DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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June 13, 1995

The Honorable Tara O'Toole
Assistant Secretary for Environment,
Safety and Health
Department of Energy
Washington, DC 20585

Dear Dr. O'Toole:

As a follow-up to Dr. Cunningham 's letter to Mr. Black on February 7, 1995, the Defense Nuclear Facilities Safety Board's staff and outside experts prepared a review on DOE-STD-1023-94, "Natural Phenomena Hazards Assessment Criteria." This consolidated review is enclosed for your consideration. The following is a summary of the main concerns:

- It is believed that the intent of the standard would be better served if the contents are segregated into the following three distinct parts: Acceptance Criteria, Commentary and Tutorial.

- As Standards 1020 and 1023 are companion documents, it is highly desirable that existing conflicts and overlaps, which can lead to difficulties during applications, are carefully edited. In fact, a clearer delineation of contents between these two standards is necessary. The enclosed review provides a suggestion on how to achieve such separation.

- Constraints on reviewers--except for composition of panel, required credentials, and scope of review--are considered inappropriate.

On the technical level, the review indicates no significant concerns regarding the section on floods, some suggestions for a minimum tornado assessment for moderate and high hazard facilities, and a large number of concerns for the seismic section. The more significant seismic concerns are highlighted below:

- The redefinition of deterministic ground motion in probabilistic terms does not help resolve the ongoing debate on probabilistic versus deterministic ground motion criteria.

- The de facto elimination of an important frequency band (2.5-5 Hz) in the development of the probabilistic ground motion is questionable considering the types of high hazard structures throughout the complex where this frequency band would be important.

- Criteria are missing that would directly consider both probabilistic and deterministic ground motions and reconciliation of significant differences, if any.

- Geotechnical issues such as liquefaction, slope stability, lateral spreading and subsidence are response related concerns and are better treated, similar to the treatment of structures in DOE-STD-1020, in a separate document.

- The standard is silent on important issues such as long period effects, duration of ground shaking, high frequency large impulses, what constitutes "nearness" to tectonic boundaries, and how to simplify PSHA for moderate hazard structures.

The Board's staff is prepared to discuss and resolve these concerns with the authors of the subject standard. Please contact Dr. Cunningham at 202/208-6554 to arrange a mutually convenient time.

Sincerely,

John T. Conway
Chairman

Enclosure

c: Mr. Richard L. Black
Mr. Mark Whitaker

Consolidated Review Comments by Staff and Outside Experts

Draft Standard DOE-STD-1023, November 1994
NATURAL PHENOMENA HAZARDS ASSESSMENT CRITERIA

The objective of this standard is to provide the requirements (criteria) for establishing adequate natural phenomena hazards (NPH) design basis load levels, which are required information to implement DOE-STD-1020-94 (1020). As the title of the standard indicates, issues related to the definition of manmade hazards, such as aircraft crash, accidental explosion, toxic material release and malevolent vehicles are not considered. Sections 1 (Scope), 2 (Applicable Documents), and 3 (Definitions) take up the first 10 pages. Seismic criteria dominate the document with 19 pages. Wind criteria take up only six pages and Flood criteria 10 pages. Review comments are provided under two main headings: General (primarily addressing major editorial concerns) and Technical.

GENERAL

The intent of the standard would be better served if the primary focus of the document shifts to defining *acceptance criteria* for the methodologies that are being used to estimate NPH load levels throughout the DOE complex. As it is presently structured, the standard attempts to cover several fronts simultaneously: The contents are a mixture of performance specifications (minimal), prescriptive step-by-step procedures (for major deliverables), and commentary (sprinkled throughout the document). These are at odds with both the title and the foreword of the standard. Once the acceptance criteria are segregated from the rest of the document, separate step-by-step recommended procedures/methods for producing the end products and an appropriate commentary could be prepared and included as Appendices if deemed necessary or even desirable.

Conflicts and overlaps with 1020, which could contribute to difficulties during applications of both standards, should be carefully edited. For example, Section 5.2.1.e of 1023 specifies that "a probabilistic wind hazard shall be conducted at a level appropriate for the performance categories of the SSCs at a site." This appears to be in conflict with Section D.1 of 1020, which does not require the use of a probabilistic wind hazard assessment, but relies on the methodology presented in ASCE 7. A clearer focus for this standard would minimize the level of conflicts and overlaps with 1020 requirements. Obviously 1020 and 1023 are companion documents and a better delineation of contents is necessary. Two alternatives are suggested:

1. All material on load levels may be edited out from 1020 and incorporated into this standard as appropriate and 1020 dedicated to only response analysis methodologies for NPH loads. Decoupling of load specification and response analysis is desirable during times of evolutionary developments in both. The temptation for easy, compensatory requirements might thus be eliminated.

