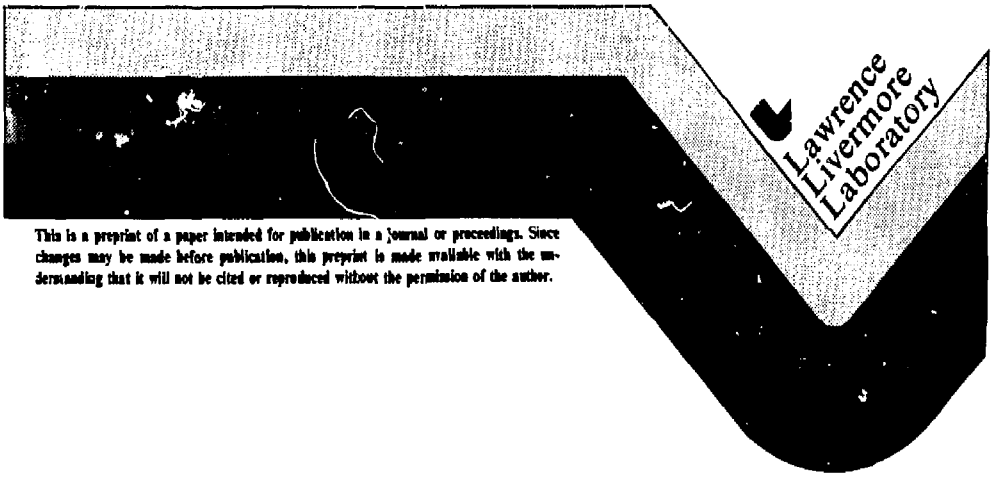
UCRL-85458
PREPRINT
CONF-810801--4

Evaluation of the Seismic Integrity of a Plutonium-Handling Facility

D. W. Coats

This paper was prepared for submittal to
the 6th International Conference on
Structural Mechanics in Reactor Technology
Paris, France
August 17-21, 1981

February 4, 1981



Summary

Many studies [1 - 9] have been made by and for the Lawrence Livermore National Laboratory (LLNL) to ensure the seismic safety of its Plutonium Facility (Building 332). These studies have included seismological and geologic field investigations to define the actual seismic hazard existing at the Laboratory site as well as structural studies of the Facility itself. Because the basic seismic design criteria has undergone changes over the years, numerous structural studies and upgrades have been completed. The seismic criteria in use at the LLNL site is reviewed on a continuing basis as new information on the seismicity and geology of the Livermore Valley is obtained. At present, the Laboratory's Earth Sciences Division is conducting a multi-million dollar program to identify and characterize the geologic hazards at the Livermore site, with the primary emphasis on earthquake hazards in the Livermore Valley. This effort is undergoing an independent review by Woodward-Clyde Associates. Additionally, because of increased concerns over the seismic safety of Building 332, the Laboratory has initiated an independent structural review. This review effort will be monitored by the California Seismic Safety Commission to ensure its independence. Both of these studies are in their early stages and results are not yet available.

---

*Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract number W-7405-ENG-48.

1. Introduction

The Lawrence Livermore National Laboratory (LLNL) conducts basic chemical and metallurgical research as part of the U.S. Nuclear Weapons Program. This research includes radioactive materials such as plutonium, which could be most hazardous to the body if inhaled. The Laboratory has a plutonium handling facility designed and built to assure the health and safety of the public and Laboratory employees. Because the facility is located in Livermore, California, which is considered to be quite active seismically, the Laboratory has spent considerable effort to ensure its seismic integrity.

This paper summarizes the steps taken by LLNL to ensure the structural capabilities of the Laboratory's plutonium facility to resist future earthquakes.

2. Plutonium Facility Description

LLNL's Plutonium Facility, Building 332, was built expressly for handling plutonium. In plan view, it looks like two buildings with a narrow connection between them (see Fig. 1). Plutonium is handled only in the facilities radioactive materials area, Increments 1 and 3. Increment 1 includes offices, a mechanical-equipment room, dressing rooms, plutonium laboratories, and a loft that houses the ventilation system. Increment 3 includes the corridor and air lock, a small control room, the main plutonium storage vault, four large laboratories, and a basement that houses mechanical equipment, the ventilation system, and emergency power and water supplies. Increment 2 is a minor addition in the corner where the connecting Increment 3 structure meets Increment 1. The plutonium handling areas are reinforced concrete, shear-wall construction.

Functionally, the design of the facility is based on erecting multiple barriers to the propagation of fires and to the formation and release of plutonium particulates. These barriers are gloveboxes, the ventilation system, and the structure of the building itself.

These barriers, together with the safety measures adopted in operating the building, constitute the protection LLNL provides both to Laboratory employees and to the public against the potential hazards of plutonium.

