

APPLICATION OF PROJECT DESIGN PEER REVIEW
TO IMPROVE QUALITY ASSURANCE

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ABSTRACT

DOE ORDER 5481.1B "Safety Analysis and Review Systems" and DOE ORDER 6430.1A "General Design Criteria" require that the design of facilities shall incorporate the necessary Quality Assurance review requirements to assure that the established program quality assurance objectives are met in the design criteria and the construction documents. The use of Project Design Peer Review to satisfy these requirements is presented.

The University of California manages the Lawrence Berkeley Laboratory, the Lawrence Livermore National Laboratory, and the Los Alamos National Scientific Laboratory. The 1988 University Seismic Safety Policy requires the use of independent Project Design Peer Review in its capital improvement and seismic reconstruction program.

INTRODUCTION

The principle of independent review of the seismic safety of critical facilities is a well-established element of good practice and a necessary measure for public health and safety. A critical facility is any structure housing or serving large numbers of people or otherwise posing unusually high hazard to public health and safety in the event of damage or malfunction due to an earthquake. These critical facilities may include (1) facilities that could pose hazard to life and property well beyond their immediate surroundings, (2) facilities whose continued functioning is necessary to maintain public health and safety during and following a destructive earthquake, and (3) public or private structures for housing or assembly of large populations, where failure could pose hazards to life and property within

the structures and in their immediate surroundings. [1]

Independent review is the autonomous and objective review of a proposed project by qualified individuals who hold no personal interest or claim in the project, and who are in no way beholden to those proposing or opposing the project. In the State of California, in the field of seismic safety, the classic cases of independent reviews in the United States are those conducted by public-sector agencies, i.e., the Office of the California State Architect, Structural Safety Section, in reviewing public school and hospital design and construction, and the Division Safety of Dams in reviewing design and construction and operation of dams and reservoirs built by local governments, individuals and corporations. [1]

The following sections present the

background, requirements, guidelines and recommendations for establishing and implementing a project design peer review process for use by the Department of Energy and its Contractors.

DEPARTMENT OF ENERGY

DOE ORDER 5481.1B, "Safety Analysis and Review System" has broad requirements and DOE ORDER 6430.1A, "General Design Criteria" has more specific requirements for the review of project design and construction documents.

DOE ORDER 5481.1B's purpose is to establish uniform requirements for the preparation and review of safety analyses of DOE operations, including identification of hazards, their elimination or control, assessment of the risk, and documented management authorization of the operations. This Order requires a safety analysis which, in part, requires the identification and demonstrated conformance with applicable guides, codes, and standards. It also requires evaluation and documentation in the facility safety analysis report of deviations from current DOE design criteria. DOE ORDER 5481.1B requires the documentation of all pertinent details of the analysis, review, and authorization relative to any DOE operation to be traceable from the initial identification of a hazard to its elimination or the application of controls necessary to appropriately reduce the risk.

DOE ORDER 6430.1A's purpose is to provide general design criteria (GDC) for use in the design of DOE facilities. It requires that facility design shall incorporate the necessary Quality Assurance requirements to assure that the established program and project quality assurance objectives are satisfied. Important to satisfying these objectives is the assurance that the project construction documents (drawings and specifications) conform to the project design codes, standards and other project requirements. For buildings and other structures designed to resist earthquake forces, DOE 6430.1A, Section 0111-2.7.1 requires an independent

review of the seismic design be made for facilities and buildings where a seismic event can have a potential risk to operator lives, to public safety, or of large economic loss. The review shall be made in two stages - the first at the end of preliminary design and the second before final design is complete. For additional guidance on independent reviews, see LBL-9143 and UCRL 15910.

DOE ORDER 6430.1A has Quality Assurance requirements related to the review of design and construction documents (drawings and specifications) and structural design calculations. Specifically, Section 0140, QUALITY ASSURANCE, requires that an adequate QA program provides the following assurances: (1) the design will satisfy program and project requirements, (2) the prepared drawings and construction specifications adequately incorporate QA requirements, (3) construction can be performed in accordance with design, and (4) tests confirm the adequacy of design and quality of construction and manufactured components, where appropriate. This Order also requires that provisions shall be made for review and checking design calculations, drawings, and construction specifications by qualified personnel, other than those responsible for the original design. To the extent practicable, and particularly in the case of innovative design, the design shall be reviewed by competent consultants in construction or manufacturing techniques to confirm the practicability of construction or manufacture.

