Department of Energy
Washington, DC 20585
May 4, 2005

The Honorable A.J. Eggenberger
Acting Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW
Suite 700
Washington, DC 20004-2901

Dear Dr. Eggenberger:

The Defense Nuclear Facilities Safety Board's letter to Under Secretary Garman dated August 27, 2004, concerned the adequacy of Department of Energy (DOE) natural phenomena hazards design standards and the performance category designation for the conceptual seismic design of the Salt Waste Processing Facility (SWPF) at the Savannah River Site. The Under Secretary responded to those concerns by letter dated October 13, 2004. As part of that response, DOE committed to provide clarification and supplemental guidance on seismic design standards by January 31, 2005. Enclosed is the draft interim revision (Section 6.1) to DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear and Nonnuclear Facilities.* A copy has also been provided to your staff for review and comment. Once comments are resolved, it will be issued for interim use.

We also recognized that it would be beneficial to review recently approved-for-issuance, but not yet published, American Nuclear Society (ANS) 2.26, *Categorization of Nuclear Facility Structures, Systems and Components for Seismic Design.* We formed a DOE-wide team to review this standard and report on its acceptability for use in DOE. ANS 2.26 was based on existing DOE seismic standards in large part and we believed initially that ANS 2.26 could be used as the supplemental guidance that would address your seismic design issues. As ANS 2.26 went through the ANS consensus process, it was revised from the original DOE seismic design standard and, in particular, how results from accident analyses will establish seismic design. Therefore, a more comprehensive review will be required to determine if it will be suitable for DOE use.

A more comprehensive review of ANS 2.26 will take several months. Given the stage of design for SWPF and other facilities in DOE, we believe it is prudent to issue supplemental guidance on seismic design standards at this time that address your concerns rather than await the results of the ANS 2.26 review. We will work with your staff to revise the enclosed Guide and other DOE directives as our ANS 2.26 review progresses.

Sincerely,

John Spitaleri Shaw
Assistant Secretary for
Environment, Safety and Health

Enclosure

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DRAFT DOE G 420.1-2
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GUIDE FOR THE MITIGATION OF NATURAL PHENOMENA HAZARDS FOR DOE NUCLEAR FACILITIES AND NONNUCLEAR FACILITIES

U.S. DEPARTMENT OF ENERGY
Office of Environment, Safety and Health

Distribution:	Initiated By:
All Departmental Elements	Office of Environment, Safety and Health

FOREWORD

This Department of Energy (DOE) Implementation Guide is approved for use by the DOE Office of Nuclear Safety Policy and Standards and is available for use by all DOE elements and their contractors. Suggestions for corrections or improvements to this Guide should be addressed to Richard Stark, EH-31, DOE Office of Nuclear Safety Policy and Standards, Germantown, Maryland.

This document provides guidance in implementing the Natural Phenomena Hazard (NPH) mitigation requirements of DOE O 420.1, FACILITY SAFETY, Section 4.4, "Natural Phenomena Hazards Mitigation." This Guide does not establish or invoke any new requirements. Any apparent conflicts arising from the NPH guidance would defer to the requirements in DOE 0420.1.

This Guide is to be used with DOE O 420.1; the current/latest versions of the NPH DOE Standards 1020, 1021, 1022, 1023, and 1024; and Interagency Committee on Seismic Safety in Construction (ICSSC) standards/guides RP 1, 2.1 A, 3, 4, 5. However, this Guide takes precedence over the DOE Standards cited above.

Consistent with Public Law 104-113, this Guide is updated to conform to national codes and standards, such as National Earthquake Hazards Reduction Program (NEHRP) 1997 provisions (which form the basis of International Building Code 2000) and American Society of Civil Engineers (ASCE) 7-98, etc. Some of the important aspects of these documents are incorporated in the Guide and these documents should be consulted for additional details, wherever pertinent. Availability of U.S. Geological Survey Seismic Maps for the continental U.S.A. is also recognized in the Guide.

Note that, throughout this Guide, the word "must" denotes actions that are required to comply with this Guide. The word "should" is used to indicate recommended practices (DOE-STD1075-94). The use of "may" refers to an item or activity that can be advised under some circumstances, but for which there is not a professional consensus. The use of "could" suggests the existence of several possibilities, one of which will be specific to the project and not driven by specific safety considerations.

CONTENTS

1. INTRODUCTION

A contractor/operator responsible for a Department of Energy (DOE) nuclear or nonnuclear facility must design, construct, and operate the facility so that the public, the workers, and the environment are protected from the adverse impacts of Natural Phenomena Hazards (NPHs) listed in Appendix C. This document provides guidance for implementing the NPH mitigation requirements in Section 4.4 of DOE O 420.1, FACILITY SAFETY. It addresses radiological and nonradiological hazards and life-safety issues, including protection of workers from exposure to hazardous materials that is caused by the failure of structures, systems, and components (SSCs).

DOE uses the requirements of the latest model building codes, the Uniform Building Code (UBC), Building Officials and Code Administrators International (BOCA), Southern Building Code Congress International (SBCCI), and national standards (e.g., ASCE 4 - "Seismic Analysis of Safety-Related Nuclear Structures" and ASCE 7, "Minimum Design Loads for Buildings and other Structures," for wind loads) to mitigate the consequences of natural phenomena hazards. The first three model building codes are now being combined as the International Building Code and these will cease to exist individually from year 2000. Initially, DOE Standards, guidance, and practices were developed and promulgated by DOE 6430.1A through the DOE General Design Criteria to provide levels of design for occupant life safety, reduction in loss of government property, functioning of essential operations, and confinement of hazardous material. These were later superseded by DOE 5480.28, which is now superseded by DOE O 420.1, Section 4.4.

The NPH Mitigation requirements of Section 4.4 in DOE O 420.1 are consistent with the DOE Order on Environment, Safety, and Health (DOE 5480.1 B), Safety Analysis and Review System (DOE 5481.1 B), and the seismic guidance of the National Earthquake Hazards Reduction Program (NEHRP) contained in the NEHRP Provisions (FEMA 302) and the Interagency Committee on Seismic Safety in Construction (ICSSC) Standard RP-4. Recent evaluations under the NEHRP studies indicate that DOE seismic requirements for design and evaluation of buildings to be "substantially equivalent" to the NEHRP provisions required by the Executive Order on Seismic Safety for New Construction (Executive Order 12699, dated 1-5-90); and in many cases, the DOE seismic requirements are substantially more conservative for levels of design beyond those judged acceptable for life safety.

