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NOT MEASUREMENT SENSITIVE

DOE-STD-1020-2002
January 2002

Superseding
DOE-STD-1020-94
April 1994

DOE STANDARD

NATURAL PHENOMENA HAZARDS DESIGN AND EVALUATION CRITERIA FOR DEPARTMENT OF ENERGY FACILITIES

U.S. Department of Energy
Washington, D.C. 20585

AREA NPHZ

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Foreword

This revision provides information to help meet the requirements of 10 CFR Part 830, "Nuclear Safety Management," (for Nuclear Facilities), DOE O 420.1 and its associated Guides, accounting for cancellation of DOE O 6430.1A and updating this standard to most current references. This standard has also been brought up-to-date to match the requirements of current model building codes such as IBC 2000 and current industry standards.

Since the publication of DOE-STD-1020-94 several new documents have been published which made the seismic design standards of DOE-1020-94 outdated.

- The 1997 *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures Parts 1 and 2* introduced new seismic maps for evaluating the seismic hazard.

- The three model building codes UBC, BOCA, and SBCCI were replaced by the *International Building Code* (IBC 2000), which adopted the 1997 NEHRP seismic provisions.

- DOE Order 420.1 and the associated guide, DOE G 420.1-2, were approved and adopted the use of IBC 2000 for PC-1 and PC-2 facilities.

Since DOE-STD-1020-94 adopted the UBC for the seismic design and evaluation of PC-1 and PC-2 structures, it was necessary to accommodate the use of the IBC 2000 instead of the UBC for DOE facilities. The seismic hazard in the IBC 2000 is provided by maps that define the seismic hazard in terms of the Maximum Considered Earthquake (MCE) ground motions. Except for locations on or near very active known faults, the maps contain accelerations that are associated with a 2500-year return period earthquake. The ground motions associated with MCE ground motions as modified by the site conditions are used for the design and evaluation of PC-1 and PC-2 structures in this revised DOE standard. The graded approach is maintained by applying a 2/3 factor for PC-1 facilities, and a factor of unity for PC-2 facilities. At the same time PC-3 design ground motions have been adjusted from a 2,000 year return period to a 2,500 year return period.

This differs from DOE-STD-1020-94 where different return periods of 500, 1000, 2000 (1000)[1], and 10,000 (5000)[1] years were used for PC-1, PC-2, PC-3, and PC-4, respectively. Also, specific performance goals were established for each performance category (PC-1 thru PC-4). These performance goals (in terms of a mean annual probability of failure) were based on a combination of the seismic hazard exceedance levels and accounting for the level of conservatism used in the design/evaluation. In this revised standard the performance goals for PC-1 and PC-2 facilities are not explicitly calculated but are consistent with those of the IBC

[1] Numbers in parenthesis are for locations near tectonic plate boundaries.

2000 for Seismic Use Group I and III, respectively[2]. For PC-3 SSCs there is no change to the performance goal when compared to the previous version of this standard. This was accomplished by making a slight adjustment to the PC-3 scale factor. Thus, it is not the intent of this revision to alter the methodology for evaluating PC-3 facilities nor to increase the performance goal of PC-3 facilities by increasing return period for the PC-3 DBE from a 2000-year earthquake to a 2500-year earthquake. Rather, the intention is more for convenience to provide a linkage from the NEHRP maps and DOE Standards. All PC-3 SSCs which have been evaluated for compliance with the previous version of this standard do not require any re-evaluation considering that the PC-3 level of performance has not changed.

Major revisions to DOE-STD-1020-94 were not attempted because of ongoing efforts to develop an ASCE standard for seismic design criteria for Nuclear Facilities. Referring the design of PC-1 and PC-2 facilities to building codes (such as the IBC 2000) is consistent with design criteria in the proposed ASCE standard.

Some of the major impacts of the above changes are identified below:

1. Use of IBC 2000, International Building Code for PC-1 to be designed as Seismic Use Group I and PC-2 to be designed as Seismic Use Group III.
2. Use of seismic hazard exceedance probability of $4x10^{-4}$ in place of $5x10^{-4}$ in current STD for PC-3 facilities.
3. Use of wind advisory for design of SSCs for straight wind referenced in DOE G 420.1-2. In addition tornados wind speeds should be based on the tornado hazards methodology of LLNL (Ref. 3-14). For steel structures, guidance per SAC (see Chapter I) should be followed based on Northridge experience. For existing buildings evaluation and upgrades, RP-6 is minimum criteria. In addition, the references in Chapter 1 have been updated for current use.

There is an established hierarchy in the set of documents that specify NPH requirements. In this hierarchy, 10 CFR Part 830 (for Nuclear Facilities only) has the highest authority followed by DOE O 420.1 and the associated Guides DOE G 420.1-1 and DOE G 420.1-2. The four NPH standards (DOE-STDS-1020, 1021, 1022, 1023) are the last set of documents in this hierarchy. In the event of conflicts in the information provided, the document of higher authority should be utilized (e.g., the definitions provided in the Guides should be utilized even though corresponding definitions are provided in the NPH standards).

The Department of Energy (DOE) has issued DOE O 420.1 which establishes policy for its facilities in the event of natural phenomena hazards (NPH) along with associated NPH mitigation requirements. This DOE Standard gives design and evaluation criteria for NPH effects as guidance for implementing the NPH mitigation requirements of DOE O 420.1 and the associated Guides. These are intended to be consistent design and evaluation criteria for

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[2] Refer to the 1997 NEHRP Provisions for a description of the performance goals associated with Seismic Use Groups.

protection against natural phenomena hazards at DOE sites throughout the United States. The goal of these criteria is to assure that DOE facilities can withstand the effects of natural phenomena such as earthquakes, extreme winds, tornadoes, and flooding. These criteria apply to the design of new facilities and the evaluation of existing facilities. They may also be used for modification and upgrading of existing facilities as appropriate. It is recognized that it is likely not cost-effective to upgrade existing facilities which do not meet these criteria by a small margin. Hence, flexibility in the criteria for existing facilities is provided by permitting limited relief from the criteria for new design. The intended audience is primarily the civil/structural or mechanical engineers familiar with building code methods who are conducting the design or evaluation of DOE facilities.

The design and evaluation criteria presented herein control the level of conservatism introduced in the design/evaluation process such that earthquake, wind, and flood hazards are treated on a consistent basis. These criteria also employ a graded approach to ensure that the level of conservatism and rigor in design/evaluation is appropriate for facility characteristics such as importance, hazards to people on and off site, and threat to the environment. For each natural phenomena hazard covered, these criteria consist of the following:

1. Performance Categories and target performance goals as specified in the Appendices B and C of this standard.

2. Specified probability levels from which natural phenomena hazard loading on structures, equipment, and systems is developed.

3. Design and evaluation procedures to evaluate response to NPH loads and criteria to assess whether or not computed response is permissible.