilities. However, it was apparent that differences between individual facilities (e.g., the nature of activities and resultant accident potential, onsite plutonium inventories, etc.) would make the generic EPZ overly restrictive in the majority of cases and perhaps too lenient for some. To minimize problems of this type, a system for classifying facilities according to their potential risk was developed. Subsequently, EPZ's for each class were estimated.

[redacted] For these risk evaluations, the methods of probabilistic risk assessment were applied. The probability of potential accidents as well as the resulting consequences were considered. Although no definitive guidance is available for specifying the degree of risk necessary for inclusion of an area within the EPZ, we applied the implicit approach in NUREG-0396 for determination of EPZ's for nuclear power plants. Philosophically, it is assumed that the degree of risk at the perimeter of a nuclear weapon facility EPZ should be commensurate with that at the nuclear power plant EPZ boundary. From this assessment it was determined that:

[redacted]
- Class I Facilities are those with the greatest risk levels comprising such sites as B-52 bomber bases and various naval staging facilities. These facilities could have an EPZ distance of up to 6 miles.

[redacted]
- Class II Facilities are those with an intermediate risk level such as missile sites would have an EPZ of about ~1 mile.

[redacted]
- Class III Facilities are low risk (e.g., storage facilities involving no significant maintenance and transport). Such facilities would likely not need an EPZ since the distance to the EPZ perimeter may fall within the site boundary.

[redacted]

[redacted]

[redacted] 5.2 Sensitivity

[redacted] The results presented here are sensitivie to some extent to the analysis methods and assumptions that were used. Although changes in any one of several factors could influence the final results, only changes in the probabilities of the initiating events, such as major alert aircraft fires on plane crashes would have a major impact on the resulting EPZ's. The more significant factors are the:

[redacted]
- o initiating event probabilities,
- o number of weapons likely to detonate,
- o release fraction,
- o particle size distribution,
- o cloud heights,
- o meteorological assumptions,
- o dispersion analysis and consequence assessment, and
- o risk comparison with nuclear power plants.

[redacted] The uncertainty in the initiating event probabilities is expected to dominate the overall uncertainty in the risk calculations. Most of the probabilities are expected to be somewhat conservative. Because of the limited nature of this analysis, we had to depend on different sets of risk analyses which used differing assumptions. In certain cases, reliance was placed on limited and sometimes only slightly relevant accident statistics. Thus, we strongly suspect that if a uniform set of assumptions were used across the board, the absolute (and perhaps relative) risk ranking of the various operations would differ. Because of the special safety precautions taken with nuclear weapons, we expect the absolute probability of weapon threatening initiating events to be lower than the estimates used in this report. Although the degree of credit is difficult to estimate, and probably varies considerably from operation to operation, it could be significant. It is reasonable to assume that detailed risk assessments might result in risk estimates different from those presented in this study. The specific impact on EPZ determination would depend on the accident sequence considered. However, in some cases, the reduction could be substantial.

[redacted]

[redacted]

[redacted] Another factor that could impact the EPZ calculations is the assumed number of weapons likely to undergo high-order detonation. This study assumes that a random mix of weapons, likely to be associated with a particular type of accident situation is involved. In some cases, such as their storage or maintenance operations, the weapons involved could very in vulnerability to the particular initiating event. Thus, potential releases could be significantly more than estimated, or no release might occur. The assumed probability that a weapon might undergo high-order detonation is based on ongoing Sandia studies and is thought to be reasonable, but conservative.

[redacted] The fraction of plutonium aerosolized was assumed to be 100 percent for all weapons undergoing high-order detonation. This is certainly conservative based on weapons accident experience. The actual release fraction could easily be 10 percent or less if the high explosive burned before detonation. A release fraction of 10 percent would significantly reduce the estimated EPZ.

[redacted] The amount of plutonium in weapons available for release is also a factor that could impact the consequences of an accident. [redacted] (b)(1) (b)(3)

[redacted] Another factor that impacts the consequence assessment is the assumed particle size distribution. The assumption that 20 percent of the aerosolized plutonium is respirable is thought to be an upper limit and hence conservative. There is a reasonable probability that considerably less plutonium would be in the respirable range, perhaps an order of magnitude less.

[redacted] The EPZ calculations are clearly sensitive to the cloud height assumptions. Higher clouds reduce maximum individual doses because of the

[redacted] [redacted]

[redacted]

greater atmospheric dilution. The overall sensitivity of the results to cloud height assumptions are discussed in Section 4.2.

[redacted] The meteorological assumptions for this generic study were based on an average of several flat terrain sites. A specific site might have considerably different meteorological conditions and hilly terrain. This would significantly impact the risk assessment and EPZ determination for a specific site.

[redacted] The dispersion analysis and consequence assessment were performed using standard, widely-accepted computer codes. It is unlikely that the application of other codes would yield significantly more reliable results.

[redacted] 5.3 Conclusions

[redacted] Based on the assessments in this study, the following conclusions can be drawn:

[redacted] 5.3.1 The risk based classification of DoD nuclear weapons capable fixed facilities provides significant advantages over the use of a single generic assessment for determining EPZ's.

[redacted] 5.3.2 To assure proper assessment, site specific evaluations based on local meteorology, operations and inventories should be performed.

[redacted] 5.3.3 To gain confidence in the safety evaluation process, a detailed probabilistic risk assessment would be desirable. Such an assessment could identify possible areas of weakness in site safety programs.

[redacted] 5.3.4 Although generic assessments such as performed in this study may be considered adequate for estimating EPZ's, they should not be applied to nuclear weapon safety in general or to specific operations.

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[redacted]

The comments presented below are offered to make the report technically stronger; and, in some cases, clearer, so that future decisions can be made on the best available data.

General Comments

The document, in its unclassified form, assumes that the reader is exceptionally familiar with the broad range of included subject matter; and the Committee feels that some, who may have to act on the report, would be aided by explicit statements of the assumptions used in each of the major sections. Different technical assumptions would lead to different conclusions.

The Committee noted that there are instances in which hazardous materials, other than those which are radioactive, may be involved in a nuclear accident; and, this should be pointed out clearly. In fact, some of these materials may require an EPZ of comparable in extent, if equivalent population protection is to be provided.

Source Term Considerations

The accident radioactive source term for nuclear explosives is fixed by design; however, the estimates of the fraction of plutonium released in an accident is derived from two tests in the Roller Coaster Nuclear Test series - Double Tracks and Clean Slate 1. These tests were conducted using the best technology of the day; however, there are more recent data available which should prove useful in current accident analysis. For example, data for a number of plutonium burning experiments show that ~1% of the particles released is in the respirable range vs. the 20% derived from the Roller Coaster data. The impact of these later data, coupled with an ICRP dose model, can reduce the extent of an EPZ.

A review of the information from which the probability of release vs. mass of "respirable" plutonium released, shows that the curve in the report (Figure 5-1) is strongly weighted by the very low probability, high inventory sites. The curve completely encompasses the upper bound of all predicted releases. Since this figure is a composite of many individual site specific accident probability curves and represents an upper bound, it can be misinterpreted easily, and words of

Page 1 could not be located.

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caution on its use is warranted. The figure (5-1), alone, does not depict the real situation which must be dealt with. It is absolutely necessary to use the classified document to ascertain the full impact of the basic data.

The corresponding graph (Figure 5-2), for cloud rise, did not have similar supporting information, as did Figure 5-1, to justify its shape. The Committee recommends that a graph of the results of Church's equation, (Page 5-11), be included, along with another graph of cloud height vs. fuel content (either in calories or jet fuel equivalent). Coupling these two new graphs should produce the graph presented in Figure 5-2. The depicted shape of Figure 5-2 is intuitively correct, but its derivation is unclear from the data reviewed; another curve should be considered which relates cloud height as a function of respirable source term.

Meteorology

The use of national average meteorology is necessary in a generic study such as the one reviewed, but the Committee cannot neglect pointing out the absolute necessity of using local data, such as prevailing winds, in planning specific EPZ's. The significance of secondary exposure from resuspension and weathering of deposited material will vary with the local climate and ground cover and the SAI report's use of Nevada's Test Site resuspension is conservative relative to most of CONUS. Transport values should be those characteristic of local sites. Because of the undue attention resuspension attracts, any area contaminated from an accident will be used to determine local resuspension values for a final assessment of long term dose. This assessment of secondary exposure can be evaluated on a case-by-case basis in the area affected by the accident. The EPA "screening level of 0.2.uCi/m^2" was developed to eliminate unnecessary measurements needed to demonstrate that basic radiological health protection guides were met. The limit should not be given too much weight in the planning activity.

Public Dose

The report used the most recent ICRP recommendations, (ICRP-26), regarding the conversion of plutonium quantity released air to dose to individuals. The use of effective dose equivalent as suggested by ICRP is an

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acceptable method for normalizing organ risks (lung, bone and liver) to whole body risks. However, a comparison of dose to persons derived from the NUREG 0396 document is misleading if the differences are not fully recognized. EPA's informal "PAG's" are not directly applicable to the weapons situation since the source terms used in their development is quite different. One can calculate specific health effects from the doses anticipated in the reactor study and make a comparison of specific health effects from plutonium. In the severe reactor accident case, accute effects are likely to be seen promptly, while any effects from plutonium exposure are likely to be seen in thirty to forty years. If this comparison is to be made, "words of caution" should be noted in the SAI report.

The probabilistic risk assessment puts the technical information in perspective for decision makers and the point of selecting an EPZ will be based on both technical and political considerations. The values suggested in the report lie in the three to ten kilometer range for a one in one-million chance of receiving a significant plutonium dose. An EPZ limit greater than 10 kilometers begins to become unrealistic and unmanageable. A lot of planning for events with an occurrence equal to or less than one in ten-million only diverts precious resources from higher probability events which require attention.

Summary

The conclusions of the report appear to be valid; and the above comments, if incorporated, would increase the strength of the report.

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APPENDIX B

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GUIDANCE FOR DEVELOPING STATE AND LOCAL RADIOLOGICAL EMERGENCY RESPONSE PLANS AND PREPAREDNESS IN SUPPORT OF DEPARTMENT OF DEFENSE AND DEPARTMENT OF ENERGY FACILITIES

19 September 1983

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FOREWORD

The purpose of this document is to provide guidance for the development of radiological emergency plans to improve emergency preparedness around Department of Defense (DOD) and Department of Energy (DOE) facilities. The objective is to have plans which will integrate the response of the facilities, the State and the contiguous local governments in the event of a radiological accident to assure the protection of the health and safety of the public. This guidance is the product of joint DOD/DOE/Federal Emergency Management Agency (FEMA) effort to coordinate the work of Federal agencies engaged in radiological emergency preparedness. It is intended to be used also by reviewers in determining the adequacy of State and local emergency plans and preparedness for the off-site areas around DOD/DOE facilities.

This planning document closely follows the format used by FEMA in its FEMA-REP-5, "Guidance for Developing State and Local Radiological Emergency Response Plans and Preparedness for Transportation Accidents" issued in March 1983. This format has been adopted for planning for DOD/DOE facilities for two reasons: (1) it has been proven practicable for radiological emergency planning in the predecessor document; and (2) it was felt that use of a format with which the States and local governments are already familiar would be less of a burden than a format different than FEMA-REP-5.

However, as noted in Section I, there are differences between radiological emergency planning for transportation accidents and DOD/DOE

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fixed facilities. These differences involve alternatives in the protective measures to be taken as well as the respective response roles of the DOD/DOE facilities and the State and local governments.

Department of Defense

Department of Energy

Federal Emergency Management Agency

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DEPARTMENT OF DEFENSE - DEPARTMENT OF ENERGY-FEDERAL EMERGENCY MANAGEMENT AGENCY-GUIDANCE FOR DEVELOPING STATE AND LOCAL RADIOLOGICAL EMERGENCY RESPONSE PLANS AND PREPAREDNESS IN SUPPORT OF DEPARTMENT OF DEFENSE AND DEPARTMENT OF ENERGY FACILITIES

I. INTRODUCTION

A. Purpose

The purpose of this document is to provide a common reference and guidance source for:

1. State and local governments in the development of radiological emergency response plans in support of DOD/DOE facilities.

2. Federal Emergency Management Agency (FEMA), DOD, DOE, and other Federal agency personnel engaged in the review of state and local government and facility plans and preparedness.

3. All participating DOD, DOE, and Federal agencies engaged in the development of the National Radiological Emergency Preparedness Plan.