For nonnuclear facilities having no hazardous materials, it is acceptable and sufficient to use any of the three model building codes or succeeding unified code IBC 2000 (when issued). For facilities containing hazardous material, DOE requirements may be more stringent. Furthermore, for seismic requirements for all existing buildings with no hazardous material, ICSSC RP-4 provisions are considered as a minimum as per Executive Order 12941.

Note that, throughout this Guide, the word "must" denotes actions that are required to comply with this Guide. The word "should" is used to indicate recommended practices (DOE-STD1075-94). The use of "may" refers to an item or activity that can be advised under some circumstances, but for which there is not a professional consensus. The use of "could" suggests the existence of several possibilities, one of which will be specific to the project and not driven by specific safety considerations.

2. APPLICATION

The provisions of DOE O 420.1 apply to covered contractors to the extent implemented under a contract or other agreement. A covered contractor is a seller of supplies or services involved with the design, operation, or evaluation of a DOE-owned or -leased facility and awarded a procurement contract, or a subcontract, containing one or more of the following contract clauses:

- Safety and Health (Government-Owned or Leased Facility) DEAR 952.223-71 and 970.5204-2;
- Nuclear Facility Safety DEAR 970.5204-26;
- Radiation Protection and Nuclear Criticality DEAR 952.223-72; or
- any other clause whereby DOE elects to enforce health and safety standards.

The provisions of the DOE O 420.1 apply to all DOE sites and facilities except as excluded in Chapter 3.

3. EXCLUSIONS

DOE O 420.1 does not apply to the parts and portions of DOE-owned or -leased facilities licensed by the Nuclear Regulatory Commission.

DOE O 420.1 does not apply to Naval Nuclear Propulsion Program activities, which are excluded by Executive Order 12344 and Public Law 98-525.

DOE facilities that have current leases with non-Federal agencies do not have to be upgraded under the provisions of ICSSC RP-4. However, leases for facilities with NPH mitigation deficiencies cannot be renewed unless the deficiencies are corrected (see RP-4, Section 1.3.2).

4. GENERAL INFORMATION

DOE regulates itself and its contractors in matters relating to environmental, safety, and health protection through a hierarchy of documents, ranked in order of precedence as follows: policy, requirements, and guidance documents (either safety guides or standards). The requirements for natural phenomena hazards mitigation are established in DOE O 420.1, Section 4.4. Implementation of NPH mitigation features for nuclear facilities is based on the safety requirements in nuclear safety analysis required by DOE 5480.23.

The National Earthquake Hazard Reduction Program (NEHRP), Executive Order 12699 (1-5-90), and Executive Order 12941 (12-1-94) were created in response to the Earthquake Hazards Reduction Act, Public Law 95-124. The Act was written to reduce the risk to life and property in Federally owned, leased, or regulated buildings. Executive Order 12699 chartered the ICSSC to recommend cost-effective seismic design and construction standards and practices that would reduce the seismic risk to life and property for new Federal buildings. The ICSSC recommendations for seismic design criteria are provided in *NEHRP Recommended Provisions for Seismic Regulations for New Buildings* (FEMA 302). The corresponding implementation guidelines for new buildings are provided in ICSSC RP-2.1-A. The ICSSC also periodically reviews the seismic provisions of current model building codes. Three model building codes (UBC, BOCA, and SBCCI, which, as mentioned earlier, will be combined in year 2000 as the International Building Code - IBC 2000) were found to be substantially equivalent to, or to exceed, NEHRP-recommended provisions. The DOE requirements for seismic engineering follow the UBC (including references to support materials), unless the importance of achieving a high level of protection warrants the use of more demanding methods and criteria. The DOE requirements are, therefore, essentially in compliance with NEHRP provisions.

Executive Order 12941, issued 12-1-94, extended seismic requirements to existing Federally owned or leased buildings. Executive Order 12941 requires an assessment of compliance with minimum performance criteria, identification of the need for seismic upgrades, and the development of a cost estimate for seismic upgrades within 4 years. The guidance provided herein is consistent with the requirements of Executive Order 12941, the provisions of ICSSC RP-4, the guidance provided in ICSSC RP-5, and the Handbook for the Seismic Evaluation of Existing Buildings (FEMA-178).

It is important to note that Executive Orders 12699 and 12941 apply to all Federal buildings (including nuclear facilities), but they do not address the confinement of hazardous materials and they do not address nonseismic natural phenomena. DOE O 420.1 and this Guide address these issues.

5. POLICY

It is the DOE policy to design, construct, and operate DOE facilities so that workers, the general public, and the environment are protected from the effects of natural phenomena hazards on DOE facilities. DOE NPH mitigation requirements are consistent with the Process Safety Management Rule, 29 CFR 1910, the National Earthquake Hazards Reduction Program, Executive Order 12699, and Executive Order 12941 for all its facilities. For nuclear facilities, DOE also requires that the nuclear safety policy of DOE 5480.23 be met for NPH mitigation, and that cost effectiveness be considered. The goals of NPH design, evaluation, and construction for NPH mitigation include

(1) providing for safe work places,

(2) protecting against property loss or damage,

(3) continued operation of essential facilities, and

(4) protecting public health, property, and the environment against exposure to hazardous materials.

The fundamental statement of policy covers the basic objectives of NPH protection. Occupants of buildings need to be protected from building collapse or other failures that could endanger their lives or prevent safe exit. This objective is referred to as "life safety."

Secondly, it may be cost-effective to engineer additional provisions to protect capital investments in structures or to reduce the risk of property damage from NPH-induced accidents and effects.

A third, more stringent objective is "continued operation." Some structures perform an essential function that is important to preserve during and/or after an earthquake or other natural disturbance. Hospitals and emergency response centers are good examples.

The fourth objective is the confinement of hazardous materials. Some facilities are capable of giving rise to severe accidents involving hazardous materials or processes. These facilities may warrant hardening of confinement features to reduce the likelihood that natural phenomena hazards, such as seismic, wind, floods, and lightning, might precipitate such accidents by damaging the installed safety features.

Cost-effectiveness is inevitably a consideration; the cost of hardening facilities and their SSCs against the effects of natural phenomena hazards may be large-the protection afforded is not absolute and the value of protection is uncertain due in part to the uncertainty in the hazard itself. Furthermore, the value of NPH risk reduction is a function of the remaining service life of a facility and the magnitude and duration of any residual hazards that may be present. The location, timing, and magnitude of future events can not be foretold, nor can the potential effects of these uncertain events be bounded without a degree of conservatism in design that would be impractical to accommodate on the scale of the DOE complex.