LBL REPORT-1943, "SEISMIC SAFETY GUIDE"

DOE 6430.1A recommends application of the recommendations in LBL Report 9143, "Seismic Safety Guide," September 1983, for practical guidelines for earthquake engineering safety and management planning and technical procedures for the design of new facilities and evaluations of existing facilities. LBL Report 9143 outlines procedures for cost-effective plan-checks or "third-party" reviews of structural/seismic designs and evaluations.

Independent structural and seismic design reviews should be made by an independent consultant. These reviews should

be made at two stages for major facilities, facilities having a potential risk to life safety due to the process contained therein, or facilities with a potentially large economic loss. The first review should be made at the end of the preliminary design or Title I services, and the second, separate review when the final design is completed, but before bids are taken.

The structural/seismic design reviews should include design philosophy, criteria used, framing system, construction materials, and other factors pertinent to the seismic capability of the proposed facility. Particularly important in the review is the check for a continuous load path, or paths, and for the adequacy of their strength and stiffness to transfer seismic forces from point of application to final point of resistance. In sum, peer review by an independent consultant or peer group need not provide a detailed check of the spacing of reinforcing bars, but rather an overview to help identify oversights, errors, conceptual deficiencies and other elements likely to cause problems during and after construction. Peer reviews can catch costly design mistakes in judgment, calculations, or philosophy. For a major facility, an independent peer review could more than pay for itself by uncovering design deficiencies before they are cast in concrete or constructed in steel.

The procedures outlined in the "Seismic Safety Guide" have been implemented at the Lawrence Berkeley Laboratory since the beginning of its seismic safety program in 1972. These procedures are recommended for consideration and use by DOE and its Contractors.

UCRL DRAFT REPORT 15910

UCRL Draft Report 15910, April 1988, "Design and Evaluation Guidelines for the Department of Energy Facilities Subject to Natural Phenomena Hazards," requires more specific Quality Assurance procedures than DOE Order 6430.1A. For General Use, Low, Moderate and High Hazard facilities, a peer review of

engineering drawings and calculations and other quality assurance measures are prescribed. For Important or Hazardous facilities, all aspects of the design or evaluation must be included in an independent peer review.

Specifically, Section 3.4 of UCRL 15910, "Quality Assurance and Peer Review" states "To achieve well designed and constructed facilities resistant to natural phenomena hazards or to assess whether existing facilities are well designed and constructed for natural phenomena hazard effects, it is recommended that important hazardous (Categories II, III, and IV) or unusual facilities be designed or evaluated utilizing an engineering quality assurance plan. Specific details about the engineering quality assurance plans depend on the natural phenomena hazard considered. As a result, such plans are described in some detail in each of the remaining chapters of this document." UCRL 15910 also states, "In general, an engineering quality assurance plan should include the following requirements. On the design drawings or evaluation calculations, the engineer of record must describe the hazard design basis including: (1) description of the system resisting hazard effects, and (2) definition of the hazard loading used for the design or evaluation. Design or evaluation calculations should be checked for numerical accuracy and for theory and assumptions. (The author has recommended the following wording be added in text of Section 3.4, "Construction drawings and specifications should be peer reviewed to verify that these design assumptions are implemented in the construction documents.") For new construction, the engineer of record should specify a material testing and construction inspection program. In addition, the engineer of record should review all testing and inspection reports as well as periodically make site visits to observe compliance with plans and specifications. For important or hazardous facilities, all aspects of the design or evaluation must include independent peer review. For various reasons, a designer may not be able to devote as much attention to

natural phenomena hazard design as he might like. Therefore, it is required to have the design reviewed by a qualified, independent consultant or group ... for major hazardous facilities, it may be prudent to have concurrent independent evaluations performed or to have the evaluation independently reviewed."