This document is intended to provide general radiological emergency planning guidance, identify the principal elements to be considered in preparing for- and responding to-radiological emergencies, and to provide a common basis for the review and evaluation of response plans and preparedness measures.

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B. Background

This document was prepared by DOD, DOE, and FEMA in a combined effort to carry out their respective functions: DOD and DOE with their responsibilities for nuclear and radioactive material facilities, and FEMA as the lead agency responsible for coordinating off-site Federal response to radiological emergencies (Ex-Ord 11248, July 20, 1979).

The DOD, DOE, and FEMA have prepared this guidance in accordance with the Atomic Energy Act of 1954, as amended, Executive Order 11248 of July 20, 1979, the President's Statement of December 7, 1979, with the accompanying fact sheet, 44 CFR Part 351, and the January 8, 1982, agreement between FEMA, the DOD and DOE defining the terms of their responsibilities in planning for and responding to nuclear weapons accidents. The responsibilities derived from these documents include development and promulgation of guidance to facilities and to state and local governments, in cooperation with other Federal agencies, for the preparation of emergency response plans.

The guidance provided in this document is not intended to obviate the need for existing emergency preparedness facilities, procedures and equipment. Rather, it is intended to be utilized as a guide for reviewing and, where appropriate, revising existing radiological emergency response plans and preparedness.

When the DOD, DOE, and FEMA developed this guidance document, the general acceptance of FEMA-REP-5 for transportation accidents resulted in the adoption of a similar format.

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C. Scope

The focus of this document is the development of plans and preparedness for possible off-site radiological consequences of an accident occurring at a DOD or DOE facility with the dissemination of radioactive contaminants into the surrounding area. However, much of the guidance is directly applicable to accidents involving the release of other hazardous materials.

This document provides general information regarding potential radiological accidents that might impact public health and safety near DOD and DOE facilities. The nature of the various DOD and DOE facilities with respect to the type of facility, operational activities, mission/programmative objectives, siting, and accident potential is unique. Accordingly, the planning guidance contained herein is presented in a format that can be readily adapted and applied on a site-specific basis.

DOD/DOE facilities, cognizant Federal agencies, as well as state and local governments should consider the guidance presented in this document when developing, updating and reviewing radiological emergency response plans and preparedness measures. However, it should be noted that utilization of this guidance is voluntary and does not represent a regulatory requirement.

Section III of this document presents 15 planning objectives and associated guidance. To assist state and local governments in identifying potential Federal and other types of assistance, a brief

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discussion of such assistance and a listing of Federal emergency contacts (Appendix 6) are also included.

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II. PLANNING BASIS

A. Background

The overall objective of emergency response plans is to provide guidance for the protection of the health and safety of the public. In the context of a radiological accident at a DOD or DOE facility, this objective translates into developing procedures that will reduce harmful radioactive contaminant doses to the public.

Invariably, a radiological emergency will involve a high level of uncertainty and public apprehension. Due to the general lack of understanding about the nature of any radiological accident, there is also a tendency to sensationalize even the most minor incident. However, an understanding of the nature of radiological materials and the principles involved in reducing their adverse effects considerably facilitates the planning process.

Because each accident could have different consequences, both in nature and degree, no single accident sequence can be identified and evaluated for planning purposes. Accordingly, the accident characteristics described in this section and the planning objectives delineated in Section III were developed based on a knowledge of the potential consequences of a spectrum of accidents, and a balance between those actions which require advanced preparation and those which can be improvised at the time of an emergency.

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B. Accident Characteristics

The consequences associated with any accident involving the release of radioactive materials depend on various factors, some of which are:

1. Severity of accident forces (crushing, fire and impact);

2. Accident location (rural, suburban and urban);

3. Quantity and type of material involved (radionuclides, chemical and physical characteristics);

4. If releases occur, the fraction of material released;

5. Meteorological conditions at the site;

6. Time required for emergency response personnel to reach the site and to diminish the consequences; and

7. The presence or possibility of a fire or explosion which may act as a dispersing mechanism.

Information concerning each of these factors is important in assessing an accident and implementing a timely-effective response.

A knowldege of the kinds of radioactive materials potentially released is necessary to establish the characteristics of monitoring instrumentation, to develop tools for estimating projected doses, and to identify the most probable exposure pathways.

The meteorological conditions prevailing at the time and immediately following the accident will determine the pattern of the contaminant

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dispersal. The radioactive material would move downwind and disperse in a short time, contaminating the nearby area. It is necessary that timely actions be taken by DOD, DOE, civil authorities, and the general public to minimize the effects of cloud passage, surface contamination or subsequent resuspension of contaminants by either wind action or movement of personnel and vehicles.

The need to specify the potential exposure pathways is evident. The location of the population for whom protective measures may be needed, responsible authorities who would carry out protective actions, and the means of communication to these authorities and to the population are all dependent on the unique characteristics of the particular accident and the affected area.

To ensure appropriate interaction and understanding between Federal, state, and local emergency management officials, DOD and DOE have adopted the terminology most commonly and currently used in state and local emergency response plans. These are the plume exposure pathway and the ingestion exposure pathway.

1. Plume Exposure Pathway: The principal exposure sources from this pathway are exposure to hazardous material from the plume and from deposited material; and inhalation exposure from the passing material. For the plume exposure pathway, shelter and/or evacuation would likely be the principal immediate protective actions to be recommended for personnel with shelter being the preferred action. [redacted]

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2. Ingestion Exposure Pathway: The principal exposure from this pathway would be from ingestion of contaminated water or food stuffs. For the ingestion exposure pathway, the planning effort involves the identification of major exposure pathways from contaminated food and water and the associated control and interdiction points and methods. The ingestion pathway exposures, in general, would represent a longer term problem, although some early protective actions to minimize subsequent contamination of food stuff should be initiated.

As soon after the accident as feasible, it will be necessary to monitor the surrounding area with instruments to ascertain the extent and intensity of the radioactivity. It will also be necessary to monitor people who may have been exposed during the accident, subsequent cloud passage, from surface contamination or during post-accident reentry into the area. Initially, the DOD or DOE may have the only instruments at the scene and may be required to perform monitoring of all personnel.

Responsibility for off-site area monitoring will shift to state radiation control personnel or, if requested, to DOE emergency response team personnel, as they arrive. Persons who may have been present at the accident site or in known contaminated areas must be identified and screened so that those who are contaminated can be decontaminated, given bioassays, and receive appropriate medical treatment. It can be anticipated that personnel outside the accident areas will request tests to ensure that they were not contaminated by the accident.

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population. The next step would be to screen that portion of the population which may have been initially alerted but subsequently determined not to have been exposed. This step is intended to dispel public fears and concerns rather than to support a technically based need; nevertheless, it may prov. a very important aspect of response to an accident involving an off-site release of contamination.

C. Organizational Responsibilities

The planning objectives delineated in this document imply that mutually supportive emergency planning and preparednesss arrangements need to be developed by several levels of government: DOD, DOE, other Federal agencies, and state and local governments.

It is anticipated that existing DOD and DOE facility plans will be expanded in accordance with the guidance provided in this document and will be coordinated with the off-site state and local jurisdictions.

States that have radiological emergency plans for commercial nuclear reactors and/or transportation accidents will be able to adapt those plans for DOD and DOE facilities. This should ease the burden as well as reduce the cost of writing additional plans. However, even in those states which presently have nuclear power plant radiological emergency plans, the location of DOD/DOE facilities may be different than the power reactors, requiring the development of additional plans.

The initial response to a radiological accident would be made by the facility and the local government where the accident has occurred.

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Support from Federal and state response agencies will follow. Instead of the facility, state and local government each sharing equally in the response, the planning should emphasize the major roles of the facility and local government. This does not diminish the significant role of the state in utilizing its resources to improve the preparedness of local governments to meet such contingencies. This would especially be true in rural areas where the local government may lack resources.

It is emphasized that much attention needs to be centered on the development of the local governments' plans to assure proper integration with the facility. Each plan should be tailored to its respective geographical area, which will vary according to the local conditions. The area may be contained in a single or several jurisdictions. In situations where the local governments already have established an agency to perform multi-jurisdictional emergency planning, it would be an advantage to include DOD/DOE facility radiological accident planning as part of its responsibilities. If the area involves more than a single state, the states should cooperatively develop plans to assure response consistent with each other.

The choice of the particular unit of local government that should develop plans for potential radiological accidents at DOD/DOE facilities will be left to each of the states involved in such planning. It is anticipated, however, that as in the planning for commercial power reactors, counties will continue to be the predominant unit, except for the New England section where towns are the unit of local government. Counties in general offer an advantage for radiological

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emergency planning where the geographical scope of an accident may extend over a larger area. In many counties which have developed plans for the nuclear power reactors, the municipal and village governments have prepared plans compatible with and as parts of their county plan. They thus contribute additional resources to strengthening their county response in the event of an accident, and by exercising their initiative, add vigor and responsiveness to the county's effort. In some counties, because of superior resources, greater population or leadership, it may well be a municipality which takes the lead role in developing the county plan.

1. <u>Specific State and Local Government Responsibilities</u>

Although the cognizant Federal agency bears the primary responsibility for assuring that radioactive materials are safely handled, offsite responsibility for responding to an accident generally falls to the state or local government, as is the case for any accident or other types of manmade and natural emergencies. The appropriate agencies should, therefore, be prepared to respond to an accident involving radioactive materials.

a. State officials have the responsibility to protect persons within the State from unwarranted radiation exposure and should therefore:

(1) Develop and distribute to appropriate persons a radiological emergency response plan ad-

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dressing Federal, state, and local and private responsibilities and resources;

(2) Designate an emergency radiological response team;

(3) Coordinate a communications system of Federal, state, and local agencies involved in emergency radiological response;

(4) Negotiate agreements with contiguous states addressing responses to incidents in close proximity to a common border; and

(5) Prepare, or assist in preparing, and distribute implementing instructions and operational procedures to be used by State, local, and/or other emergency response personnel in carrying out their responsibilities.

b. The local government should coordinate the development of a local emergency response plan compatible with the state response plan, and should specify the respective roles and responsibilities of Federal, state, local, and private organizations. The local government, probably its law enforcement or fire service agency, will most likely be the first off-site governmental responder to an accident, and should, therefore, be prepared to:

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(1) Administer emergency measures to save lives and attend to the injured;

(2) Determine if radioactive or other hazardous materials are present in the incident and secure information about these materials;

(3) Notify appropriate authorities to obtain radiological expertise; and

(4) Determine the action required to prevent further damage to life or property.

2. Federal Government

a. DOD and Federal Programs

At the Federal level, there are continuing efforts to ensure and improve safety at DOD and DOE facilities, as well as respond immediately and effectively to any accident involving such a facility. DOD and DOE provide radiological emergency response training, instrumentation, and emergency equipment to enable their on-site personnel to respond quickly and effectively to any emergency involving radioactive materials. Detailed procedures, describing actions to be taken by site personnel have been developed and are regularly exercised to ensure continuous preparedness for such contingencies. In the event of an actual occurrence, in addition to on-site actions, DOD and DOE have response teams on alert to provide additional assistance to their facility personnel. DOD and DOE facilities should develop and maintain a close relationship with states and local governments so that the appropriate

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authorities are promptly notified of the occurrence and current status of an accident.

The other principal Federal agencies tasked to provide support in the event of a radiological emergency are: Department of Agriculture (USDA), Department of Commerce (DOC), Department of Health and Human Services (HHS), Department of Transportation (DOT), and the Environmental Protection Agency (EPA).

FEMA is responsible for the development of the overall Federal Radiological Emergency Response Plan which includes the full range of Federal agency responsibilities in the event of an accident. FEMA has established Regional Assistance Committees (RACs) at each of the ten Regional Offices, to assist state and local governments in developing and evaluating their radiological plans and preparedness.

Additionally, FEMA offers training in radiological accident response procedures to Federal, state and local government personnel at the National Emergency Training Center (NETC) at Emmitsburg, Maryland.

b. Federal Response

DOE's current Radiological Assistance Program (RAP), the Federal Interagency Radiological Assistance Plan (IRAP), other radiological emergency assistance plans, and DOE's national laboratories capabilities as well as those of the EPA and HHS and other Federal capability, are being incorporated in a Federal Radiological Monitoring and Assessment Plan. Response plans should contain provisions for integration of this important Federal assistance.