DOE policy for NPH mitigation does not prescribe the balance to be struck among the four mitigation goals and the cost-effectiveness consideration, but these issues are addressed in the requirements and guidance. The appropriate balance requires judgment and cannot be captured by a simple formula.

For facilities with a remaining service life of less than 5 years, it may not be necessary to upgrade the facility for NPH mitigation unless the presence of hazardous materials or other special conditions present an "exceptionally high risk" to occupants or the public at large. (See ICSSC RP-5.)

6. GUIDELINES

Adequate design, construction, and operational measures to mitigate NPH occurrences have been shown in many cases to yield considerable benefit in terms of risk reduction. However, in view of the large uncertainties in the NPH hazard and the uncertainties in the possible impact on a given facility if a NPH event occurs, achieving the appropriate balance between the expense of mitigation measures and the residual risk is a particularly difficult challenge.

Designing a new facility to be resistant to NPH loads is usually easier and cheaper than backfitting to achieve the same NPH capacity after the structure is completed and in service. In addition to the feasibility of retrofitting, cost-effectiveness (which depends on factors such as projected service life or the time integral of residual risks) must be weighed in considering upgrade approaches for existing facilities. Each natural phenomena hazard (as listed in Appendix C) that poses a threat or danger to workers, the public, or to the environment by potential damage to SSCs must be considered in developing the safety analysis.

DOE has prepared and is updating the following five supporting standards to implement the NPH requirements of DOE O 420.1; compliance with the most current version of these standards is required in order to provide desired safety at DOE facilities.

> DOE-STD-1020-94*, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities;*
>
> DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Criteria for Structures, Systems, and Components;*
>
> DOE-STD-1022-94, *Natural Phenomena Hazards Site Characterization Criteria;*
>
> DOE-STD-1023-95, *Natural Phenomena Hazards Assessment Criteria;*
>
> DOE-STD-1024-92, *Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites.*

These standards and their role in NPH mitigation are discussed below.

6.1 Graded Approach

A key element of DOE NPH mitigation requirements is the use of a graded approach. DOE facilities are diverse enough to warrant a graded approach (e.g., some are office buildings while others contain substantial inventories of hazardous material). Such an approach recognizes the diversity of objectives for NPH protection, the diversity of facilities, and the diversity of measures that are appropriate to ensure suitable NPH protection. When properly developed and implemented, a graded approach optimizes the allocation of effort and resources.

The nuclear SAR process yields insights into the preventive and mitigative functions of the SSCs that are necessary for determining appropriate NPH categories. The design sequence for new facilities and the evaluation sequence for existing facilities should proceed from hazard categorization, through SAR preparation, and then to final NPH categorization of SSCs into Performance Categories (PCs). As discussed in DOE G 420.1-X, the design process is an iterative one with safety analysis.

The link between the SAR process and NPH categorization must be driven by the graded approach. The grading process needs to be thought of in terms of three different concepts: (1) life safety, (2) mission (e.g., damage limitation for essential facilities), and (3) hazardous material safety. With regard to life safety and mission, ample guidance and precedents exist in current building codes and in the NEHRP provisions to determine which SSCs are important to these functions and to distinguish between the need for design criteria for life safety versus the need for design criteria for an essential facility. The DOE NPH Standards refer to the UBC (being superceded by IBC 2000) and also provide a comprehensive picture of the life safety or mission reliability achieved with any choice of hazard level and importance factor. USGS (1996) Seismic Hazard Curves are now available and should be considered when implementing DOESTD-1023-95. PC-1 facilities must be designed as per Seismic Use Group 1 and PC-2 facilities as per Seismic Use Group III in IBC 2000 with associated importance factors. With respect to the hazardous material grading scale, however, little consensus guidance exists, so a substantial part of the categorization guidance in DOE-STD-1021-93 is devoted to this subject.

The concept of PCs with corresponding target probabilistic performance goals has been developed to assist in applying the graded approach to NPH design and evaluation. Each SSC in a DOE facility is assigned to one of five performance categories depending upon its safety importance. Each performance category is assigned a target performance goal in terms of the probability of unacceptable damage due to natural phenomena. The unacceptable level of damage is related to the safety function of the SSCs during and after the occurrence of NPH. The target performance goals given in Appendixes B and C of DOE-STD-1020-94 have been prescribed to be substantially equivalent with (1) the goals of model building code provisions for SSCs in PC-1 and PC-2 and (2) the goals intended by commercial nuclear power plant seismic criteria for SSCs in PC 4. DOESTD-1020-94 (Appendixes B and C) also provide details about the graded performance of SSCs in various performance categories including the extent of expected damage, deformation, cracking, and yielding of SSCs in PC-1 to PC-4.

The relative probabilities and consequences of potential damage or failure of SSCs making up DOE facilities are accounted for by providing several sets of NPH design/evaluation provisions with increasing conservatism (i.e., producing a decrease in probability of damage or failure to perform intended safety function). Mean annual exceedance probabilities for various PCs to accomplish these target performance goals for different NPHs is given in DOE-STD-1020-94. This graded approach provides a different level of NPH provisions for each performance category, as described below.

1. PC-0 SSCs are those for which no consideration of natural phenomena is necessary; that is, where natural phenomena hazards are not an issue.

2. For PC-1 SSCs, the primary concern is preventing major structural damage, collapse, or other failure that would endanger personnel (life safety). Repair or replacement of the SSC or the ability of the SSC to continue to function after the hazard has occurred is not considered. (Design/evaluate as Seismic Use Group I of IBC 2000.)

3. PC-2 SSCs are meant to ensure the operability of essential facilities (e.g., fire house, emergency response centers, hospitals) or to prevent physical injury to in-facility workers. When safety analyses determine that confinement of the attendant hazardous materials is required for worker protection, PC-2 designation should be used for the SSCs involved unless the potential consequences to collocated workers are serious (see below for additional guidance), especially for the facilities that have large off-site boundary distances. In these cases, PC-2 designation may apply to SSCs, such as drums, packaging, gloveboxes; local HEPA filters; air flow control systems (ventilation and dampers); and room air monitors, alarms, corridors, stairways and doors, pager systems, and emergency lighting important to evacuation. Design of PC-2 SSCs should result in limited structural damage from design basis natural phenomena events to ensure minimal interruption to facility operation and repair following the event. PC-2 performance is analogous to the design criteria for essential facility (e.g., hospitals, fire and police stations, centers for emergency operations) in the model building codes. (Design/Evaluate as Seismic Use Group III of IBC 2000.)