UNIVERSITY OF CALIFORNIA

The University of California manages and operates the Lawrence Berkeley Laboratory, the Lawrence Livermore National Laboratory, and the Los Alamos National Scientific Laboratory. Following the occurrence of earthquake damage at the University of California at Los Angeles, caused by the 1971 San Fernando earthquake, the University adopted a University Seismic Safety Policy in early 1975, [2] & [3]. This Policy was reaffirmed in a letter from President David Pierpont Gardner, dated May 17, 1988, to the Chancellors and the Directors of the aforementioned laboratories. This Policy combined with a letter from President Gardner, dated September 30, 1986, to the same persons addressed the "Policy for Independent Seismic Review of Structures."

The "Policy for Independent Seismic Review of Structures" requires that an independent review shall be conducted of the structural seismic design of all capital projects, whether new construction or remodeling, which involve structural design and are intended for human occupancy or which affect human safety. The review shall be initiated early in the project life and preferably during the preparation of schematic designs so that it can be performed in conjunction with the independent design and cost review and value engineering processes where applicable. Also, the review shall be continued at appropriate times during the design process. In all cases, working drawings and calculations shall be reviewed for conformance of the new work to the most current applicable seismic design code requirements prior to letting bids for such work or authorizing structural change orders. The Chancellor or equivalent responsible Officer or

Director shall provide for the selection of the reviewer and for the organization, plan, and type of review, subject to the following: (1) a licensed structural engineer with demonstrated experience in seismic design shall perform the review and prepare a written report, (2) the reviewer shall be contracted for and paid by the University and not by the architect or engineer of record for the design, and (3) the reviewer shall not be an employee of the University. Similar requirements pertain for an independent review of the structural and seismic design of facilities being considered for lease or purchase for University purposes.

The approximate cost of the above independent seismic review is the same as the Plan Review Fee which is 65 per cent of the Building Permit Fee in Table No. 3-A, 1988 Uniform Building Code [4]. At the Lawrence Berkeley Laboratory, the use of the independent structural and seismic review process has proven to be cost-effective with improved structural and seismic designs as well as improved construction documents (drawings and specifications) with fewer design change orders during construction.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The American Society of Civil Engineers has undertaken a very ambitious and significant program to improve the quality in constructed projects. A major milestone has been reached with the publication of the Preliminary Edition for Trial Use and Comment of the Manual, "Quality in Constructed Project, a Guideline for Owners, Designers, and Constructors" [5]. According to Chapter 13, "Peer Review" of the Manual, the following issues are very important to understanding and implementing a "Peer Review" process. "Peer review is a technique that promotes quality in design organization and their services. It is the highest level of action to improve quality in design of constructed projects. A project design peer review is a comprehensive examination of the technical aspects of the project design as they relate to concept, progress or final results. A peer review is conducted by

peers of the original manager, authors, or design professionals. A peer review is a special effort, not a routine procedure performed daily on typical projects or design processes. A peer review has a specific purpose, scope, format, and duration. A peer review is paid for by the commissioning authority, who benefits from this valuable service. The original design professional retains all authority and responsibility for the design and is the undisputed design engineer or record. Attempts to assign undue responsibility to a peer review team ultimately will result in less use of the peer review process.

"A peer review is not simply any review of a document by anyone other than its author, even if the reviewer is at or above the author's "peer" level. A peer review is not a review by a building code official or by any other government agency as it carries out its regularly mandated responsibilities covering some area of the design and construction. Peer review is not a value engineering study, despite certain similarities in the two processes. As a basic difference, value engineering of a design focuses on potential cost savings, while peer review of a design examines the quality of the design, including, in many cases, the procedures used and the management of the process. In other words, a peer reviewer is likely to ask first, "Is it good enough?" whereas the usual value engineering question is, "Does it cost too much?"

"A peer review may be voluntarily requested or authorized, or it may be mandated by some authority other than the persons or agency to be reviewed. Any peer review must have adequate budgets of time, effort, and money. The steps of a project peer review normally consist of acquiring information, examining the information and evaluating its relevance, thoroughness and accuracy, drawing conclusions about the status or technical quality (or both) of the project from these evaluations, and presenting and discussing the report.