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DOD/DOE facilities should make provisions for supplying information to and receiving advisories from the National Military Command Center (NMCC), the DOE Headquarters Emergency Operations Center, or headquarters operations centers. In addition, the plan should provide for communication between state authorities, DOD/DOE and FEMA.

The specific interrelationships of the Federal agencies and their roles during a nuclear weapons accident are defined in the DOD Nuclear Weapons Accident Response Procedures manual (Reference D.1.).

D. Form and Content of Plans

This document provides an outline (in Section III) and sequence of activities that permit an effective and timely response by all organizations involved. Use of the format contained in this document will ensure that all the necessary measures are taken and included in the plan.

All plans should contain a table of contents and a cross reference to the guidance contained in this document. Applicable supporting and reference documents and tables may be incorporated by reference, and appendices should be used whenever necessary. The plans should be kept as concise as possible. They should make clear what is to be done in an emergency, how it is to be done, and by whom.

In addition to addressing the substance of all guidance, the plans should define the facilities on a site-specific basis and each area to which the plans apply.

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A continued state of readiness must be maintained by all organizations. Periodic reviews by FEMA (for regions), the DOD and DOE will examine the capability of their respective response organizations to implement various aspects of the developed response plans. This may include observation of exercises and drills by DOD, DOE, FEMA, and other Federal agencies including those participating in the RACs.

Because of the potential need to take immediate action off-site in the event of a significant radiological accident, notifications to appropriate off-site response organizations (state or states and local government organizations) should go directly from the facility. The response organizations which receive these notifications should have the authority and capability to take immediate predetermined actions. These actions could include prompt notification of the public in the off-site area, followed by advisories to the public in certain areas to stay inside (take shelter) or, if appropriate, evacuate to predetermined location or host areas. State agencies, which are likely to have greater radioprotective resources than local agencies, should bring their resources to bear and make decisions with regard to whether the protective measures are adequate for the off-site situation.

In the longer timeframe, substantial Federal and private sector organization resources should also supplement the initial response of the facility.

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III. PLANNING GUIDANCE

A. Assignment of Responsibility (Organization Control)

Planning Objective

To ensure that primary responsibilities for emergency response by appropriate state and local organizations have been assigned, the emergency responsibilities of the offsite supporting organizations have been specifically established, and each principal response organization has adequate staff for timely response and augmentation of its initial response on a continuous basis.

Guidance

1. a. Each plan should identify the facility, state, local, Federal, and private sector organizations that are intended to be part of the overall planning and response.

   b. Each plan should identify authority for lead and support responsibilities for offsite emergency planning and operations. References should be made to laws, codes, statutes, or acts, as appropriate.

   c. Each organization and suborganization having an operational role should specify its concept of operations and its relationship to the total effort.

   d. Each organization should identify a specific individual by title and their alternates who would be in charge of the emergency response.

   e. Each organization should provide for 24-hour per day emergency response, including 24-hour per day manning of communications links.

2. Each organization should specify the emergency response functions and responsibilities for major elements and key individuals by title, including the following: Command and Control, Alerting and Notification, Communications, Public Information, Accident Assessment, Public Health and Sanitation, Social Services, Fire and Rescue, Traffic Control, Emergency Medical Services, Law Enforcement,

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Transportation, Protective Response (including authority to request Federal assistance and to initiate other protective actions), and Radiological Exposure Control. The description of these functions should include a clear and concise summary such as a table of primary and support responsibilities.

3. Each plan should include written agreements referring to the concept of operations developed between the DOD/DOE facility, Federal, state, and local agencies and other support organizations having an emergency response role. The agreements should identify the emergency measures to be provided and the mutually acceptable criteria for their implementation, and specify the arrangements for exchange of information. These agreements may be provided in an appendix to the plan, or the plan itself may contain descriptions of these matters and a signature page in the plan may serve to verify the agreements.

4. Each principal organization should be capable of continuous (24-hour) operations for a protracted period. The individual in the principal organization who will be responsible for assuring continuity of resources (technical, administrative, and material) should be specified by title.

B. On-Site Emergency Organization

Planning Objective

To ensure that DOD/DOE facility responsibilities for emergency response are unambiguously defined, adequate staffing to provide initial facility accident response in key functional areas is maintained at all times, timely augmentation of response capabilities is available, and the interfaces among various on-site response activities and off-site support and response activities are specified.

Guidance

1. Each facility should specify the on-site emergency organization.

2. Each facility commander/manager should designate an individual as emergency coordinator who has the authority and responsibility to immediately and unilaterally initiate any emergency actions, including providing protective action

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recommendations to authorities responsible for implementing off-site emergency measures.

3. Each facility should identify a line of succession for the emergency coordinator position.

4. Each facility should establish the functional responsibilities assigned to the emergency coordinator and should clearly specify which responsibilities may not be delegated to other elements of the emergency organization.

5. Each facility should specify the positions or title and major tasks to be performed by the persons to be assigned to the functional areas of emergency activity. For emergency situations, specific assignments should be made for all response members, both on-site and away from the site.

6. Each facility should specify the interfaces between and among the on-site functional areas of emergency activity, facility headquarters support, local services support, and state and local government response organization.

7. Each facility should specify the command/management, administrative, and technical support personnel in the following areas:

   a. Logistics support for emergency personnel (e.g., transportation, communications, temporary quarters, food and water, sanitary facilities in the field, and special equipment and supplies procurement).

   b. Technical support for planning and reentry/recovery operations.

   c. Command/management level interface with governmental authorities.

   d. Release of information to news media during an emergency (coordinated with governmental authorities). IAW DOD Inst 5230.16, Joint DOD/DOE/FEMA Agreement.

8. Each facility should specify the organizations that may be requested to provide technical assistance to and augmentation of the emergency organization.

9. Each facility should identify the services to be provided by local agencies for handling emergencies (e.g., police, ambulance, medical, hospital, and fire-fighting organizations should be specified). The facility should provide for transportation and treatment of on-site injured personnel who may also be contaminated. Copies of the arrangements and agreements reached with contractor,

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private, and local support agencies should be appended to the plan. The agreements should delineate the authorities, responsibilities, and limits on the actions of the contractor, private organization, and local services support groups.

C. Contiguous State and Local Coordination

Planning Objective

To ensure that contiguous state and local political jurisdictions can adequately coordinate their capabilities for responding to a radioactive material accident.

Guidance

1. The state and local emergency response plans should recognize that certain accidents may occur along any border with an adjacent state, or between adjacent local government jurisdictions (e.g., counties).

2. The emergency response plan should identify the potential interfaces that may be called into action in the event of an interstate or intercounty accident (e.g., health departments from adjacent states or counties, sheriffs and fire departments from adjacent counties).

3. Formal mutual aid agreements should be made between contiguous states and between contiguous local jurisdictions within a state. Interstate agreements should also provide for agreements between local jurisdictions within each state that are located on state borders.

4. The objectives of such mutual aid agreements are to:

   a. Identify authority and responsibility for emergency planning and response for accidents occurring on or near the boundaries of states and localities;

   b. Identify each agency and available resources of the signatory parties available for implementing action under the agreement, including the role to be played by each resource;

   c. Promulgate appropriate mechanisms (e.g., legal agreements, plans, and procedures) for administering the agreement;

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d. Identify the scope of the radiological emergency assistance developed under the agreement, both geographically and functionally.

e. Identify uniform Protective Actions Guides (PAG's) for use in the contiguous region;

f. Clarify the legal and financial liability of the parties to the agreement and provide a mechanism to limit liability for all personnel who may be called upon to provide assistance during any emergency within the scope of the agreement;

g. Establish a system of communications between the signatory parties to provide for rapid and consistent alerts and responses; and

h. Clarify the circumstances under which it would be called into action, perhaps by specifying the following: a minimum distance to a border; distance combined with meteorological, geological, hydrological conditions; special resources needed or available or some other factors such as the emergency response triggering circumstances.

5. If not already established, a mutual aid agreement may also be drawn up to respond to those accidents which affect only one state or local jurisdiction. Such an agreement would enable the signatory parties to concentrate their expertise, equipment, and funding in different areas, while enabling each party, through the assistance of the others, to dispatch a complete and all-around expert response team.

6. As an outgrowth of a mutual aid agreement, memoranda of understanding should be signed between counterpart agencies (e.g., the states' health departments, the counties' sheriffs departments). This would ensure that the subunits of a state or local government were fully aware of the mutual aid agreement and their respective responsibilities under it.

7. A mutual assistance agreement should clarify the circumstances under which it would be called into action. A triggering mechanism would depend on the following factors, which should be agreed upon in advance:

a. Type of problem;

b. Type of resources needed;

c. Where resources should be delivered; and

d. What equipment would be available for transfer between governments.

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8. The mutual assistance agreement may call for joint training and drill exercises between contiguous states and/or local jurisdictions.

9. One of the means available to states for establishing mutual aid agreements is through interstate nuclear compacts.

D. Emergency Equipment, Facilities and Resources

Planning Objective

To ensure that adequate emergency equipment and facilities to support the emergency response are provided and maintained; that arrangements for requesting and effectively using assistance resources have been made, and other organizations capable of augmenting the planned response have been identified.

Guidance

1. Each facility should establish an Emergency Control Center from which evaluation and coordination of all activities related to an emergency are to be carried out and from which the facility should provide information to Federal, state, and local authorities responding to radiological emergencies.

2. Each organization should establish an emergency operations center for use in directing and controlling response actions.

3. Each organization should provide for timely activation and staffing of the facilities and centers described in the plan.

4. Each facility should identify a location for an alternate emergency control center which could be used if the primary center were unavailable for any reason.

5. Each facility should identify and establish on-site monitoring systems that are to be used for conducting assessment.

6. Each facility should make provision to acquire data from, or for emergency access to, off-site monitoring and

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analysis equipment, including laboratory facilities, fixed or mobile.

7. Each facility should provide meteorological instrumentation and procedures and provisions to obtain representative current meteorological information from other sources.

8. Each facility should provide for operations support, including respiratory protection, protective clothing, portable lighting, portable radiation monitoring equipment, and communications equipment.

9. Each organization should make provisions to inspect, inventory, and operationally check emergency equipment/instruments. Calibration of equipment should be at intervals recommended by the supplier of the equipment.

10. Each plan should, in an appendix, include identification of emergency kits by general category (protective equipment, communications equipment, radiological monitoring equipment, and emergency supplies).

11. The Federal government maintains in-depth capability to assist facilities, states and local governments through the Federal Radiological Monitoring and Assessment Plan (formerly Radiological Assistance Plan [RAP] and Interagency Radiological Assistance Plan [IRAP]). Each state and facility should make provisions for incorporating the Federal response capability into its operation plan, including the following:

    a. Specific persons by title authorized to request Federal assistance. Specific limitations, if any.

    b. Specific Federal resources expected, including expected times of arrival at site of emergency.

    c. Specific facility, state, and local resources available to support the Federal response (e.g., air field, command posts, telephone lines, radio frequencies, and telecommunications centers).

12. a. The state or local authorities may dispatch representatives to the facility control center.

    b. The facility should prepare for the dispatch of a representative to principal off-site governmental emergency operations center.

13. Each organization should identify radiological laboratories and their general capabilities and expected availability to provide radiological monitoring and analyses services which can be used in an emergency.

 [redacted]

[redacted]

14. Each organization should identify organizations or individuals which can be relied upon in an emergency to provide assistance. Such assistance should be identified and supported by appropriate letters of agreement.

E. Notification Methods and Procedures

Planning Objective

To ensure that procedures have been established for notification of state and local response organizations, by the facility, and for notification of emergency personnel by all response organizations; initial and followup messages to response organizations and the public are sufficient and appropriate; and means to provide early notification and clear instruction to the nearby populace have been established.

Guidance

1. Each organization should establish procedures which describe mutually agreeable bases for notification of response organizations consistent with the emergency. These procedures should include means for verification of messages. The specific details of verification need not be included in the plan.

2. Each organization should establish procedures for alerting, notifying, and mobilizing emergency response personnel.

3. The facility should notify state and local organizations of the emergency. Notification should contain information about the emergency, whether a release has taken place, potentially affected population areas, and whether protective measures may be necessary.

4. Each facility should make provisions for followup messages from the facility to off-site authorities which contain the following information if it is known and appropriate:

   a. Location of incident and name and telephone number (or communications channel identification) of caller.

   b. Date/time of incident.

   c. Class of emergency.