2. The load level acceptance criteria in this standard could be subsumed into 1020 and the present document modified to become a stand-alone Commentary on 1020 and a Tutorial on recommended procedures.

Although several paragraphs are devoted to the *independent* review of the specification and assessment of NPH loads, prescriptive requirements are made relative to what is acceptable and what is not acceptable (section 5.1.5). By definition, independent reviewers should be left alone to determine if a given result is acceptable or not. The requirements for an independent review should be limited only to the composition of the review panel, the required credentials of the panelists and a general scope or level of the review.

TECHNICAL

Seismic: This Section reiterates, in general terms, the steps of how to generate:

1. Probabilistic hazard curves for both zero period acceleration (ZPA) and spectral amplification, for two rather arbitrarily selected frequency bands (which, incidentally, miss the very important frequency band of 2.5-5 Hz for reinforced concrete shear wall structures); and

2. How to deaggregate the results of the probabilistic seismic hazard assessment (PSHA) to obtain *controlling* magnitude and distance sets for the preselected frequency bands. This deaggregation is erroneously characterized as the *deterministic* approach (section 5.1.3.1).

Any deterministic approach should employ an *independent* methodology, as for example described in the Draft Regulatory Guide DG-1015. Moreover, the use and mixing of median, mean, 84th percentile ZPAs, analytic and empirical spectral shapes, needs to be clarified and a rational basis for the use of one or the other provided. The selection of means, medians and other fractiles should be based on sound technical arguments. Having a rational basis becomes particularly important when the concept of a *unified* approach is being promoted for seismic, wind and flood. Obviously, the selection of any exceedance fractile cannot be made without considering the inherent safety factors employed in the design process *and* the ultimate target reliability of a given structure, system or component (SSC).

It is expected that significant differences would exist between probabilistically and deterministically generated ground motions, particularly, when close-in faults or seismogenic regions are known to generate characteristic earthquakes. These differences should be explainable, since both the deterministic and probabilistic ground motions stem from the same basic site geology and seismology. Having explained and reconciled the different results, the *design basis* ground motion could then be specified based on the specific geologic and geotechnical facts at each site. Ground motions based on the so-called *controlling* magnitude and distance sets may not even be compatible with local site characteristics, except maybe in an average sense.

Except for fault offset estimation (as a possible design basis), earthquake induced ground failure modes, such as liquefaction, slope stability, lateral spreading and subsidence, are related to the *response* of soils subjected to ground shaking and thus must be covered outside of this standard, in a manner similar to, for example, the treatment of structures in 1020. However, the characterization of ground motion with adequate energy in the frequency range of engineering interest and/or duration of strong shaking is an important issue that needs to be directly addressed in the acceptance criteria. For example, liquefaction, slope stability and tank hydrodynamic analyses require that long period and long duration effects be adequately modeled into the design ground motions. Similarly, high frequency large impulses (thought to have caused the many cracks in the welded beam-column connections of steel high-rise buildings during the Northridge earthquake) should also be adequately considered in the specifications of the design ground motions.

The following is a sample of specific concerns:

- A choice, from among three methods, is provided to generate site specific spectra without any requirements as to how to select the one that is most appropriate. Differences in these spectra would suggest that some sensitivity checks be made during the selection process.

- A similar concern as above relates to the choice of control points where design ground motions are specified.

- Criteria to decide when a site is *near* a tectonic boundary is missing. And the basis for the different multipliers (1.5 and 1.25) requires justification.

- The level of simplification of the PSHA that would be acceptable for PC-3 is not provided.

- The use of existing hazard curves simply because they exist is questionable. Some evaluation as to the adequacy of the existing curves needs to be established.

- The use of the deterministic site spectra cannot be a choice by the user. Deterministic spectra should always be considered as a sanity check on the final ground motion selected.

Wind: It is not clear why industry standards (i.e., ASCE 7-93 and ANS 2.3) are not used to define *minimum* wind hazards, as the data base of extreme wind, particularly tornadoes, is not robust enough to apply on a site specific basis. Additionally, for PC-4 and PC-3 facilities a minimum tornado assessment should be considered (e.g., Fujita 2-157mph and Fujita 1-112 mph, respectively). It would also be prudent to require the exploration of other types of wind (e.g., "microbursts") that could be characteristic of certain sites.

Flooding: No significant concerns.