4. PC-3 SSCs are those for which failure to perform their safety function could pose a potential hazard to public health, safety, and the environment because radioactive or toxic materials are present and could be released from the facility as a result of that failure. PC-3 SSCs would prevent or mitigate criticality accidents, chemical explosions, and events with the potential to release hazardous materials outside the facility. Design considerations for these categories are to limit facility damage as a result of design basis natural phenomena events so that hazardous materials can be controlled and confined, occupants are protected, and the functioning of the facility is not interrupted. When safety analyses determine that local confinement of high-hazard materials is required for worker safety, PC-3 designation may be appropriate for the SSCs involved. PC-3 NPH provisions are consistent with those used for reevaluation of commercial plutonium facilities with conservatism in between that of model building code requirements for essential facilities and civilian nuclear power plant requirements.

   When safety analyses determine that confinement safety function (prevention or mitigation of accidental releases) is required for adequate protection of the workers, PC-3 designation may be appropriate for the SSCs involved. The possibility exists that collocated workers can be exposed to significant consequences resulting from seismically induced accidents. In cases where site boundary distances are large, so that PC-3 designation is not required for public protection, the potential unmitigated consequences to collocated worker population can be assessed to provide additional insight on the overall risk from the seismic event in a conservative manner. For a new construction project involving Hazard Category 2 nuclear facilities with significant inventories of nuclear materials, it would be prudent to assume PC-3 requirements to increase the confidence level for providing worker protection, if the nature of the material at risk (including availability of internal energy sources and external driving forces caused by the seismic event) can pose a serious consequence to collocated workers.

It is important to avoid progressing in design to the point where a change in design requirements results in unanticipated increases in design and construction costs and undesirable increased in schedule. As design progresses, if it becomes apparent that a case can be made that design to PC-3 standards is not required for worker safety, or a particular strategy is developed to address worker safety issues, then that case should be presented at as early a time as possible, so that a design decision can be made before considerable resources are expended.

The following considerations are important in making this decision:

a. The magnitude of the hazard, in terms of potential worker (in-facility and collocated) consequences from seismically-induced accidents, should be considered. In-facility worker doses from accidents can be quite large because of their proximity to the accident location. Numeric dose criteria are not endorsed, but dose estimates do give a sense of the seriousness of the hazard.

b. The concern for worker safety during a seismically-induced accident condition arises from the necessity for confinement of hazardous material. Generally there are three levels of confinement. The first is the primary confinement, closest to the hazardous material. This may be a drum, a glove box, a hot cell, etc. Next is secondary confinement, which may be an area within a facility that is separately treated regarding pressure differential and ventilation flows and includes the primary confinement. The third is building confinement, generally including HEPA filtration of effluents from the building to the environment and includes both primary and secondary confinement within it. Assurance of primary confinement is effective in protecting both in-facility workers and collocated workers. Assurance of building confinement is effective in protecting collocated workers, but it alone does not protect in-facility workers. The most cost effective approach should be considered.

c. PC-2 design criteria provide lesser assurance of effective confinement than does PC-3. However, they do provide for overall structural integrity such that structures do not collapse under the seismic loads. PC-3 design criteria provide increased assurance of the effectiveness of confinement. Design consideration of confinement should proceed from inside out. That is, if primary confinement can be assured, say by designing to PC-3 criteria, then secondary and tertiary confinement need not be to PC-3 criteria, but PC-2 would be appropriate to protect the primary confinement.

d. Alternate design approaches for providing assurance of confinement functionality should be considered. Additional engineering enhancements beyond PC-2 criteria should be allowed to increase confinement performance when PC3 criteria are not required or fully met.

e. Overall considerations for the appropriateness of PC-3 designation of structures for worker protections should also include: i. active lifetime of the facility, ii. consideration of emergency procedures, iii. number of workers potentially affected (in-facility and collocated), iv. cost/effectiveness or benefit analyses, v. others, as appropriate.

5. PC-4 SSCs are also those for which failure to perform their safety function could pose a potential hazard to public health, safety, and the environment because radioactive or toxic

materials are present in large quantities and could be released as a result of that failure. However, PC-4 SSCs are designated as "reactor like" in that the quantity of hazardous materials and energetics is similar to a large Category A reactor (>200 MW_t). These types of SSCs are associated with facilities with quantities and forms of hazardous materials, and sufficient energy sources, that could produce significant off-site effects unless the SSCs withstand NPH effects. The SAR results provide an essential element in identifying specific SSCs for which a failure could result in a release as large as the potential release from a large reactor. Design considerations for this category are to limit facility damage from design basis natural phenomena events so that hazardous materials can be controlled and confined, occupants are protected, and essential functions of the facility are not interrupted. PC-4 seismic provisions are similar to those used for reevaluation or design of civilian nuclear power plants, where off-site release of hazardous material must be prevented.

DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components,* provides guidance to facility designers or safety evaluators to aid in determining which NPH performance category to assign to a specific system, structure, or component in a DOE facility. It treats the concepts of facility hazard classification, SSC safety classification, and performance categorization. The standard does not attempt to define what constitutes a "safety function" in each type of facility, but refers the user to other DOE guidance on this subject. Engineers with knowledge of systems, safety requirements, and facility operations should select performance categories in a manner to ensure that DOE safety policies are met. Economic or programmatic considerations may require use of more stringent goals for specific SSCs (i.e., they may be placed in a higher performance category). The performance categorization is to be derived from hazard analysis and what SSCs are required to mitigate NPH hazards. For nuclear facilities, the SAR results provide an essential element in categorizing SSCs. For existing nonreactor nuclear facilities, DOE-STD-3009 should be used in conjunction with Standard 1021 and the SAR for performance categorization. Also refer to DOE G 420.1-X for further discussions on this subject.

6.2 NPH Design

6.2.1 Objectives

SSCs should be designed, constructed and operated to withstand the effects of natural phenomena as necessary to ensure the confinement of hazardous material, the operation of essential facilities (as described in discussions on PC-2 above), the protection of government property, and the protection of occupants of DOE buildings. The design and evaluation process should consider potential damage and failure of SSCs due to both direct natural phenomena effects, including common cause, and indirect natural phenomena effects, including interaction with other SSCs.