[redacted]

[redacted]

d. Type of actual or projected release (airborne, surface) and estimated duration/impact times.

e. Estimate of quantity, type, and of radioactive material released or being released.

f. Meteorological conditions at appropriate levels (wind speed, direction [to and from], indicator of stability, precipitation, if any).

g. Actual or projected dose or exposure rates at site boundary; projected integrated dose at site boundary.

h. Projected dose or exposure rates and integrated dose at the projected peak and including down wind area affected.

i. Estimate of any surface radioactive contamination on-site or off-site.

j. Facility emergency response action underway.

k. Recommended emergency actions, including protective measures.

l. Request for any needed on-site support by off-site organizations.

m. Prognosis for worsening or termination of the event.

5. State and local government organizations should establish a system for disseminating to the public appropriate information contained in initial and followup messages received from the facility including the appropriate notification to appropriate broadcast media (e.g., the Emergency Broadcast System [EBS]).

6. State and local government organizations should establish administrative and physical means for notifying and providing prompt instructions to the public within the exposure pathway.

7. Each state and local government organization should provide written messages intended for the public, consistent with the facility, state, and local emergency plan. In particular, draft messages to the public giving instructions with regard to specific protective actions to be taken by occupants of affected areas should be prepared and included as part of the state and local plan. Such messages should include the appropriate aspects of sheltering ad hoc respiratory protection (e.g., handkerchief over mouth), or evacuation. The role of

 [redacted]

[redacted]

the facility is to provide supporting information for the messages.

F. Emergency Communications

Planning Objective

To determine that provisions exist for prompt communications among principal response organizations to emergency personnel and to the public.

Guidance

1. The communication plans for emergencies should include organizational titles and alternates for both ends of the communication links. Each organization should establish reliable primary and backup means of communication for facility, local, and state response organizations. Such systems should be selected to be compatible with one another. Each plan should include:

   a. Provision for 24-hour per day notification to and activation of the state/local emergency response network; and at facility a minimum of a telephone link and alternate, including 24-hour per day manning of communications links that initiate emergency response actions.

   b. Provision for communications with contiguous facility state/local governments.

   c. Provision for communications as needed with Federal emergency response organizations.

   d. Provision for alerting or activating emergency personnel in each response organization.

   e. Provision for communication by the facility with facility headquarters and radiological monitoring team assembly area.

2. Each organization should ensure that a coordinated communication link for fixed and mobile medical/radiological support facilities exists.

3. Each organization should conduct periodic testing of the entire emergency communications system.

[redacted]

[redacted]

G. Public Education and Information

Planning Objective

To ensure that information is made available to the public on a periodic basis on how they will be notified and what their initial actions should be in an emergency (e.g., listening to a local broadcast station and remaining indoors), the principal point of contact with the news media for dissemination of information during an emergency (including the physical location or locations) is established in advance, and procedures for coordinated dissemination of information to the public are established.

Guidance

1. Each state and local government organization should provide a coordinated periodic dissemination of information to the public regarding how they will be notified and what their actions should be in an emergency. This information should include, but not necessarily be limited to:

   a. Educational information on radiation.

   b. Contact for additional information.

   c. Protective measures (e.g., evacuation routes and relocation centers, sheltering, respiratory protection).

   d. Special needs of the aged or handicapped.

   Means for accomplishing this dissemination may include, but are not necessarily limited to: information in the telephone book; posting in public areas; and publications distributed on an annual basis.

2. The public information program should provide the population with an adequate opportunity to become aware of the information. The programs should include provision for written material that is likely to be available in a residence during an emergency.

3. a. Each principal organization should designate the points

[redacted]

[redacted]

of contact and physical locations for use by the news media during an emergency.

b. Each facility should provide space which may be used for a limited number of the news media.

4. a. Each principal organization should designate a spokesperson who should have access to all necessary information.

b. Each organization should establish arrangements for timely exchange of information among designated spokespersons.

c. Each organization should establish coordinated arrangements for dealing with rumors.

5. Each organization should conduct coordinated programs to acquaint news media with the emergency plans, information concerning radiation, and points of contact for release of public information in an emergency.

6. In the event of a nuclear weapons accident, a Joint Information Center should be established.

E. Accident Assessment

Planning Objective

To determine that adequate methods, systems, and equipment for assessing and monitoring actual or potential off-site consequences of a radiological emergency condition are planned.

Guidance

1. Each facility should identify radiological background values to be used to define normal conditions following an accident. Such background values should be included in the appropriate facility emergency procedures. Facility emergency procedures should specify the kinds of instruments being used and their capabilities.

2. On-site capability and resources to provide initial radiological values and continuing sampling assessment throughout the course of an accident.

3. Each facility should establish methods and techniques to be used for determining the source term of potential

[redacted]

[redacted]

releases of radioactive material and the magnitude of actual releases.

4. Each facility should establish the relationship between monitor readings and on-site and off-site exposures and contamination for the prevailing and forecasted meteorological conditions.

5. Each facility should have the capability of acquiring and evaluating meteorological information sufficient to make adequate atmospheric stability determinations. The facility should make available, to the state, suitable meteorological data which will permit independent analysis by the state to effectively use this information.

6. Each facility should establish the methodology for determining the release rate/projected doses.

7. Each organization, where appropriate, should provide methods, equipment, and expertise to make rapid assessments of the actual or potential magnitude and locations of any radiological hazards. This should include activation, notification means, field team composition, transportation, communication, monitoring equipment, and estimated deployment times.

8. Each organization should establish means for relating the various measured parameters (e.g., contamination levels, water and air activity levels) to dose rates for key isotopes and gross radioactivity measurements. Provisions should be made for estimating integrated dose from the projected and actual dose rates and for comparing these estimates with the protective action guides. The detailed provisions should be described in separate procedures.

9. Arrangements to locate and track the airborne radioactivity should be made, using facility, local, Federal, and state resources.

I. Protective Response

Planning Objective

To ensure that guidelines for the choice of protective actions during an emergency, consistent with Federal guidance, are developed and in place, and that protective actions appropriate to the locale have been developed.

[redacted]

[redacted]

Guidance

1. Each facility should establish the means and time required to warn, advise, and protect all individuals within the facility area.

2. Each organization should make provisions for sheltering or evacuation to include routes and transportation for individuals to some suitable location, including alternatives for inclement weather, high traffic density, and specific radiological conditions.

3. Each organization should provide for radiological monitoring of personnel sheltered or evacuated from the contaminated area.

4. Each facility should establish a mechanism for recommending protective actions to the appropriate state and local authorities. Prompt notification should be made directly to the off-site authorities responsible for implementing protective measures within the exposure pathway.

5. Each organization should develop time estimates for evacuation within the exposure pathway, implementation of sheltering/evacuation.

6. Each organization should establish a capability for implementing protective measures based upon protective action guides and other criteria.

7. The organization's plans to implement protective measures (sheltering/evacuation) for the exposure pathway should where applicable include:

   a. Maps showing shelter areas, evacuation routes, preselected radiological sampling and monitoring points, and relocation centers in host areas.

   b. Maps showing population distribution around the facility.

   c. Means for notifying all segments of the transient and resident population.

   d. Means for protecting those persons whose mobility may be impaired due to such factors as institutional or other confinement.

   e. Means of relocation if required.

   f. Relocation centers in host areas which are at least <u>beyond</u> the boundaries of the contaminated area.

[redacted]

[redacted]

g. Projected traffic capacities of potential evacuation routes under emergency conditions.

h. Identify security measures necessary for control of access to evacuated areas and organization responsibilities for such control.

i. Identification of and means for dealing with potential impediments (e.g., seasonal impassability of roads) to use of evacuation.

j. The basis for choice of recommended protective actions from the exposure pathway during emergency conditions should include expected local protection afforded in residential units or other shelter for direct and inhalation exposure.

8. Each state should specify the protective measures to be used, including the methods for protecting the public from consumption of contaminated foodstuffs. This should include criteria for deciding whether dairy animals should be put on stored feed. The plan should identify procedures for detecting contamination, for estimating the dose commitment consequences of uncontrolled ingestion, and for imposing protection procedures such as impoundment, decontamination, processing, decay, product diversion, and preservation. Maps for recording survey and monitoring data, key land use data (e.g., farming), dairies, food processing plants, watersheds, water supply intake and treatment plants, and reservoirs should be maintained. Provisions for maps showing detailed crop information may be made by including reference to their availability and location and a plan for their use. Up-to-date lists of the name and detailed location data of all facilities which regularly process milk products and other large amounts of food or agricultural products should be maintained.

9. Each organization should describe the means for registering and monitoring of personnel at shelter/relocation centers. The personnel and equipment available should be capable of monitoring all residents and transients.

J. Radiological Exposure Control

Planning Objective

To determine that means for controlling radiological exposures, in an emergency, are established for emergency workers. The means

 [redacted]

[redacted]

for controlling radiological exposures include exposure guidelines consistent with EPA Emergency Worker and Lifesaving Activity Protective Action Guides.

Guidance

1. Each organization should establish on-site exposure guidelines consistent with EPA Emergency Worker and Lifesaving Activity Protective Actions Guides for:

    a. Removal of injured persons.

    b. Undertaking corrective actions.

    c. Performing assessment actions.

    d. Providing first aid.

    e. Performing personnel decontamination.

    f. Providing ambulance service.

    g. Providing medical treatment services.

2. Each organization should establish a radiation protection program to be implemented during emergencies, including methods to implement exposure guidelines. The plan should identify individual(s), by position or title, who can authorize emergency workers to receive doses in excess of EPA limits. Procedures should be worked out in advance for permitting on-site volunteers to receive radiation exposures in the course of carrying out lifesaving and other emergency activities. These procedures should include expeditious decision making to authorize emergency workers to exceed EPA PAGs for life saving activities and consideration of relative risks.

3. a. Each organization should make provision for 24-hour per day capability to determine the doses received by emergency personnel involved in any radiological accident, including volunteers. Each organization should make provisions for distribution of adequate monitoring devices or equipment.

    b. Each organization should ensure that monitoring devices are read at appropriate frequencies and provide for maintaining dose records for emergency workers involved in any accident.

4. a. Each organization, as appropriate, should specify action levels for determining the need for decontamination.

 [redacted]

b. Each organization, as appropriate, should establish the means for radiological decontamination of emergency personnel, wounds, supplies, instruments, and equipment, and for waste disposal.

5. Each organization should provide contamination control measures to include:

a. Area access control.

b. Water and food supplies.

c. Criteria for permitting return of areas and items to normal use.

6. Each organization should provide the capability for decontaminating relocated personnel, including provisions for extra clothing.

K. Medical and Public Health Support

Planning Objective

To ensure that arrangements are made for medical services for contaminated injured individuals.

Guidance

1. Each organization should arrange for local and backup hospital and medical services having the capability for evaluation of radiation exposure, and assure that the persons providing these services are adequately prepared to handle contaminated individuals.

2. Each state should develop lists indicating the location of public, private, and military hospitals and other emergency medical service facilities within the state or contiguous states considered capable of providing medical support for any contaminated injured individual. The listing should include the name, location, type, and capacity of facility and any special radiological capabilities. These emergency medical services should be able to radiologically monitor contamination of personnel, and have facilities and trained personnel able to care for contaminated injured persons. This listing should be provided to the facilities and local organization.

3. Each organization should arrange for transporting victims of a radiological accident to medical support facilities.

[redacted]

L. Recovery and Reentry Planning and Post-Accident Operations

Planning Objective

To ensure that general plans for recovery and reentry are developed.

Guidance

1. Each organization, as appropriate, should develop general plans and procedures for reentry and recovery and describe the means by which decisions to relax protective measures (e.g., allow reentry into a contaminated area) are reached. This process should consider both existing and potential conditions.

2. Each facility plan should contain the position/title, authority, and responsibilities of individuals who will fill key positions in the recovery operation. This should include technical personnel with responsibilities to develop, evaluate, and direct recovery and reentry operations considering the following:

   a. Establishment of reentry authority and responsibility for the accident site, including provision for personnel accountability.

   b. Adoption of exposure control procedures for all personnel.

   c. Determination of the accessibility to the accident area.

   d. Assurance that response personnel protective equipment, protective clothing, etc., are available.

3. Each plan should specify means for informing members of the response organizations that a recovery operation is to be initiated, and of any changes in the organizational structure that may occur.