3. Seismic Design Basis

The plutonium facility, Increment 1, completed in 1961, was designed and built in accordance with the Uniform Building Code. After the San Fernando earthquake of February 1971, LLNL examined in detail the seismic hazard for the Laboratory site [1]. An independent engineering and geology firm was engaged to carry out both a seismological and geologic field investigation of the area [2,3]. From this investigation, it was concluded that the maximum ground motion level at the site would be a horizontal acceleration of 0.5 g with no evidence of a potential for surface offset near the plutonium facility. This 0.5 g maximum horizontal acceleration and a response spectrum was established as the design-basis earthquake* for the Livermore site. After a detailed review of the 1972 study, LLNL's staff in 1974 derived a value of 0.8 g for the maximum horizontal acceleration of the ground due to earthquake shaking [8]. In

*The design basis earthquake for a site is defined as the earthquake that will produce the maximum possible ground motion at the site, after which structures, systems, and components important to safety associated with facilities which house radioactive materials must remain functional.

light of this result, the LLNL staff is using this higher ground motion value to re-evaluate all Laboratory facilities that house radioactive material at the Livermore site.

4. Structural Studies and Upgrading

Because of changing seismic design criteria over the years, numerous structural studies and upgrading have been completed.

Increment 1 was designed and built entirely of reinforced concrete. In 1973, LLNL staff conducted a structural analysis of both the loft structure and the radioactive materials area [6]. Results from this analysis indicated that the radioactive materials area would easily resist the 0.5 g level but that the loft structure, which is constructed of a moment-resisting steel space frame, needed modification. In 1975, modifications were designed and made to the loft structure so that it could resist the 0.5 g design basis earthquake.

Increment 3, a two-story reinforced-concrete structure, was designed in 1973. The design criterion was the 0.5 g design basis earthquake. Both time history and response spectrum methods of analysis were used. LLNL staff reviewed the design calculations and agreed that Increment 3 could adequately resist the design basis earthquake.

In 1973, LLNL initiated a Laboratory-wide program to secure gloveboxes, equipment, and systems against shaking caused by earthquakes. Throughout the Laboratory, all such items that needed to be tied down were secured against a seismic loading equivalent to a 2.0 g horizontal acceleration. LLNL also did some confirmatory experimental investigations into the integrity of gloveboxes. In these experiments, the glovebox, the filter, and the tools inside were subjected to a ground shock level of 1.0 g. Results from these tests and other analyses by LLNL staff clearly indicate that gloveboxes like those in the plutonium facility will easily survive earthquake ground motions at the 1.0 g level without damage.

LLNL is currently in the process of re-evaluating facilities that house appreciable amounts of radioactive material at the Livermore site for a peak ground acceleration of 0.8 g's. Because of public attention centered on the plutonium facility, this re-evaluation concentrated on the as-built structures of Increments 1 and 3 of Building 332. As part of this re-evaluation, LLNL staff assessed the integrity of this facility to the 0.8 g level by means of a conservative extrapolation of the structural analyses made at the 0.5 g ground motion level. Our results for Increment 1 show no structural problem in the radioactive materials area; in the loft, however, some local yielding of column anchor bolts and weld connections may occur. No structural problems are anticipated for Increment 3 at the 0.8 g peak ground acceleration level.

The recent controversy surrounding the establishment of the Las Positas fault zone to the south of the LLNL site as mapped by the USGS in 1977, does not adversely affect the seismic analysis results and conclusion. The potential ground motion levels are not increased, and no evidence of a potential for surface offset near the plutonium facility has been found.

In the interests of promoting a consensus concerning the seismic hazard at the Livermore site, LLNL has recently initiated comprehensive field investigations. We are also initiating independent structural evaluations. Both studies will use outside private industry reviewers.

5. Site Seismic Safety Program

The overall mission of the Site Seismic Safety Program (SSSP), which began in January, 1979, is to identify and characterize geologic hazards at the Livermore site. Primary emphasis is to be placed on earthquake hazards in the Livermore Valley. In addition to the hazards study, a specific objective of the SSSP is to provide input to the Geology, Seismology, and Hydrology Sections of the Final Environmental Impact Statement for the LLNL site. The five major areas to be considered by the SSSP are:

1. Re-evaluation of the surface-rupture potential;
2. Re-evaluation of surface and subsurface geology (including definition of bedrock);
3. Improved seismotectonic model;
4. Determination of design basis earthquake;
5. Independent review.

Areas 1, 2, 3, and 4 require both a review of all currently available geological and seismological information pertinent to the site, and the generation of new information. The Site Seismic Safety Program is being conducted by LLNL's Earth Sciences Division and independently reviewed by Woodward-Clyde Associates.

The results of this study will be carefully reviewed with respect to seismic safety issues relating to LLNL's Plutonium Facility.

6. Independent Review of LLNL Plutonium Facility

Because of increased attention focused on the seismic safety of LLNL's Plutonium Facility (Building 332) following the Greenville earthquake sequence of January, 1980, the Livermore Laboratory and the San Francisco Department of Energy Operations Office, have initiated an independent structural review. The objective of this review is to provide an independent assessment of the expected structural performance of the Building 332 structure, systems and components under earthquake generated ground accelerations.