Interaction. The design and evaluation process must consider potential damage and failure of SSCs due to both direct natural phenomena effects (including common cause) and indirect natural phenomena effects due to the response of other SSCs (interaction). Examples of interaction include the following:

(1) failure of an SSC, which falls on an SSC important to safety or mission;

(2) impact damage due to displacements of adjacent SSCs;

(3) displacements of adjacent SSCs resulting in failure of connecting pipes or cables;

(4) SSCs (such as lighting, communication systems, access hallways and doors) whose failure following natural phenomena events could hinder necessary operator actions;
(5) flooding and exposure to fluids from vessels or piping systems ruptured during a natural phenomena event;
(6) offsite natural phenomena effects on the facility, such as NPH-induced loss of offsite power and failure of upstream dams and reservoirs; and
(7) effects of natural phenomena-induced fires.

Common Cause Effects. The occurrence of a natural phenomena event, especially earthquake, affects many or all SSCs in a facility or across an entire site. Hence, it is possible to have multiple natural phenomena-induced failures of SSCs. These common cause effects must be considered in design or evaluation. For example, multiple failures in a tank farm can result in loss of contents greater than that held in any single tank. The effects of this large quantity of tank contents on SSCs must be considered.

DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, provides guidance for the treatment of natural phenomena loads in the design of new facilities and the evaluation of existing facilities. The standard delineates design/evaluation procedures for SSCs assigned to each performance category. Based on the site hazard definition, the natural phenomena loads are determined, and responses to the natural phenomena loads are evaluated. The standard employs a graded approach to ensure that the level of conservatism and rigor in design or evaluation is appropriate for each SSC category. Design detailing provisions are required to conform to the model building codes; the quality assurance and peer review requirements are applied using the graded approach.

Wind Load Design methodology had been changed in ASCE 7-95 and ASCE 7-98. Therefore, an interim advisory on straight winds and tornados issued in January 1998 by the Director of the DOE Office of Nuclear Safety Policy and Standards for conforming to ASCE standards must be used in conjunction with DOE-STD-1020-94.

6.2.2 New Facilities

SSCs for new DOE facilities should be designed, constructed, and operated to meet the objectives of the design process in paragraph 1 above.

6.2.3 Additions and Modifications

Additions and modifications to existing DOE facilities should not degrade the performance of existing SSCs to the extent that the objectives in paragraph l above cannot be achieved under the effects of natural phenomena. New SSCs added to existing DOE facilities should be designed, constructed, and operated to meet the requirements in paragraph l above. Any modifications of existing DOE facilities should be designed, constructed, and operated to meet the requirements in paragraph 1 above.

6.3 Evaluation and Upgrade of Existing DOE Facilities

SSCs in existing DOE facilities should be evaluated in accordance with paragraph 1 of Section IV.2 when there is a significant degradation in the safety basis for the facility or if the provisions of Executive Order 12941 for existing facilities require a reevaluation of seismic mitigation. In general, a degradation of the safety basis would be identified as part of the USQ process.

If either of the conditions above are satisfied, the contractor/operator must establish a plan for evaluating the affected SSCs. The plan must incorporate a schedule for evaluation taking into account programmatic mission considerations, the safety significance of the potential failure of SSCs due to natural phenomena, and the cost/benefit of potential improvements. The evaluation plan and schedule must conform to the provisions that implement Executive Order 12941.

The evaluation would only be conducted for the "affected SSCs"; that is, those SSCs for which a safety function would be required after or during natural phenomena.

If the evaluation of existing SSCs identifies NPH mitigation deficiencies, the contractor/operator must evaluate the cost/benefit of potential improvements and establish an upgrade plan for cost-beneficial improvements. The upgrade plan must incorporate a prioritized schedule for upgrading the SSCs. The upgrade plan must address possible time or funding constraints, the cost/benefit of anticipated improvements, and programmatic mission considerations.

The plan to upgrade existing SSCs to eliminate NPH mitigation deficiencies must be consistent with the Interagency Committee on Seismic Safety in Construction Standard, RP-4, and meet the provisions thereof, as a minimum. Guidance on the implementation of ICSSC RP-4 provisions is given in IC SSC RP-5. As indicated in Executive Orders 12699 and 12941, it is the intent of the Federal Government to ensure that both new and existing Federal buildings provide life safety and prevent property loss in the event of a seismic occurrence.

For DOE facilities leased from a non-Federal agency, upgrades of SSCs with NPH mitigation deficiencies are not necessary according to the provisions of ICSSC RP-4. Rather, existing leases should not be renewed and new leases should not be made if NPH mitigation deficiencies exist.

6.4 Natural Phenomena Hazards Assessment

Earthquakes and other severe natural phenomena are the result of complex phenomena that are difficult to analyze and nearly impossible to predict. Earthquakes of significant magnitude are infrequent and are predominantly centered along the edges of tectonic plates. However, large earthquakes have occurred in other locations, and these events are the result of poorly understood geological processes. Other natural phenomena, such as tornados, hurricanes, floods, and fires, tend to be regionalized, but their frequency or recurrence and magnitude are also difficult to predict. Thus, selecting defensible and appropriate design loads for SSCs is challenging. Using information from historical records, regional geological maps, and other investigations, scientists can develop models for use in estimating the likelihood of natural phenomena of various magnitudes impacting a site. This information can then be applied by designers and builders to produce SSCs that are strengthened to resist the effects of these phenomena and thus reduce the risk to human life, essential property, and the environment. DOE-STD-1023 describes NPH assessment methods that are applicable to DOE sites.

Examples of natural phenomena to be considered in the hazard assessment are listed in Appendix C.

6.4.1 Hazard Assessment Methods

DOE-STD-1022 provides comprehensive guidance for investigating the site for NPHs. The guidance is general because of the wide variability in site characteristics. The most extensive requirements for NPH investigations (applied to PC-4) are consistent with those required by the Nuclear Regulatory Commission for commercial nuclear power reactor sites. A very thorough assessment of historical seismicity, geology, geotechnology, meteorology, and hydrology is required for the most hazardous facilities. All potential sources of severe natural phenomena must be identified, and their potential effect at the site must be evaluated. Investigations to establish the potential for soil failure, such as liquefaction and fault displacement, are required.

DOE-STD-1023, describes methods for conducting a Probabilistic Seismic Hazard Analysis (PSHA) to produce a seismic hazard curve to be used in selecting the design basis earthquake (DBE) for PC-3 and PC-4 SSCs.