4. Each plan should establish procedures for periodically estimating total population exposure.

 [redacted]

[redacted]

M. Exercises and Drills

Planning Objective

To ensure that periodic exercises may be conducted to evaluate major portions of emergency response capabilities. This is to assure that periodic drills conducted will develop and maintain key skills, and that deficiencies identified as a result of exercises or drills will be corrected.

Guidance

1. a. An exercise is an event that tests the integrated capability and a major portion of the basic elements existing within emergency preparedness plans and organizations. The emergency preparedness exercise should simulate a credible emergency that results in off-site radiological releases which would require response by off-site authorities.

   b. An exercise should include mobilization of state and local personnel and resources adequate to verify the capability to respond to an accident scenario requiring response. The organization should provide for a critique of the exercise by the facility, DOD, DOE, Federal, state, and local observers/evaluators. Exercises should be conducted under various weather conditions. Some exercises could be unannounced.

2. A drill is a supervised instruction period aimed at testing, developing, and maintaining skills in a particular operation. A drill is often a component of an exercise. A drill should be supervised and evaluated by a qualified drill instructor. Each organization should conduct periodic drills, in addition to exercises.

   a. Communication Drills. Communications with state and local governments should be tested. Communications with Federal emergency response organizations should be tested. Communications between the facility, State and local emergency operations center, and field assessment teams should be tested. Communication drills should also include the aspect of understanding the content of messages.

[redacted]

b. Fire Drills. Fire drills should be conducted in cooperation with the facility fire service.

c. Medical Emergency Drills. A medical emergency drill involving a simulated contaminated individual which contains provisions for participation by the facility and local support services agencies (i.e., ambulance and medical treatment facility) should be conducted. The portions of the medical drill should be performed as part of the exercise.

d. Radiological Monitoring Drills. Radiological monitoring drills (on-site and off-site) should be conducted. These drills should include collection and analysis of all sample media (e.g., water, vegetation, soil, and air) and provisions for communications and record keeping. The established state drills need not be at each site. Where appropriate, local organizations should participate.

e. Health Physics Drills. Health physics drills should be conducted which involve response to, and analysis of, airborne radiation measurements in the environment. The established state drills need not be at each site. Where appropriate, local organizations should participate.

3. Each organization should describe how exercises and drills are to be carried out to allow free play for decision making and to meet the following objectives. The scenarios for use in exercises and drills should be credible and should include, but not be limited to, the following:

a. The basic objective(s) of each drill and exercise and appropriate evaluation criteria.

b. The date(s), time period, place(s), and participating organizations.

c. The simulated events.

d. A time schedule of real and simulated initiating events.

e. A narrative summary should be prepared describing the conduct of the exercises or drills to include such things as simulated casualties, on-site and off-site fire department assistance, rescue of personnel, use of protective clothing, deployment of radiological monitoring teams, and public information activities.

f. A description should be included of the arrangements for advance materials to be provided to official observers.

4. Official observers from DOD, DOE, Federal, state, or local governments may observe, evaluate, and critique

[redacted]

the exercises. A critique should be scheduled at the conclusion of the exercise to evaluate the ability of organizations to respond as called for in the plan. The critique should be conducted as soon as practicable after the exercise, and a formal evaluation should result from the critique.

5. Each organization should establish means for evaluating observer and participant comments on areas needing improvement, including emergency plan procedural changes, and for assigning responsibility for implementing corrective actions. Each organization should establish management control to ensure that corrective actions are implemented.

E. Radiological Emergency Response Training

Planning Objective

To ensure that radiological emergency response training is provided to those who may be called on to assist in an emergency.

Guidance

1. Each organization should assure the training of appropriate individuals.

   a. Each facility should provide site-specific emergency response training for those off-site emergency organizations that may be called upon to provide assistance in the event of an emergency.[1]

   b. Each offsite response organization should participate in and receive training. Where mutual aid agreements exist between local agencies such as fire, police, and ambulance/rescue, the training should also be offered to the other departments that are members of the mutual aid district.

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[1] Training for hospital personnel, ambulance/rescue, police, and fire departments should include the procedures for notification, basic radiation protection, and their expected roles. For those local support organizations that may enter the site, training should also include site access procedures and the identity (by position and title) of the individual in the on-site emergency organization who will control organization's support activities Off-site emergency response support personnel should be provided with appropriate identification cards where required.

 [redacted]

[redacted]

2. The training program for members of the on-site and off-site emergency organization should, besides classroom training, include practical drills in which each individual demonstrates ability to perform his assigned emergency function. During the practical drills, on-the-spot correction of erroneous performance should be made and a demonstration of the proper performance offered by the instructor.

3. Training for individuals assigned to first aid teams should include courses equivalent to Red Cross Multi-Media.

4. Each organization should establish a training program for instructing and qualifying personnel who will implement radiological emergency response plans.[2] The specialized initial training and periodic retraining programs (including the scope, nature, and frequency) should be provided in the following categories:

   a. Directors or coordinators of the response organizations.

   b. Personnel responsible for accident assessment.

   c. Radiological monitoring teams and radiological analysis personnel.

   d. Police, security, and fire fighting personnel.

   e. Repair and damage control or correctional action teams (on-site).

   f. First aid and rescue personnel.

   g. Local support services personnel including Civil Defense/Emergency Service personnel.

   h. Medical support personnel.

   i. Facility headquarters support personnel.

   j. Personnel responsible for transmission of emergency information and instructions.

5. Each organization should provide for the initial and continued retraining of personnel with emergency response responsibilities.

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[2] If state and local governments lack the capability and resources to accomplish this training, they may look to the facility and the Federal government for assistance in this training.

[redacted]

[redacted]

O. Responsibility for the Planning Effort: Development, Periodic Review, and Distribution of Emergency Plans

Planning Objective

To determine that responsibilities for plan development and review and for distribution of emergency plans are established, and planners are properly trained.

Guidance

1. Each organization should provide for the training of individuals responsible for the planning effort.

2. Each organization should identify by title the individual with the overall authority and responsibility for radiological emergency response planning.

3. Each organization should designate an Emergency Planning Coordinator (with appropriate security clearances) assigned the responsibility for the development and updating of emergency plans and coordination of these plans with other response organizations.

4. Each organization should update its plan and agreements as needed, and review and certify it to be current on an annual basis. The update should take into account changes identified by drills and exercises.

5. The emergency response plans and approved changes to the plans should be forwarded to all organizations and appropriate individuals with responsibility for implementation of the plans. Revised pages should be dated and marked to show where changes have been made.

6. Each plan should contain a detailed listing of supporting plans and their sources.

7. Each plan should contain as an appendix listing, by title, procedures required to implement the plan. The listing should include the section(s) of the plan to be implemented by each procedure.

8. Each plan should contain a specific table of contents. Plans submitted for review should be cross-referenced to these criteria.

[redacted]

[redacted]

9. Each organization should arrange for and conduct independent reviews of their emergency preparedness program. The review should include the emergency plan, its implementing procedures and practices, training, readiness testing, equipment, and interfaces with the facility, state, and local governments. Management controls should be implemented for evaluation and correction of review findings.

10. Each organization should provide for updating telephone numbers in emergency procedures.

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APPENDIX 1

DEPARTMENT OF DEFENSE EMERGENCY ACTION LEVELS FOR NUCLEAR FACILITIES

The policy of the Department of Defense is to insure that state or local officials are notified of an occurrence that might cause concern because of radiological effects outside the facility. Releases of radioactivity as used in the emergency plan require specific response actions by site personnel for recovery operations. These actions are further classified as a facility area emergency or a general emergency to standardize reporting to state or local authorities for their off-site response activities.

The classes of Emergency Action Levels are established as follows:

Facility Area Emergency

General Emergency

The rationale for the notification and alert classes is to provide prompt notification of an event which could lead to more serious consequences. The facility area emergency class reflects conditions where some significant release could occur, but the situation is under control based on current information. The general emergency class involves actual release of radiological contamination. In this situation full mobilization of emergency response personnel is indicated. The immediate action for this class is sheltering (staying

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inside) rather than evacuation until an assessment can be made by response force personnel.

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Class	Facility Actions	Recommended State and/or Local Offsite Authority Actions
FACILITY AREA EMERGENCY <u>Class Description</u> Events are in progress or have occurred which involve actual or likely major failures of facility functions needed for protection of onsite personnel, the public health and safety, and the environment. Releases offsite of radioactive material, not exceeding protective response recommendations are likely. <u>Purpose</u> Purpose of the facility area emergency level is to assure that emergency control centers onsite and offsite are manned, that appropriate teams are dispatched, that personnel required for determining onsite/offsite protective measures are at duty stations and to provide current information to DOD/DOE and consultation with offsite officials and organizations.	1. Immediately notify State and/or local offsite authorities of site emergency status and reason for emergency as soon as discovered. Recommends steps be taken to control access and warn the general public and recommend preparatory steps be taken for directing the general public to take shelter or evacuate. 2. Augment resources by activating Emergency Center. 3. Assess and respond. 4. Dispatch onsite and offsite monitoring teams and associated communications. 5. Dedicate an individual for status updated to offsite authorities and periodic press briefings. 6. Make senior technical and staff onsite available for consultation with State/local on a periodic basis. 7. Provide meteorological and dose estimates to offsite authorities for actual releases via a dedicated individual. 8. Provide release and dose projections based on available condition information and foreseeable contingencies. 9. Escalate to general emergency class, if appropriate. 10. Close out or recommend reduction in emergency class.	1. Provide any assistance requested. 2. Augment resources by activating primary response centers and bring EBS to standby status. 3. Dispatch key emergency personnel including monitoring teams and associated communications. 4. Alert to standby status other emergency response personnel (e.g., those needed for possible evacuation). 5. Provide offsite monitoring results to facility, DOE and others and jointly assess them. 6. Continuously assess information from facility and offsite monitoring with regard to changes to protective actions already initiated for public and mobilizing evacuation resources. 7. Provide press briefings, jointly with facility. 8. Escalate to general emergency class in concert with the facility. 9. Maintain site area emergency status until closeout or reduction of emergency class.

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Class	Facility Actions	Recommended State and/or Local Offsite Authority Actions
GENERAL EMERGENCY Class Description Events are in progress or have occurred which provide actual or imminent substantial reduction of facility nuclear safety. Releases offsite are occurring or are expected to occur and exceed protective response recommendations. Purpose Purpose of the general emergency level is to initiate predetermined protective actions for onsite/offsite personnel, for the public health and safety, and the environment; provide continuous assessment of emergency conditions and exchange of information both onsite and offsite. Declaration of a general emergency will initiate major activation of nation's resources required to effectively mitigate the consequences of emergency conditions and assure the protection of onsite/offsite personnel, the public health and safety, and the environment, to the extent possible.	1. Immediately notify State and local offsite authorities of general emergency status and reason for emergency as soon as discovered (parallel notification of State/local). Recommend steps be taken to control access and recommend the general public in specific sectors be directed to take shelter or evacuate. 2. Augment resources by activating onsite emergency center. 3. Assess and respond. 4. Dispatch monitoring teams and associated communications. 5. Dedicate an individual for status updates to offsite authorities and periodic press briefings joint with off-site authorities. 6. Make senior technical and management staff available for consultation with state/local on a periodic basis. 7. Provide meteorological and dose estimates to offsite authorities for actual releases. 8. Provide release and dose projections based on available information and foreseeable contingencies. 9. Close out or recommend reduction of emergency class.	1. Provide any assistance requested. 2. Activate immediate public notification of emergency status and provide public periodic updates. 3. Recommend sheltering downwind. Consider advisability of evacuation. 4. Augment resources by activating primary response centers. 5. Dispatch key emergency personnel including monitoring teams and communications. 6. Dispatch other emergency personnel to duty stations. 7. Provide offsite monitoring results to facility, DOE and others and jointly assess them. 8. Continuously assess information from from facility and offsite monitoring with regard to protective actions already initiated for public and mobilizing evacuation resources. 9. Provide press briefings, jointly with facility. 10. Maintain general emergency status until closeout or reduction of emergency class.

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APPENDIX 2

MEANS FOR PROVIDING PROMPT ALERTING AND NOTIFICATION OF RESPONSE ORGANIZATIONS AND THE POPULATION

DOD, DOE, and FEMA recognize that the responsibility for activating the prompt notification system called for in this section to notify the public is properly the responsibility of state and local governments. The initial notification to the state and local officials will be made by the DOD/DOE facility when appropriate and relayed to the affected population. It must be completed in a manner consistent with assuring the public health and safety. The design objective does not, however, constitute a guarantee that early notification can be provided for everyone with 100% assurance or that the system when tested under actual field conditions will meet the objective in all cases.