To help insure the independence of the review process, the California Seismic Safety Commission (CSSC) has agreed to review all phases of the procedure, from the selection of the review team to the production of a final report and public meeting to present the findings of the panel.

As of this writing, the process is in the initial stages of selecting qualified independent reviewers. All reviewers under consideration have met the approval of the CSSC. A minimum of three reviewers will make up the review team. The primary criteria used to select potential reviewers were as follows:

- Must have broad experience in seismic structural dynamics and structural engineering.
- Must be familiar with the characteristics of California earthquakes.
- Must have experience in observation of structural damage caused by earthquakes.
- Must command peer recognition for their work in seismic engineering and public respect based on their professional achievements.
- Must be practicing in the field of seismic engineering, preferably experienced in addressing the dynamic behavior of structures similar to Building 332, such that their familiarity with the issues is current and based on experience.
- Authority to use the title Structural Engineer is highly desirable.

At the conclusion of the review process, the review team will submit a joint Draft Final

Report to the DOE SAN office. This report will then be made available to the CSSC and the public in preparation for a public discussion of the review team findings.

The Draft Final Report will identify:

- the structure(s), systems and/or components reviewed;
- the seismic environment used in the evaluation;
- the models and methodology used, including the structural failure criteria and the basis for their use;
- the Building 332 structure response anticipated under the seismic environment and methodology used and specifically a detailed description of the nature, extent and location of the anticipated damage, if any;
- conclusion reached and any recommendations necessary and feasible for the structural integrity of Building 332.

After the public meeting, the review team will address relevant public comments and any comments or observations offered by the CSSC. A Final Report signed by all reviewers will be delivered to the DOE.

6. Conclusions

LLNL has completed extensive investigations and studies to ensure the seismic integrity of Building 332. This work has included both defining a design basis earthquake for the site and making structural analyses to evaluate the integrity of the built-in safeguard barriers--i.e., the building, the gloveboxes, and the ventilation system. Additionally, studies are currently underway to further identify and characterize the seismology and geology of the Livermore Valley and to perform an independent, structural assessment of Building 332.

References

[1] D. L. Bernreuter and F. J. Tokarz, Design Basis Earthquakes for the Lawrence Livermore Laboratory Site, Lawrence Livermore Laboratory Report UCRL 51193, May 19, 1972.

[2] John A. Blume & Associates, Engineers, San Francisco, California, Plutonium Laboratory, Lawrence Livermore Laboratory, Geologic, Seismologic, and Foundation Investigations, prepared for Maher and Martens--Architects, San Francisco, California, November, 1971.

[3] John A. Blume & Associates, Engineers, Investigation of Faulting at the Lawrence Livermore Laboratory, Lawrence Livermore Laboratory Report UCRL 13568, December, 1972.

[4] U.S. Department of Energy, Washington, D.C., Draft Environmental Impact Statement, Livermore Site, Livermore, California, DOE/EIS-0028-D, September, 1978.

[5] Preliminary Safety Analysis Report for Building 332, Increment III, Lawrence Livermore Laboratory Report UCRL-51436 Rev. 1, January 18, 1974.

[6] Safety Analysis Report for Building 332, Lawrence Livermore Laboratory Report UCRL-51590, Draft, June 20, 1974.

[7] Final Safety Analysis Report for Building 332, Increment III, Lawrence Livermore Laboratory Report UCID-17565, August 31, 1977.

[8] L. H. Wight, A Geological and Seismological Investigation of the Lawrence Livermore Laboratory Site, Lawrence Livermore Laboratory, Livermore, California, Report UCRL-51592, June 3, 1974; also appears as Appendix 2A of DEIS (1978).

[9] F. Tokarz and G. Shaw, Seismic Safety of the LLL Plutonium Facility (Building 332), Lawrence Livermore Laboratory, Livermore, California, Report UCRL-52786, January, 1980.

Figure Captions

Fig. 1. Plan view of Bldg. 332 (ground floor). The radioactive-materials areas are shaded.

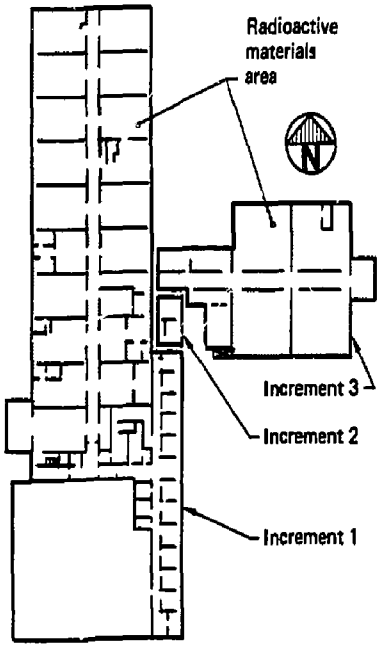

Radioactive
materials
area
N
Increment 3
Increment 2
Increment 1

Fig. 1.