"Peer reviews are requested, as added safeguards for the public, the

owner, and the design professional. All of these groups who are familiar with peer review have encouraged their use by large or small organizations and on large or small projects. A fresh, unbiased and diplomatic review by an independent, high-level professional can be a highly cost-effective measure." [5]

The aforementioned Manual has extensive guidelines for project design peer review and is recommended to those who have a need for or can appreciate the value of the project design peer review process.

INDEPENDENCE, COMPETENCE AND INTEGRITY

Report SSC-81-01, "Independent Review of Critical Facilities: With Special Emphasis on State-Federal Relationships and Dam Safety, January 1981, [1] discusses in a very frank and straight-forward manner the "human problems" with the selection of independent peer reviewers and how the peer review process can work if there is a "common basis of understanding" among all those involved in the process. "A degree of independence is possible, even working within the same organization, if a special office or staff is established whose principal or sole purpose is safety review, and safety criteria are used in guiding their judgment (internal independent review). But full independence (later called external independent review or "third-party" review) is insured only when those who are responsible for a review are not organizationally connected with or otherwise beholden to (1) those who did the original design and computations, or (2) the entrepreneurs of the project for which the design has been made" [1]

John P. Gnaedinger refers to the independent review process as "peer review": "The principal process ... contemplated here is one whereby project plans and specifications are reviewed by one or more independent peers with recognized competence in the technical areas involved" [6] He emphasized the term "peer" review rather than just independent review, because "it is crucial that the competence and

experience be present." [6] He also adds that the term "peer" has yet another pertinent connotation: "... namely the freedom to express one's concurrence and criticisms without the domination or interference implied and even explicit in structural authority systems." [6]

CONCLUSIONS AND RECOMMENDATIONS

1. DOE 5481.1B "Safety Analysis and Review Systems" establishes the need for uniform requirements for the preparation and review of safety analyses of DOE operations.

2. DOE 6430.1A requires that facility design shall incorporate the necessary Quality Assurance requirements to assure that established program and project quality assurance objectives are satisfied using peer review procedures.

3. LBL Report-9143, "Seismic Safety Guide" and UCRL Draft Report 15910 provide specific guidelines and recommendations for implementing a project peer review process.

4. The University of California Seismic Safety Policy, as set forth in the "University of California Systemwide Facilities Manual," Section B, Administration, 3 University Policies, 2 Seismic Safety, provides specific procedures which are mandated for implementation by the nine Chancellors of the University campuses and the three Directors of the Lawrence Berkeley Laboratory, the Lawrence Livermore National Laboratory, and the Los Alamos National Scientific Laboratory. This 1988 University Seismic Safety Policy requires the use of independent project design peer review for its capital improvement and seismic reconstruction program.

5. American Society of Civil Engineers "Manual of Professional Practice, Quality in the Constructed Project" provides extensive background and recommendations for the development and execution of a project design peer review process.

6. With the volume and wealth of information concerning the need for and importance of project design peer review as well as the guidelines and recom-

mendations to implement such a program, there are ample reasons why this design peer review process should be more widely used by the Department of Energy and its Contractors.

REFERENCES

- [1] Stanley Scott, "Independent Review of Critical Facilities; with Special Emphasis on State-Federal Relationships and Dam Safety," State of California, Seismic Safety Commission Report 81-01, January 1981.
- [2] Frank E. McClure, "Development and Implementation of the University of California Seismic Safety Policy," Proceedings of the Eighth World Conference on Earthquake Engineering, 1984.
- [3] Frank E. McClure, "An Update Overview of the University of California Seismic Safety Program," Proceedings of the Ninth World Conference on Earthquake Engineering, 1988.
- [4] International Conference of Building Officials, "1988 Uniform Building Code," Whittier, California 90601, May 1, 1988.
- [5] American Society of Civil Engineers, "Manual of Professional Practice Quality in the Constructed Project," Volume 1, Chapter 13, "Peer Review," May 1988.
- [6] John P. Gnaedinger, "Peer Review: Old Concepts in New Situations," Civil Engineering-ASCE 48: pages 45-47 (February 1978).