The plan should include:

1. The specific organizations or individuals, by title, who will be responsible for notifying response organizations and the affected population and the specific decision chains for rapid implementation of alerting and notification decisions.

2. A capability for 24-hour per day alerting and notification.

3. Provision for the use of public communications media

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or other methods for issuing emergency instructions to members of the public.

4. A description of the information that would be communicated to the public under given circumstances, for continuing instructions on emergency actions to follow, and updating of information.

A. Concept of Operations

1. Commercial broadcast messages are the primary means for advising the general public of the conditions of a significant radiological accident. It is desirable for the public notification system to have a phasing capability. The arrangements for phasing are a function of the case-by-case population distribution or topography around each facility and the details of each site-specific preparedness plan of state and local government.

2. A prompt notification scheme should include the capability of local and state agencies to provide information promptly over radio and TV. The emergency plans should include evidence of such capability via agreements, arrangements, or citation of applicable laws which provide for designated agencies to air messages on TV and radio in emergencies. Initial notifications of the public might include instructions to stay inside, close windows and doors, and listen to radio and TV for further instructions. [redacted]

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B. **Physical Implementation**

1. **Communications Supporting Alerting and Notification Systems Guidance Objective**

Federal, state, and local government and facility authorities should develop and maintain plans, systems, procedures, and relationships that are effective in mobilizing responsible authorities and operating elements in alerting and notifying the general public and in assuring appropriate and effective responses by the public.

Incident Alert Notification

The triggering of processes to mobilize forces and warn the public is dependent upon the communication between the facility and government authorities (Federal, state, and local). The communications net should feature the following capacity.

a. Coverage. 24-hour coverage at the facility and at the primary points to receive and act upon notification.

b. Points to Be Linked. Assured dissemination of alert and warning information by the facility to appropriate local and state warning points should be maintained at all times and under all conditions.

c. Net Control. To assure effective utilization, net discipline, and availability, one location should be assigned responsibility for net control, and an alternate

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designated. It should issue and update procedures on testing, net access, and discipline and maintenance and repair.

d. System Availability and Reliability. All stations/points on the network and the communications linkage should provide a capability for immediate dissemination, receipt, and acknowledgment of alert and warning messages on a 24-hour basis The system should be able to function notwithstanding adverse environmental conditions, such as floods and power outages. It should not be subject to preemption for lower priority purposes nor to failure due to traffic (subscriber) overloading. To the extent a single system does not meet this performance guidance, alternate means should be in place which have dissimilar vulnerability characteristics.

e. Information Sensitivity. The communication system design should take into consideration that emergency information is at times highly sensitive and, if monitored by the general public, is subject to misinterpretation and can lead to undesirable and counterproductive reactions. Therefore, it is desirable not to cite specific radio frequencies in public planning documents.

f. System Features. Dissemination should be rapid and reliable and provide acknowledgment and verification of message

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content. It is desirable for voice traffic to be supported by hard copy verification.

g. Multipurpose Use. Whatever system is designed and installed to meet all of the above capabilities for accident alerting may be used for communication in support of other response functions. However, systems designed for other purposes should not be adapted to incident alert notification unless (1) all of the criteria are met and (2) such adaptation does not compromise their primary purpose. Exception may be justified when a system designed for other purposes is adapted to incident alert notification to serve as a back-up to the primary system.

2. Notification of Response Organizations

a. Assigned Responsibility. Plans should clearly designate the responsibility and means of notifying response organizations by either the facility or by the state or local warning points designated to receive initial alert notification.

b. Dissemination Time. Notification points cannot be encumbered by sequential call down processes nor can response organizations accept the time lost by such processes. This second level notification should be a one-call process to all assigned organizations to be notified. Acknowledgment and message verification is essential. Message content must be clear and brief. A preferred procedure is to communicate

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a posture code which calls for various predetermined responses for each organization based on its mission.

c. Capability of Organizations to Be Notified. Organizations with immediate response functions should also have a 24-hour capability of receiving and acting upon a notification.

d. Internal Alerting. Each organization with response functions should develop reliable procedures for internal alerting and mobilization of forces. The system should account for the non-emergency nature of some organizations and the routine posture of key staff elements.

3. Notification Systems

a. The Emergency Broadcast System (EBS). The Emergency Broadcast System exists to furnish an expedited means of furnishing real-time communications to the public in the event of war, threat of war, or grave national, regional, or local crisis.

To activate the EBS at the state level, a request may be directed to an Originating Primary Relay Station (usually an FM station located near the state capital) by the governor, his designated representative, the National Weather Service, the State Civil Preparedness or Emergency Services Office, or other designated state authority.

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At the local level, a request for activation may be directed to the Common Program Control Station (CPCS-1) by designated officials of local government or the National Weather Service.

In either case, communications facilities developed for use in contacting and providing emergency program material may include any of the following: telephone, remote pickup units, NOAA Weather Wire Service or NOAA Weather Radio, police and fire communications, amateur and citizens band radio. Station management at the Originating Primary Relay Station and/or the Common Program Control Station authenticates the validity of all requests to activate the system. Other broadcast stations may activate the EBS on an individual basis as needed. This is important since station management is responsible for all program material broadcast to the public.

The Originating Primary Relay Station at the state level, or the Common Program Control Station at the local level, will take the following steps to activate the EBS:

1. Take action to broadcast emergency programming which may include recording the emergency message for use later.

2. Broadcast an initial statement.

3. Transmit the two-tone Attention Signal.

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4. Broadcast the emergency announcement.

All other participating stations, alerted via their off-the-air monitoring of the two-tone signal, repeat the above procedures. The state and local EBS is available for public officials who have specifically been designated "activating officials." These designees are responsible to the community for determining the appropriateness of activating the EBS for disseminating emergency public information. In this regard, the activating official could determine that an early alert to the broadcasters was advisable, because of certain actual or contemplated adverse conditions. Such a decision could be implemented by the activating official notifying the broadcasters by available communications. The bottom line of the early alert would be to notify stations that are off the air that there may be a need for activation, which in turn would cause the stations to notify appropriate personnel. Alerting and notification systems around the subject DOD/DOE facilities should be integrated with the state and local EBS Operational Area Plan. Operational Area EBS plans involve agreements with the Common Program Control Stations (CPCS-1) and local emergency preparedness organizations, while the state EBS plan is coordinated with the state emergency communications chairman. It may be necessary for organizations to sign agreements with CPCS-1 stations in order to cover a fast-breaking general emergency. However, actual public notices

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would only take place upon authorization of governmental authorities.

b. National Oceanic and Atmospheric Administration (NOAA) Weather or Emergency Alert. Receivers compatible with Weather or Emergency Alert transmitters can be obtained commercially. Where transmitters or repeaters are not available, such could be provided independently, or perhaps by negotiation with the NOAA or the Federal Communications Commission (FCC). Receivers and servicing thereof could be offered as a service.

c. Telephone Automatic Dialers. Systems are available whereby pre-selected telephone numbers could be dialed automatically and a recorded announcement played when a telephone is answered. After a fixed number of rings, the next number is dialed automatically; the unanswered numbers are redialed at the end of the sequence. This system could be most cost-effective and secure for warning to principal response officials, school systems, selected industrial complexes, downstream water works, or isolated farms.

d. Aircraft with Loudspeakers. Hiking trails and hunting areas are illustrative of areas where it may not be feasible to provide a prompt notification by any other means except by aircraft equipped with powerful sound systems or by dropping prepared leaflets. Such would not work in bad weather, of course, but such areas are less likely to be used in bad

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weather. These areas should be reached on a best-effort basis.

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APPENDIX 3

PROTECTIVE RESPONSE

In the event of a radiological accident at a DOD/DOE facility, a controlled area should be established around the existing or projected location of contamination, identified by sector and distance to control access to the area and to control evacuation of the effected population if that becomes necessary. Procedures for limiting or preventing the radiological exposure of the general public should be by two actions, either in place protection or evacuation.

IN PLACE PROTECTION

The appropriate initial action for the public is to remain inside their homes or office building and turn off fans, air conditioners, and forced air heating units. Drink and eat only canned or packaged foods. If outside, the public should proceed to the nearest permanent structure by covering their nose and mouth with a cloth and take precautions against stirring up and breathing any dust. It is important to remember that movement outside could cause greater exposure and spread contamination.

The public should be advised that trained monitoring teams will be moving through the area wearing special protective clothing with equipment to determine the extent of any possible contamination and to establish a movement route for evacuation if required.

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EVACUATION

In the event of evacuation, traffic control points should be established at road intersections immediately outside of the existing or projected contaminated area.

All vehicles approaching the controlled area should be stopped, be advised of the hazard, and be denied access to the area. The only authorized access points to the controlled area should be designated by local on-scene emergency response forces.

Traffic on main arteries should be re-routed so as not to transit a controlled area and to prevent interference with evacuation routes.

The on-scene emergency response forces should establish evacuation routes and direct evacuees to a designated reception area and center and coordinate all evacuation activities.

Evacuation instruction and orders should be made in accordance with facility/State/local procedures.

Personnel monitoring teams should be located at each established traffic control point on the evacuation route.

All vehicles leaving the controlled area should be stopped and evaluated for possible radioactive contamination. Contaminated vehicles in excess of established standards should be impounded at the traffic control points on the evacuation route to prevent spreading the contaminated material.

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All personnel leaving the controlled area should be registered and be evaluated for possible radioactive contamination.

Personnel determined to be contaminated should be decontaminated as much as possible at the traffic control points and sent to a reception center for further evaluation and decontamination.

Suitable facility(s) should be established to receive persons evacuated from the controlled area in order to facilitate emergency feeding and to provide emergency shelter and medical service to evacuees. All persons being evacuated from the controlled area should be informed of this information and advised when reentry to the area is permitted.

It is assumed that the affected population will voluntarily accept and obey evacuation instructions.

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APPENDIX 4 [redacted]

DEFINITIONS

<u>Accident Response Group (ARG)</u> - The Department of Energy Accident Response Group consists of qualified scientific, medical, and technical personnel and specialized equipment designated to carry out the Department of Energy's accident response operations upon notification of a peacetime nuclear weapons accident.

<u>Aerial Measuring System (AMS)</u> - Performs aerial measurements of ground and airborne radioactivity over large areas by utilizing instrumentation for detecting and recording gamma radiation, both as gross count rates and gamma energy spectra. Equipment for determining the position of the aircraft is also integrated into the system.

<u>Airborne Radioactivity</u> - Any radioactive material suspended in the atmosphere.

<u>Air Force Radiation Assessment Team (AFRAT)</u> - A field qualified team of health physicists and health physics technicians established at the USAF Occupational and Environmental Health Laboratory (USAF OEHL) capable of responding worldwide with air-transportable equipment to radiation accidents/incidents, providing on-site health physics consultation and instrumentation for detecting, identifying, and quantifying any possible radiation hazard.

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Air Sampler - A device used to collect a sample of the radioactive contamination suspended in the air.

Air Transportable Radiac Package (ATRAP) - A collection of RADIAC equipment, spare parts, and trained instrument repair technicians maintained in an alert status by the Air Force Logistics Command for airlift to the scene of a nuclear accident/incident to supplement the local RADIAC equipment and repair capability.

Alpha Team - An Army team possessing an alpha radiation monitoring capability. They are usually identified as part of a Nuclear Accident and Incident Control (NAIC) Team.

Anti-Contamination Clothing (Anti-C's) - Clothing consisting of coveralls, shoe covers, cotton gloves, and hood or hair cap. Anti-contamination clothing provides protection for the user from alpha-beta radiation, but is primarily a control device to prevent the spread of contamination. A respirator is worn with the anti-contamination clothing which provides protection against the inhalation of contaminants.

Atmospheric Release Advisory Capability (ARAC) - A Department of Energy asset capable of providing a computer generated model of the most probable path of the radioactive contamination released at an accident site.

Background Count (in connection with health protection) - The background count usually includes radiation produced by naturally occurring radioactivity and cosmic rays.

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Background Radiation - Radiation arising from radioactive material other than the one directly under consideration. Background radiation due to cosmic rays and natural radioactivity is always present.

