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Seismic Vulnerability Assessment Waste Characterization Reduction and Repackaging Building, TA-50-69

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Seismic Vulnerability Assessment

Waste Characterization Reduction and Repackaging Building, TA-50-69

by

Michael W. Salmon, Jessica Ruminer, and Isabel Cuesta

Abstract

This report presents the results of the seismic structural analyses completed on the Waste Characterization Reduction and Repackaging (WCRR) Building in support of ongoing safety analyses. WCRR is designated as TA-50-69 at Los Alamos National Laboratory, Los Alamos, New Mexico. The facility has been evaluated against Department of Energy (DOE) seismic criteria for Natural Phenomena Hazards (NPH) Performance Category II (PC 2). The seismic capacities of two subsystems within the WCRR building, the material handling glove box and the lift rack immediately adjacent to the Glove Box are also documented, and the results are presented.

1 Introduction

1.1 Purpose

The purpose of this report is to present the results of analyses completed on the Waste Characterization Reduction and Repackaging (WCRR) Building in support of ongoing safety analyses. WCRR is designated as TA-50-69 at Los Alamos National Laboratory, Los Alamos, New Mexico.

Calculations were performed to investigate the seismic capacity of the WCRR Building (Ref. 1). The seismic capacity of the following subsystems within the WCRR building is also documented in Ref.1 as requested by facility management:

- Material Handling Glove Box

- Lift Rack Immediately Adjacent To The Glove Box

This report presents the results of those analyses.

1.2 Background

Los Alamos National Laboratory is in the process of upgrading the safety basis (SB) for its nuclear and nonnuclear facilities. These upgrades were precipitated by a number of factors, including conclusions of the LANL self-assessment of safety basis documented in the Authorization Basis Quality Review Final Report (Ref. 2), Laboratory-wide efforts to implement Integrated Safety Management, and Defense Nuclear Facilities Safety Board concerns. Efforts are well under way to improve nuclear facility authorization bases. The Nonnuclear Facility Safety Survey and Safety Basis Upgrade Program have been established to upgrade the safety basis of nonnuclear facilities.

Facility and Waste Operations-Systems Engineering and Maintenance (FWO-SEM) was asked to assist the facility manager with responsibilities for SB authorization in Chemistry-Facility Management (C-FM) in their ongoing safety activities by evaluating the WCCR facility against Natural Phenomena Hazards (NPH) Performance Category 2 (PC 2) criteria. As part of this analysis the following structures, systems, and components were evaluated:

- Building Structure
- Material Handling Glove Box
- Lift Rack Immediately Adjacent to the Glove Box.

1.3 Scope

Calculations were performed to assess the ability of the TA-50-69 structure to meet Department of Energy (DOE) PC 2 requirements and DOE PC 1 requirements. In addition, these calculations document the judgment used in evaluating the seismic adequacy of the components listed in Section 1.1.

1.4 Plan of Development

This report has five main sections. Section 1 is the introduction. Section 2 provides a brief summary of the results, and tabulates those results so that this information is readily available to safety analysts. Section 3 provides a narrative description of the methodology used in the

evaluation of the facility and facility components. Section 4 provides results from the analysis. Section 5 presents results and conclusions, and Section 6 contains a list of references.

2 Summary

TA-50 Building 69 was constructed in 1979. The building may be characterized as a light-framed single-story structure. The roof is constructed of steel decking with a 4-in.-thick reinforced-concrete deck. The walls are constructed of light-gauge metal studs and are covered with gypsum board on the interior and stucco on the exterior. Lateral forces are resisted by light-gauge metal straps let in to the metal studs. The foundation consists of reinforced-concrete spread footings that support the bearing walls. A structural evaluation of the facility was performed to PC 2 criteria, and the structure was found to be unable to meet those criteria. The structural evaluation of the facility was then performed to PC 1 criteria, and the structure was found to be unable to meet those criteria. Details of the evaluation may be found in Section 4 and Ref. 1.

A walkdown evaluation of selected components was performed in addition to the structural evaluation (Table 2–1). Seismic capability engineers trained to the Seismic Evaluation Procedure (SEP) for Equipment in U.S. DOE Facilities (Ref. 3) performed the evaluation. The review was largely based on the SEP and consisted of a walkdown of each component in the field. The seismic capacity of each component was determined using engineering judgment and the performance of similar components in real earthquakes.

Table 2-1
Summary of Seismic Assessment for Selected Components

Component Description	Meet PC 2 Criteria	Walkdown Notes
Structure	No	None
Glove Box	Yes	Concern about the stability of the hydraulic lifts that hold the barrels being examined. They are on a cart with a hydraulic lift and locking wheels. Anchorage and support of the glove box itself is adequate.
Lift rack	Yes	Double pulley system. The barrel is securely attached to the lift rack. Concern would only be about the jostling of the rack, not the possibility of the barrel falling off the rack.