A necessary part of seismic design is the selection of one or more design levels of ground motion. Because of the random nature of earthquakes, selection of a design level of ground motion inherently has a probability of occurrence associated with it. A site's seismic characteristic can be illustrated by a seismic hazard curve that is a graph of a parameter, such as peak ground acceleration, plotted against the annual probability of exceeding each specific value. If consensus building codes such as UBC are used, this selection is made by the code, employing seismic zone maps and a specified frequency spectrum. However, the UBC and DOE-STD-1023 both allow specific site investigation and development of a site-specific seismic hazard assessment for use in the design.

The USGS (1996) has recently published a National Seismic Hazard map. Complete seismic hazard curves are available from the USGS, and these should be obtained when implementing DOE-STD-1023-95. In the eastern United States it is recommended that use of the USGS curves be for hard rock sites conditions, and as a result the USGS should be contacted to complete the appropriate computations. Any site whose site-specific hazard curves exceed the USGS curves (for similar site conditions) should continue to use these site-specific curves. If this is not the case, and specifically for the eastern United States, the USGS curves should be appropriately factored into existing assessment of site-specific seismic hazard.

DOE-STD-1023 also discusses the shape of response spectra developed for an earthquake of a magnitude and distance generating motions with energy in a particular range of frequencies. The result of this analysis can be a family of response spectra appropriate for different source mechanisms or, conservatively, an envelope of such spectra. In some cases, the ordinates of the probabilistic response spectrum are computed directly at different frequencies, so the two steps are combined to yield a so-called uniform hazard spectrum. For details and constraints, refer to DOE-STD-1023 and DOE-STD-1020.

The methods for developing and using a seismic hazard curve have caused concern on the part of several experts. The two principal concerns are that (1) the methods are subject to considerable judgment and may be misused, and (2) there is a potential for the process to imply unwarranted certainty about the selected hazard and thereby lead to unrealistic confidence in the state of knowledge about the seismic hazard. Those experts who are critical of PSHA tend to support alternative methods such as prescriptive procedures for selection of the DBE. Seismic professionals call the first approach the "probabilistic method" and refer to the prescriptive approach as the "deterministic method." However, both methods have probabilistic and deterministic elements, and it would be more accurate to say that one is more probabilistic and the other is more deterministic.

DOE-STD-1023 has recognized these differences in approach and included a requirement to perform an independent check of the chosen DBE based on a set of prescriptive rules. The independent check uses historical earthquake experience and other rules to select the DBE for comparison with the selection based on PSHA. The final DBE selection would be the larger earthquake from the two approaches and should be consistent with the historic data for the region.

DOE-STD-1024-92 provides guidance on the use of the seismic hazard curves developed by the Lawrence Livermore National Laboratory (LLNL, June 1990) and the Electric Power Research Institute (EPRI). While both these methods have been widely used, experience has shown that these methodologies can yield significantly different results. In response to this issue, a Seismic Working Group was formed at DOE Headquarters to coordinate the use of these methodologies within DOE in a consistent manner. The position developed by the Seismic Working Group and contained in DOE Standard 1024 is intended for use in developing seismic hazard estimates for the evaluation of new and existing DOE facilities. However, more modern PSHA methods should be used where possible, as discussed in detail in DOE-STD-1023-95. A Senior Seismic Hazard Analysis Committee (SSHAC 1997) has issued a report on how PSHA should be conducted. This report should provide a valuable resource for seismic hazard assessment methods. As stated above, recently issued USGS (1996) seismic maps may also provide useful seismic hazard information.

6.4.2 Assessment Requirements

Section 4.4.4 of DOE O 420.1 requires an assessment of the likelihood of future NPH occurrence. The level of NPH assessment to be conducted should be appropriate for the performance categories being considered in a manner consistent with the graded approach. For sites containing facilities with SSCs in Performance Categories 3 and 4, a site-specific NPH assessment must be conducted in accordance with the applicable DOE standard. For sites containing facilities with SSCs only in Performance Categories 1 and 2 and that have no sitespecific NPH assessment, it is sufficient to use NPH maps from model building codes or national consensus standards. For sites with site-specific NPH assessments, the SSCs in Performance Categories 1 and 2 must be evaluated or designed for the greater of the site-specific values or the model code values unless site-specific values are lower and can be justified.

1. New Sites.

a. Assessment. For a new site containing SSCs in Performance Categories 3 and 4, a site-specific NPH assessment must be conducted in accordance with DOE Standard-1023. This NPH assessment must include adequate site-specific information as described in DOE-STD-1022.

b. Sitin . Site planning must consider all consequences of NPHs. For example, seismicity, geological hazards, and soil failure hazards must all be considered. Siting of structures over active geologic faults, in areas of instability subject to landslides, or where soil liquefaction is likely to occur must be avoided. In addition, structures must not be sited within flood plains where flood water depth and other flood effects at an annual probability of exceedance equal to or greater than the performance goal can adversely affect structural performance unless protection is provided (e.g., levees, or dikes). Special attention must be given to sites potentially subject to flooding from upstream dams or reservoirs including earthquake caused failures.

2. Existing Sites.

For an existing site, if there are significant changes in NPH assessment state-of-the-art or site-specific information, the NPH assessments must be updated. If SSCs of Performance Categories 3 and 4 are constructed or installed at an existing site that previously had only Performance Category l and 2 SSCs and/or that did not have a site-specific NPH assessment, a site-specific NPH assessment must be performed. A review of the state-ofthe-art of NPH assessment methodology and of site-specific information must be conducted at least every 10 years. The review should include recommendations to the cognizant secretarial officers (CSOs) on the need for updating the existing NPH assessments based on identification of any significant changes in methods or data. If no change is warranted from earlier assessment, then this only needs to be documented.

3. DOE Approval.

The hazard assessment for new sites or the reassessment and recommendations for existing sites, as available, must be submitted with the implementation plan as described in DOE-STD-1082-94.

6.5 Seismic Detection

Facilities or sites with SSCs in PC-2 (with hazardous material), PC-3, or PC-4 should have instrumentation, such as strong motion detectors or other means, to detect and record the occurrence and severity of seismic events. In those cases where safety analysis identifies the need for rapid response reactions, annunciation of seismic event should be considered for personnel evacuation or other vital mitigative actions. For a large site, several representative facilities spread over the site must have such instrumentation.

6.6 Post-Natural Phenomena Procedures

Facilities or sites that have SSCs in PC-2, PC-3, or PC-4 must have procedures to inspect the facility for damage due to a severe natural phenomena event, to place the facility into a safe configuration when damage occurs, and to document and report such damage.