Bent Spear - A term used to identify those incidents involving nuclear weapons that are of significant interest but are not categorized as PINNACLE NUCFLASH or PINNACLE BROKEN ARROW.

Bioassay - The method or methods for determining the amount of internal contamination received by an individual.

Broken Arrow - A term used to identify an unexpected event involving nuclear weapons or nuclear components that results in any of the following situations where creating a risk of outbreak of nuclear war does not exist:

1. Nuclear detonation.
2. Non-nuclear detonation or burning of a nuclear weapon.
3. Radioactive contamination.
4. Seizure, theft, or loss of a nuclear weapon or nuclear component, including jettisoning.
5. Public hazard, actual or implied.

The Navy includes significant incidents in this category.

Consequences - The results or effects (especially projected doses or dose rates) of a release of radioactive material to the environment.

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Contamination - The deposit and/or absorption of radioactive material, biological, or chemical agents on and by structures, areas, personnel, or objects.

Contamination Control - Procedures to avoid, reduce, remove, or render harmless, temporarily or permanently, nuclear, biological, and chemical contamination for the purpose of maintaining or enhancing the efficient conduct of military operations.

Contamination Control Line - The inner boundary of the contamination control station.

Contamination Control Station (CCS) - An area specifically designated for permitting ingress and egress of personnel and equipment to/from the radiation control area. The outer boundary of the Contamination Control Station is the radiological control line, and the inner boundary is the line segment labeled the contamination control line. An illustration of the Contamination Control Station is given in Figure 6-1.

Contamination Disposal Coordinating Element (CDCE) - A specialized Air Force unit that has primary responsibility for the disposal of contaminated materials at the scene of a nuclear weapons accident.

Cumulative Dose (radiation) - The total dose resulting from repeated exposure to radiation of the same region, or of the whole body.

Decay (radioactive) - The decrease in the radiation intensity of any radioactive material with respect to time.

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Decontamination - The process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing chemical or biological agents, or by removing radioactive material clinging to or around it.

Decontamination Station - A building or location suitably equipped and organized where personnel and material are cleansed of chemical, biological, or radiological contaminants.

Department of Defense (DOD) Nuclear Weapons Capable Fixed Facility - A DOD facility capable of receiving, storing, maintaining, or deploying nuclear weapons or radiological components.

Department of Energy Team Leader - The coordinator of all Department of Energy matters on-site, including Department of Energy Accident Response Group operations.

Directorate of Military Support (DOMS) - A Headquarters, Department of Army (ODCS OP), action agency which, upon Presidential declaration of a disaster or emergency (Public Law 92-288), becomes the DOD executive agent to provide military support for various emergency activities.

Disaster Control - Measures taken before, during, or after hostile action, natural or man-made disasters, to reduce the probability of damage, minimize its effects, and initiate recovery.

Disaster Control Officer (DCO) - The DCO is the DOD point of contact for

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coordination with FEMA of support provided for off-site operations by the Director of Military Support (DOMS).

Disaster Preparedness - That series of actions required to control and manage nuclear incidents or accidents and bring them to the most practicable conclusion within the established security and safety framework. This includes initial and subsequent reporting response, Explosive Ordnance Disposal procedural action on the weapon, appropriate security, legal and medical aspects, public information, and control of hazards caused by the accident. Control of the accident-caused hazards includes such things as: survey of the incident/accident area to establish isodose lines and all types of monitoring; personnel and area decontamination; disposition of nuclear, high explosive, and contaminated items.

Disaster Response Force (DRF) - The USAF base level organization which responds to disasters for establishing command and control, and to support disaster operations.

Dose Rate Contour Line - A line on a map, diagram, or overlay joining all points at which the radiation dose rate at a given time is the same.

Dosimetry - The measurement of radiation doses. It applies to both the devices used (dosimeters) and to the techniques.

Emergency Planning Zone (EPZ) - A generic area defined to facilitate off-site emergency planning and develop a significant response base. During an emergency response, best efforts are made making

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use of plan action criteria without regard to whether particular areas are inside or outside EPZ.

Exclusion Area - Any designated area containing one or more nuclear weapons or components.

Explosive Ordnance - All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads; guided and ballistic missiles; artillery, mortar, rocket, and small arms ammunition; all mines, torpedoes, and depth charges; pyrotechnics; clusters and dispensers; cartridge and propellant actuated devices; electroexplosive devices; and all similar or related items or components explosive in nature.

Explosive Ordnance Disposal (EOD) - The detection, identification, field evaluation, rendering-safe, and/or disposal of explosive ordnance which have become hazardous by damage or deterioration when the disposal of such explosive ordnance is beyond the capabilities of personnel normally assigned the responsibility for routine disposal.

Explosive Ordnance Disposal Incident - The suspected or detected presence of unexploded explosive ordnance, or damaged explosive ordnance, which constitutes a hazard to operations, installation, personnel, or material. Not included in this definition are the accidental arming or other conditions that develop during the

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manufacture of high explosive material, technical service assembly operations, or the laying of mines and demolition charges.

Explosive Ordnance Disposal Procedures - Those particular courses or modes of action of access to, recovery, rendering-safe, and final disposal of explosive ordnance or any hazardous material associated with an explosive ordnance disposal incident.

1. Access procedures. Those actions taken to locate exactly and to gain access to unexploded explosive ordnance.

2. Recovery procedures. Those actions taken to recover unexploded explosive ordnance.

3. Render safe procedures. The portion of the explosive ordnance disposal procedures involving the application of special explosive ordnance disposal methods and tools to provide for the interruption of functions or separation of essential components of unexploded explosive ordnance to prevent an unacceptable detonation.

4. Final disposal procedures. The final disposal of explosive ordnance by explosive ordnance disposal personnel, which may include demolition or burning in place, removal to a disposal area, or other appropriate means.

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5. Explosive Ordnance Disposal Unit. Personnel with special training and equipment who render explosive ordnance safe (such as bombs, mines, projectiles, and booby traps), make intelligence reports on such ordnance, and supervise the safe removal thereof.

Explosive Ordnance Reconnaissance - Reconnaissance involving the investigation, detection, location, marking, initial identification, and reporting of suspected unexploded explosive ordnance, by explosive ordnance reconnaissance agents, in order to determine further action.

Exposure Dose - The exposure dose at a given point is a measurement of radiation in relation to its ability to produce ionization. The unit of measurement of the exposure dose is the roentgen.

Facility Area Emergency - The emergency action level at a DOD fixed nuclear weapon facility which indicates that a significant release could occur, but the situation is under control based on current information.

Federal (organizations) - Agencies, departments, or their components, of the U.S. Federal government, having a role in emergency planning and preparedness.

Federal Coordinating Officer (FCO) - A Federal official appointed by the President in the event a major disaster or emergency is declared (Public Law 93-288). He/she may be from FEMA, DOD, DOE, or another source (e.g., White House Staff or Department of Justice).

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In other than a declared emergency, the FEMA official is so designated.

Federal Emergency Management Agency (FEMA) - This Agency establishes Federal policies for and coordinates all civil defense and civil emergency planning, management, mitigation, and assistance functions of executive agencies. FEMA assists local and state agencies in their emergency planning. Its primary role in a nuclear weapon accident is one of coordinating Federal, state, local, and volunteer response agencies.

Federal Response Center - The on-scene focal point for coordination of overall Federal response to an accident/incident. It contains the office of the Federal Coordinating Officer and representatives of other Federal, state, local, and volunteer agencies.

Field Instrument for the Detection of Low Energy Radiation (FIDLER) - A probe, used with the PRM-5 and other supporting instrument packages, capable of detecting low energy gamma and x-rays.

Film Badge - A photographic film packet to be carried by personnel, in the form of a badge usually used for measuring and permanently recording gamma ray dosage.

General Emergency - An emergency action level at a DOD nuclear weapon capable fixed facility which indicates an actual release of radioactive contamination.

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Half-Life - The time required for the activity of a given radioactve species to decrease to half of its initial value due to radioactive decay. The half-life is a characteristic property of each radioactive species and is independent of its amount or condition. The biological half-life of a given isotope is the time in which the quantity in the body will decrease to half as a result of both radioactive decay and biological elimination.

Hot Spot - Region in a contaminated area in which the level of radioactive contamination is considerably greater than in neighboring regions in the area.

Initial Response Force (IRF) - A force, identified in the Nuclear Accident Response Capabilities Listing (NARCL), belonging to DOD or DOE installations, facilities, or activities, within the United States and its territories, tasked with taking emergency response actions necessary to maintain command and control on-site pending arrival of the service or agency response force. Functions which the initial response force is tasked to perform, within its capabilities, are:

1. Rescue operations.
2. Accident site security.
3. Firefighting.
4. Initial weapon emergency safing.
5. Radiation monitoring.

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6. Establishment of command, control, and communications.

7. Public affairs activities.

<u>Joint Information Center (JIC)</u> - A joint DOD/DOE/FEMA center responsible for the coordination of all public information prior to release. It includes public affairs representatives from the DOD, DOE, and FEMA as well as provisions for other Federal, state, and local representatives and is established near the scene of a nuclear weapon accident/incident which affects (or appears likely to affect) areas outside DOD or DOE facility boundaries.

<u>Joint Nuclear Accident Coordinating Center (JNACC)</u> - A combined Defense Nuclear Agency and Department of Energy centralized agency for exchanging and maintaining information concerned with radiological assistance capabilities and coordinating assistance activities.

<u>Joint Radiological Control Center</u> - A facility, staffed by representatives from each of the agencies conducting radiological operations, for the coordination of radiological survey data and radiological safety/health physics matters.

<u>Licensed Material</u> - Source material, special nuclear material, or by-product material received, possessed, used, or transferred under a general or special license issued by the Nuclear Regulatory Commission or a state.

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Local (organization) - The local government agency or office having the principal or lead role in emergency planning and preparedness. Generally this will be the county government. Other local government entities (e.g., towns, cities, municipalities) are considered to be sub-organizations with supportive roles to the principal or lead local government organization responsible for emergency planning and preparedness. In some cases there will be more than one lead organization at the local level, but designation of one lead local organization is preferable.

Maximum Permissible Dose - That radiation dose which a military commander or other appropriate authority may prescribe as the limiting cumulative radiation dose to be received over a specific period of time by members of his command, consistent with operational military considerations.

Monitoring - The act of detecting the presence of radiation and the measurement thereof with radiation measuring instruments.

National Defense Area (NDA) - An area established on non-Federal lands located within the United States, its possessions, or territories for the purpose of safeguarding classified defense information or protecting Department of Defense equipment and/or material. Establishment of a National Defense Area temporarily places such non-Federal land under the effective control of the Department of Defense and results only from an emergency event. The senior Department of Defense representative at the scene will define the boundary, mark it with a physical barrier, and post warning

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signs. The landowner's consent and cooperation should be obtained whenever possible; however, military necessity will dictate the final decision regarding location, shape, and size.

National Security Area (NSA) - An area established on non-Federal lands located within the United States, its possessions, or territories for the purpose of safeguarding classified and/or restricted information, or protecting Department of Energy equipment and/or material. Establishment of an NSA temporarily places such non-Federal lands under the effective control of the DOE and results only from an emergency event. The senior DOE representative having custody of the material at the scene will define the boundary, mark it with a physical barrier, and post warning signs. The landowner's consent and cooperation will be obtained whenever possible; however, operational necessity will dictate the final decision regarding location, shape, and size.

Nuclear Accident and Incident Control Team (NAIC) - An Army team organized to minimize and prevent the loss of life, personal injury, hazardous effects, and destruction of property, to secure classified material, and to enhance and maintain the public's confidence in the Army's ability to effectively respond to a nuclear accident or incident.

Nuclear Accident and Incident Control Officer (NAICO) - An Army officer designated by the commander responsible for Nuclear Accident and Incident Control to represent him at the scene of a nuclear weapons accident or significant nuclear weapons incident and to act as

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on-scene commander during the absence of the appointed on-scene commander.

Nuclear Contribution - Explosive energy released by nuclear fission or fusion reactions, as part of the total energy released by the accidental explosion of a nuclear weapon. Any nuclear contribution equivalent to four or more pounds of TNT is considered significant, and would add beta and gamma radiation hazards to other radiological and toxic hazards present at a nuclear weapons accident site.

Nuclear Detonation - A nuclear explosion resulting from fission or fusion reactions in nuclear materials, such as that from a nuclear weapon.