7. IMPLEMENTATION

Contractors must submit implementation plans to DOE. Most contractors will have prepared implementation plans that meet the requirements of DOE 5480.28, and these will be considered acceptable. DOE will work with contractors in the development of any new plans and will seek mutual agreement on how and when to achieve compliance. However, DOE will act to fulfill its obligation to ensure the safe operation of its facilities and, if agreement cannot be reached with a contractor, DOE will exercise its authority to modify submitted plans to include actions and schedules appropriate for achieving compliance in a reasonable manner. Moreover, DOE will review implementation of the plans and, if necessary, require appropriate modifications to an approved plan. Specific guidance on the preparation of the implementation plan is provided in DOE-STD-1082-94. The implementation plan must be integrated with the safety review process required in Section 6 of DOE O 420.1. However, actions required under Executive Orders 12699 and 12941 must proceed as per the requirements of the Executive Orders.

7.1 Implementation Steps

1. Establish performance categories for SSCs using DOE-STD-1021.

2. Perform site-specific studies of site characteristics using the methods given in DOE-STD-1022, or evaluate existing data for site characteristics related to NPH and augment with site-specific studies where needed in accordance with DOE Standard 1022.

3. Perform NPH assessment of the site in accordance with DOE Standard 1023. Include consideration of using recently issued USGS (1996) seismic hazard information and the SSHAC (1997) report.

4. Design and construct new SSCs or evaluate existing SSCs. Specified annual probabilities of exceedance for NPHs to establish loadings, deterministic design methods for response evaluation, permissible response levels, load combination rules, design detailing requirements, and quality assurance and independent peer review requirements are provided in DOE Standard 1020. The Standard provides sufficient documentation to

    a. communicate the process, rationale, and results of the NPH evaluation;

    b. present information that can be evaluated during peer reviews; and

    c. provide traceability and a basis for future assessments.

Provisions for seismic design and evaluation of high-level waste storage tanks and related SSCs could be obtained from the BNL Seismic Design and Evaluation Guidelines (BNL 52361, Rev. 10/95).

5. Establish a prioritized schedule for reevaluation and upgrade of existing facilities when there is a significant degradation in the safety basis for the facility, or when Executive

Order 12941 requires that this be done. A prioritization program will direct initial efforts to facilities of greatest importance in terms of safety, mission, and cost. A screening program will enable relatively rapid initial evaluations to be conducted such that areas of greatest vulnerability to natural phenomena effects can be identified and addressed. Areas where SSCs might not be vulnerable to natural phenomena effects due to inherent ruggedness or benign site conditions can be identified and eliminated from further consideration.

7.2 Implementation at New and Existing Facilities

1. New Sites. In addition to the nuclear safety requirements of the DOE O 420.1, Executive Order 12699 provides requirements for protecting life safety for seismic hazards.

2. Existing Sites. Required actions depend on the status of site characterization and NPH assessment. In addition to the nuclear safety requirements of DOE O 420.1, Executive Order 12941 provides requirements for protecting life safety for seismic hazards.

3. New SSCs. In addition to the nuclear safety requirements of DOE O 420.1, Executive Order 12699 provides requirements for protecting life safety for seismic hazards. Thus, this Guide is to be used in conjunction with the ICSSC Implementation Guide for new facilities (ICSSC RP-2.l-A).

4. Existing SSCs. The implementation plan for evaluation and upgrade of existing SSCs must be completed and submitted to the CSO.

5. Leased Facilities. DOE facilities that are leased from a non-Federal Agency must meet the requirements of DOE O 420.1 with one exception: upgrades of NPH deficiencies are not required for DOE facilities under a current lease agreement. However, such leases should not be renewed when they expire. (See RP-4, Section 1.3.2.)

APPENDIX A

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APPENDIX B

DEFINITIONS

Accident. An unplanned sequence of events that results in undesirable consequences.

Additions and Modifications. Changes to a structure, system, and component for reasons other than increasing resistance to natural phenomena hazards.

Design Basis. Information that identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or range of values chosen for controlling parameters as reference bounds of design. These values may be (1) restraints derived from generally accepted "state of the art" practices for achieving functional goals or (2) requirements derived from analyses (based on calculations and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals.

Design Basis Accident. An accident postulated for the purpose of establishing functional and performance requirements for safety structures, systems, and components.

Deterministic Method. The technique in which a single estimate of parameters is used to perform each analysis. To account for uncertainty, several analyses may be conducted with different parameters.

Existing Facility. A DOE facility that has received authorization to operate on or before the effective date of the requirement, or if authorization is not required, a DOE facility that has begun normal operation on or before the effective date of the requirement.

Facility. For the purpose of this Guide, the definition most often refers to buildings and other structures, their functional systems and equipment, and other fixed systems and equipment installed therein to delineate a facility. However, specific operations and processes independent of buildings or other structures (e.g., waste retrieval and processing, waste burial, remediation, groundwater or soil decontamination, decommissioning) are also encompassed by this definition. The flexibility in the definition does not extend to subdivision of physically concurrent operations which have potential energy sources that can seriously affect one another or which use common systems fundamental to the operation (e.g., a common glove-box ventilation exhaust header).

Function. The capability of structures, systems, and components to perform their intended mission. Maintaining function after an NPH occurrence is required by the NPH Order for SSCs important to safety, and to minimize property losses based on cost benefit considerations. Maintaining function such that programmatic objectives are achieved is not required by the NPH Order but is commonly a goal for NPH design and evaluation.

Graded Approach. A process by which the level of analysis, documentation, and actions necessary to comply with a requirement in this Part are commensurate with

the relative importance to safety, safeguards, and security;
the magnitude of any hazard involved;
the life cycle stage of a facility;
the programmatic mission of a facility;
the particular characteristics of a facility; and any other relevant factor.

Hazard. A source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to an operation or to the environment (without regard for the likelihood or credibility of accident scenarios or consequence mitigation).

Hazard Analysis. The determination of material, system, process, and plant characteristics that can produce undesirable consequences, followed by the assessment of hazardous situations associated with a process or activity. Largely qualitative techniques are used to pinpoint weaknesses in design or operation of the facility that could lead to accidents. The SAR hazard analysis examines the complete spectrum of potential accidents that could expose members of the public, onsite workers, facility workers, and the environment to hazardous materials.

Hazard Classification. Evaluation of the consequences of unmitigated releases to classify facilities or operations into the following hazard categories.

Hazard Category 1: The hazard analysis shows the potential for significant offsite consequences.
Hazard Category 2: The hazard analysis shows the potential for significant onsite consequences.
Hazard Category 3: The hazard analysis shows the potential for only significant localized consequences.