Nuclear Emergency Search Team (NEST) - A DOE asset which has specialized equipment for conducting radiation survey and detection, field communications, EOD support, bomb/weapon diagnostics, hazard prediction, damage mitigation, and decontamination.

Nuclear Radiation - Particulate and electromagnetic radiation emitted from atomic nuclei in various nuclear processes. The important nuclear radiations, from the weapons standpoint, are alpha and beta particles, gamma rays, and neutrons. All nuclear radiations are ionizing radiations, but the reverse is not true.

Nuclear Weapon - A device in which the explosion results from the energy released by reaction involving atomic nuclei, either fission or fusion, or both.

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Nuclear Weapon Accident - An unexpected event involving nuclear weapons or radiological nuclear weapon components that results in any of the following:

1. Accidental or unauthorized launching, firing, or use by U.S. forces or U.S. supported allied forces of a nuclear-capable weapons system which could create the risk of an outbreak of war.

2. Nuclear detonation.

3. Non-nuclear detonation or burning of a nuclear weapon or radiological nuclear weapon component.

4. Radioactive contamination.

5. Seizure, theft, loss, or destruction of a nuclear weapon or radiological nuclear weapon component, including jettisoning.

6. Public hazard, actual or implied.

Nuclear Weapon Accident/Significant Incident Assistance - That assistance provided after an accident or significant incident involving nuclear weapons or radiological nuclear weapon components to:

1. Evaluate the radiological hazard.

2. Accomplish emergency rescue and first aid.

3. Minimize safety hazards to the public.

4. Minimize exposure of personnel to radiation and/or radioactive material.

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5. Establish security, as necessary, to protect classified government material.

6. Minimize the spread of radioactive contamination.

7. Minimize damaging effects on property.

8. Disseminate technical information and medical advice to appropriate authorities.

9. Inform the public (as appropriate) to minimize public alarm and to promote orderly accomplishment of emergency functions.

10. Support recovery operations of damaged weapons or weapon components.

11. Support the removal of radiological hazards.

Nuclear Weapon Incident - An unexpected event involving a nuclear weapon, facility, or component resulting in any of the following, but not constituting a nuclear weapon(s) accident:

1. An increase in the possibility of explosion or radioactive contamination.

2. Errors committed in the assembly, testing, loading, or transportation of equipment, and/or the malfunctioning of equipment and material which could lead to an unintentional operation of all or part of the weapon arming and/or firing sequence, or

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which could lead to a substantial change in yield or increased dud probability.

3. Any act of God, unfavorable environment, or condition resulting in damage to a weapon, facility, or component.

<u>Nuclear Weapon Significant Incident</u> - An unexpected event involving nuclear weapons or radiological nuclear weapon components which does not fall in the nuclear weapon accident category but:

1. Results in evident damage to a nuclear weapon or radiological nuclear weapon component to the extent that major rework, complete replacement, or examination or recertification by the DOE is required.

2. Requires immediate action in the interest of safety or nuclear weapons security.

3. May result in adverse public reaction (national or international) or premature release of classified information.

4. Could lead to a nuclear weapons accident and warrants that high officials or agencies be informed or take action.

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Nuclear Yield - The energy released in the detonation of a nuclear weapon, measured in terms of the kilotons or megatons of trinitrotoluene (TNT) required to produce an equivalent energy release.

Occupational and Environmental Health Laboratory (OEHL) - A USAF unit that provides consultant, engineering, and analytical support in radiological health programs. This USAF unit offers a multitude of technical services on radiological problems. The field unit of the OEHL is called the Air Force Radiological Assessment Team (AFRAT).

Off-Site - That area beyond the boundaries of a DOD installation or DOE facility, including the area beyond the boundary of an NDA or NSA, that has been, or may become, affected by a nuclear weapon accident or significant incident.

On-Scene Commander - The person designated to coordinate the DOD rescue efforts at the rescue site.

On-Site - That area around the scene of a nuclear weapon accident or significant incident that is under the operational control of the installation commander, facility manager, DOD on-scene commander, or DOE team leader. The on-site area includes any area which has been established as a NDA or NSA.

Oralloy - Enriched uranium. One of the primary fissionable materials used in nuclear weapons.

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Particulate Radiation - Radiation in the form of particles (e.g., neutrons, electrons, alpha and beta particles) as opposed to electromagnetic radiation.

Planning Basis - Guidance in terms of (1) size of planning area distance; (2) time dependence of release; and (3) radiological characteristics of releases.

Planning Standard - The standard that must be met for on-site and off-site emergency plans and preparedness.

Plutonium (Pu) - An artificially produced radioactive material. The Pu-239 isotope is used primarily in nuclear weapons.

Primary Command Responsibility - The service or agency in physical possession or custody of nuclear material when an accident occurs will have primary command responsibility at the scene.

Principal (organizations): - Federal, state, local agencies or departments or executive offices and nuclear weapons fixed facilities having major or lead roles in emergency planning and preparedness.

Private Sector (organizations): - Industry, volunteer, quasi-governmental, etc., having a role in emergency planning and preparedness. It is not possible to totally specify each class or type of organization that may be involved in the total emergency planning and preparedness scheme. Nor is it possible to define the particular roles, functions, and responsibilities of "principal organizations" and "sub-organizations." This is a matter that is

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best defined by the various parties involved in developing plans and preparedness for each nuclear weapons fixed facility. Where the guidance in this document indicates a function that must be performed, emergency planners at all levels must decide and agree among themselves which organization is to perform such function.

Projected Dose - An estimate of the radiation dose which affected individuals could potentially receive if protective actions are not taken.

Protective Action - An action taken to avoid or reduce a projected dose (sometimes referred to as protective measure).

Protective Action Guide - Projected absorbed dose to individuals in the general population which warrants protective action.

Radiation Absorbed Dose (RAD) - One RAD represents the absorption of 100 ergs of nuclear (or ionizing) radiation per gram of the absorbing material or tissue.

Radioactivity Detection Indication and Computation (RADIAC) - A term devised to designate various types of radiological measuring instruments or equipment.

Radioactivity - The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays from the nuclei of an unstable isotope.

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Radiological Advisory Medical Team (RAMT) - A special team established at Walter Reed Army Medical Center under the Commander, U.S. Army Health Services Command, which is available to the on-scene commander, Nuclear Accident and Incident Control Officer, or commander of a military hospital. Team personnel will advise on radiological health hazards and exposure level criteria.

Radiological Control Area (RCA) - The control area encompassing all known or suspected radiological contamination at a nuclear weapons accident.

Radiological Control Line (RCL) - A control line surrounding the radiological control area. Initially, the radiological control line should extend 100 meters beyond the known/suspected radiological contamination to provide a measure of safety.

Radiological Control Team (RADCON) - Special radiological teams of the U.S. Army and U.S. Navy that are organized to provide technical assistance and advice in radiological emergencies.

Radiological Survey - The directed effort to determine the distribution of radiological material and dose rates in an area.

Residual Contamination - Contamination which remains after steps have been taken to remove it. These steps may consist of nothing more than allowing the contamination to decay naturally.

Roentgen - A unit of exposure dose of gamma (or x-ray) radiation in field dosimetry; one roentgen is essentially equal to one RAD.

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Roentgen Equivalent Man (REM) - One REM is the quantity of ionizing radiation of any type which, when absorbed by man or other mammals, produces a physiological effect equivalent to that produced by the absorption of one roentgen of x-ray or gamma radiation.

Service/Agency Response Force (SRF) - A DOD or DOE response force that is appropriately manned, equipped, and capable of performing the initial response force tasks and coordinating all actions necessary to effectively control and recover from an accident or significant incident. The specific purpose of a service/agency response force is to be able to provide nuclear weapon accident/significant incident assistance. Service/agency response forces are organized and maintained by those services or agencies which have custody of nuclear weapons or radioactive nuclear weapon components.

State (organization) - The state government agency or office having the principal or lead role in emergency planning and preparedness. There may be more than one state involved, resulting in application of the evaluation criteria separately to more than one state. To the extent possible, however, one state should be designated lead.

Sub (organizations) - Any organization such as agencies, departments, offices, or local jurisdictions having a supportive role to the principal or lead organization(s) in emergency planning and preparedness.

Tuballoy - Natural uranium used in nuclear weapons.

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<u>Tritium</u> - Tritium is a radioactive isotope of hydrogen having one proton and two neutrons in the nucleus. Tritium is a beta emitter.

<u>Uranium</u> - Uranium is a heavy, silvery white, radioactive metal. In air, the metal becomes coated with a layer of oxide that will make it appear from a golden-yellow color to almost black. Uranium is an alpha emitter.

<u>Weapon Debris (nuclear)</u> - The residue of a nuclear weapon after it has exploded; that is, the materials used for the casing, and other components of the weapon, plus unexpended plutonium or uranium, together with fission products, if any.

<u>Weapons Recovery</u> - Includes a comprehensive assessment of the accident, neutralizing the weapon hazards, and removing, packaging, and shipping of the weapon hazards.

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ABBREVIATIONS

AF	Air Force
AFOC	Air Force Operations Center
AFRAT	Air Force Radiological Assistance Team
AMS	Aerial Measurement System
AOC	Army Operations Center
ARAC	Atmospheric Release Advisory Capability
ARG	Accident Response Group
ATRAP	Air Transportable RADIAC Package
ATSD(AE)	Assistant to the Secretary of Defense (Atomic Energy)
AUTODIN	Automatic Digital Network
AUTOSEVOCOM	Automatic Secure Voice Communications Network
AUTOVON	Automatic Voice Network
CCS	Contamination Control Station
CDCE	Contamination Disposal Coordination Element
CEOI	Communication Electronic Operational Instruction
CP	Command Post
CPM	Counts Per Minute

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ABBREVIATIONS, continued

CPX	Command Post Exercise
DCE	Disaster Control Element
DCO	Disaster Control Officer
DDD	Direct Distance Dialing
DOD	Department of Defense
DOE	Department of Energy
DOE/AL	(DOE) Albuquerque Operations
DOE/NV	(DOE) Nevada Operations
DOMS	Director of Military Support
DOT	Department of Transportation
DMP/M^3	Disintegrations Per Minute per Cubic Meter
DNA	Defense Nuclear Agency
DRF	Disaster Response Force
ECS	Exercise Control Staff
EEFI	Essential Elements of Friendly Information
EOC	Emergency Operation Center
EOD	Explosive Ordinance Disposal
EMT	Emergency Medical Team
EPA	Environmental Protection Agency

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ABBREVIATIONS, continued

FCO	Federal Coordinating Officer
FCDNA	Field Command, Defense Nuclear Agency
FEMA	Federal Emergency Management Agency
FONAC	Flag Officers' Nuclear Weapons Accident Course
FRMAP	Federal Radiological Monitoring and Assessment Plan
FTS	Federal Telecommunications System
GMF	Ground Mobile Force
GSA	General Services Administration
HF	High Frequency
H&HS	Department of Health and Human Services
HOT SPOT	Department of Energy Mobile Accident Response Group Unit
HQDNA	Headquarters, Defense Nuclear Agency
INWS	Interservice Nuclear Weapons School
IRAP	Interagency Radiological Assistance Plan
IRF	Initial Response Force
JA	Judge Advocate
JACC/CP	Joint Airborne Communications Center/Command Post
JCCSA	Joint Communications Contingency Station Assets
JCS	Joint Chiefs of Staff

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ABBREVIATIONS, continued

JCSE	Joint Communications Support Element
JIC	Joint Information Center
JNACC	Joint Nuclear Accident Coordinating Center
JSCP	Joint Strategic Capability Plan
KEV	Thousand Electron Volts
LOS	Limit of Sensitivity
MCi/m^3	Microcuries per cubic meter
MEV	Million Electron Volts
NARCL	Nuclear Accidents Response Capabilities Listing
NARP	Nuclear Weapons Accident Response Procedures Manual
NCA	National Command Authority
NCAIC	Nuclear Chemical Accident/Incident Control
NEST	Nuclear Emergency Search Team
NDA	National Defense Area
NMCC	National Military Command Center
NSA	National Security Area
NTS	Nevada Test Site
NTSB	National Transportation Safety Board
NUWAX	Nuclear Weapons Accident Exercise
OASD(PA)	Office of the Assistant Secretary of Defense (Public Affairs)

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APPENDIX 6

FEDERAL EMERGENCY CONTACTS

This is Appendix C from FEMA-REP-5. Appendix C title is Federal Emergency Contacts.

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