DOE-STD-1027-92 provides guidance and radiological threshold values for determining the hazard category of a facility. DOE-STD-1027-92 interprets Hazard Category 1 facilities as Category A reactors and other facilities designated as such by the Program Secretarial Officer.

Hazardous Material. Any solid, liquid, or gaseous material that is chemical, toxic, explosive, flammable, radioactive, corrosive, chemically reactive, or unstable upon prolonged storage in quantities that could pose a threat to life, property, or the environment.

Model Building Codes. Codes that contain design and construction requirements that apply to normal commercial buildings (e.g., 1994 ICBO Uniform Building Code, UBC, the 1993 Supplement to the BOCA National Building Code, and the 1994 Amendments to the SBCCI Standard Building Code).

Natural Phenomena Hazard (NPH). An act of nature (for example, earthquake, wind, hurricane, tornado, flood, precipitation (rain or snow), volcanic eruption, lightning strike, or extreme cold or heat) that poses a threat or danger to workers, the public, or to the environment by potential damage to structures, systems, and components (SSCs).

New Facility. A DOE facility that does not qualify as an existing facility.

NPH Mitigation. An action taken to reduce the impacts of Natural Phenomena Hazards. This includes natural phenomena hazard-resistant design, evaluation, construction requirements, and operational procedures.

Nonreactor Nuclear Facility. Those activities or operations that involve radioactive and/or fissionable materials in such form and quantity that a nuclear hazard potentially exists to the employees or the general public. Included are activities or operations that

produce, process, or store radioactive liquid or solid waste, fissionable materials, or tritium;
conduct separations operations;
conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations;
conduct fuel enrichment operations;
perform environmental remediation or waste management activities involving radioactive materials.

Incidental use and generation of radioactive materials in a facility operation (e.g., check and calibration sources and use of radioactive sources in research, experimental, and analytical laboratory activities, electron microscopes, and x-ray machines) would not ordinarily require the facility to be included in this definition.

Nuclear Facility. Reactor and nonreactor nuclear facilities.

Nuclear Safety. Those aspects of safety that encompass activities and systems that present the potential for uncontrolled releases of fission products or other radioactive materials to the environment or for inadvertent criticality.

Performance Category (PC). A classification using a graded approach in which structures, systems, or components in a category are designed to ensure similar levels of protection (i.e., meet the same performance goal and damage consequences) during natural phenomena hazard events.

Probabilistic Method. A technique that uses distributions of parameters (including uncertainty and randomness) to perform an analysis. Results are expressed in terms of probabilistic distributions that quantify uncertainty.

Public. All individuals outside the DOE site boundary.

Reactor. Unless modified by words such as "containment," "vessel," or "core," "reactor" is the entire nuclear reactor facility, including the building/structure, equipment, and associated areas devoted to the operation and maintenance of one or more reactor cores. Any apparatus that is designed or used to sustain nuclear chain reactions in a controlled manner, including critical and pulsed assemblies and research, test, and power reactors, is defined as a reactor. All assemblies designed to perform subcritical experiments that could potentially reach criticality are also considered to be reactors. Critical assemblies are special nuclear devices designed and used to sustain nuclear reactions. Critical assemblies may be subject to frequent core and lattice configuration change and may be used frequently as mockups of reactor configurations. Therefore, requirements for modifications do not apply unless the overall assembly room is modified, a new assembly room is proposed, or a new configuration is not covered in previous safety evaluations (i.e., Safety Analysis Reports, Safety Analysis Report Addenda, or Technical Safety Requirements).

Release. Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or otherwise disposing of substances into the environment. This includes abandoning/discarding any type of receptacle containing substances or the stockpiling of a reportable quantity of a hazardous substance in unenclosed containment structures.

Risk. The quantitative or qualitative expression of possible loss that considers both the probability that an event will occur and the consequence of that event.

Safety Analysis. A documented process to

provide systematic identification of hazards within a given DOE operation;
describe and analyze the adequacy of the measures taken to eliminate, control, or mitigate identified hazards; and
analyze and evaluate potential accidents and their associated risks.

Safety Analysis Report (SAR). A report that documents the adequacy of safety analysis to ensure that a facility can be constructed, operated, maintained, shut down, and decommissioned safely and in compliance with applicable laws and regulations.

Safety Basis. The combination of information relating to the control of hazards at a facility (including design, engineering analyses, and administrative controls) upon which DOE depends for its conclusion that activities at the facility can be conducted safely.

Structures, Systems, and Components (SSCs).

Structure is an element, or a collection of elements, to provide support or enclosure, such as building, free standing tank, basins, dikes, or stacks.

System is a collection of components assembled to perform a function, such as piping, cable trays, conduits, or HVAC.

Component is an item of equipment, such as a pump, valve, or relay, or an element of a larger array, such as a length of pipe, elbow, or reducer.

Safety-class Structures, Systems, and Components (Safety-class SSCs). Structures, systems, or components whose preventive or mitigative function is necessary to keep hazardous material exposure to the public below the offsite Evaluation Guidelines.

Safety-significant Structures, Systems, and Components (Safety-significant SSCs). For full discussions, refer to DOE-STD-3009 and DOE G 420.1X. Structures, systems, and components not designated as safety-class SSCs, but whose preventive or mitigative function is a major contributor to defense in depth (i.e., prevention of uncontrolled material releases) and/or worker safety as determined from hazard analysis.

Safety Structures, Systems, and Components (Safety SSCs). The combined set of both safety-class and safety-significant structures, systems, and components for a given facility.

Site. A geographic entity comprising leased or owned land, buildings, and other structures required to perform program activities.

Site Boundary. A well-marked boundary of the property over which the owner or operator can exercise strict control.

Upgrade. A design and construction measure taken to increase the resistance of structures, systems, and components to the effects of natural phenomena hazards. Upgrade, strengthening, and retrofit are equivalent terms.

APPENDIX C

NATURAL PHENOMENA HAZARDS TO BE ADDRESSED

(Per Existing Model Building Codes or

**Consensus Industry Standards Where There's
No Specific Guidance is Provided)**

Primary Natural Phenomena Hazards:

Earthquakes
Volcanic Events
Tornadoes
Hurricanes
High Winds
Floods
Excessive rains
Excessive snow
Ice cover
Lightning
Forest fires

Secondary Natural Phenomena Hazards:

Drought
Fog
Frost
High Temperatures
Low Temperatures
Landslides
Subsidence
Surface Collapse
Uplift
Storm surges
Waterspouts