3 Methodology

3.1 Determination of Natural Phenomena Performance Category

Before the initiation of the analysis, a review of the NPH Performance Category of the Structures, Systems, and Components (SSC) was performed following the guidance in DOE-STD-1021 (Ref. 4). The systems and components had been classified as NPH PC 2 based on their safety class. This classification was judged to be appropriate.

According to Ref. 4, “safety significant” components are assigned a preliminary NPH PC 2. SSC may also be placed in a PC 3 category for improved performance if justified from cost-benefit considerations. The final NPH categorization may be modified considering source-interaction effects. At the time this analysis was initiated, however, the final NPH determination had not been made. Therefore, the components were evaluated according to PC 2 criteria, as shown in Table 3-1.

**Table 3-1. Preliminary NPH Categorization Based on Safety Documentation
and DOE-STD-1021**

Component	Safety Category (Ref. 3)	Preliminary NPH Category	Potential for Interaction with Safety-Class Components	Final NPH Category
Glove Box	None	2	None	2
Lift Rack	None	2	None	2

3.2 Structure Evaluation

The structure was evaluated in accordance with the Los Alamos National Laboratory, Facility Engineering Standard Manual (ESM), Chapter 5–Structural (Ref. 5). The Laboratory ESM references DOE Standard 1020-94 (Ref. 6), and DOE Order 420.1 (Ref. 7) as the criteria documents to be used in evaluation of existing facilities. In accordance with Refs. 5 and 6, the analysis of PC 2 structures “may be designed or evaluated using the approaches specified in

building code seismic provisions.” Ref. 6 further recommends that seismic design or evaluation of Performance Category 2 and lower SSC be based on the current version of the Uniform Building Code (UBC) (Ref. 8) and the Minimum Design Loads for Buildings and Other Structures (known as ASCE 7) for Design Standards (Ref. 9).

In accordance with Ref. 6, the evaluation of PC 2 facilities follows the 1997 UBC modified slightly to account for the site-specific seismic hazards information available at Los Alamos. The UBC procedure is an equivalent static lateral force procedure in which the empirically based total base shear, V , is distributed over the height of the facility. The total demand on the structure and structural components is obtained by combining load effects from dead, live, snow, partition, and equipment and earthquake loads.

Results from these evaluations are presented in Section 4.

3.3 Component Evaluation

Operations at TA-50-69 involve the classification of waste. Hazardous material is handled in the shaded areas shown in Figure 3–1. These areas include the process room where the glove box is located. Components in this area evaluated for seismic vulnerability include

- the lift rack and
- the glove box.

Photographs of these components are provided in Figure 4–2.

The evaluation was performed by seismic capability engineers trained to the SEP for Equipment in U.S. DOE Facilities (Ref. 3). The review was largely based on the SEP, and consisted of a walkdown of the components to determine if there were any obvious weak links in the lateral-force resisting-system for the component. Calculations are then performed on those components that demonstrated a weak link in the lateral-force resisting system (e.g., missing anchor bolts, lack of bracing). In addition to a review of the components, seismic II/I issues were reviewed in the field. Seismic II/I issues are defined as interactions of lesser safety class components onto higher safety class components. For example, if the failure of a room heater could impact the ability of a glove box to perform its intended safety function, then anchorage of the room heater to the seismic requirements of the glove box would be required.

The initial phase consisted of a walkdown of each component in the field. The seismic capacity of each component was determined using engineering judgment and the performance of similar components in real earthquakes. Each component was then assigned to one of the seismic

capacity bins shown in Table 3-2. The capacities shown in Table 3-2 correspond to those that would be calculated following a methodology similar to that used in DOE-STD-1020 (Ref. 6). The Peak Ground Acceleration (PGA) capacity of 0.22 g was selected based on the design-basis earthquakes for PC 2 at the LANL site. For components assigned to the low- or medium-capacity bins, anchorage calculations are required.

Table 3-2. Capacity Bins and Performance Goals

Bin	PGA Capacity*	Mean Annual Seismic-Induced Failure Frequency	DOE-STD-1020 Performance Category
High	$\text{PGA} \geq 0.31 \text{ g}$	$P_f < 1 \times 10^{-4}$	PC 3
Medium	$0.31\text{g} \geq \text{PGA} \geq 0.15 \text{ g}$	$1 \times 10^{-3} < P_f < 1 \times 10^{-4}$	PC 1 to PC 2
Low	$\text{PGA} < 0.15 \text{ g}$	$P_f < 1 \times 10^{-3}$	PC 0

* The PGA capacity is defined as the expected peak ground acceleration that would stress the component beyond its code-specified limit state. For unanchored components in this evaluation, the PGA capacity is defined as the PGA that would topple the component.

Figure 3-1. Hazardous materials operations at TA-50-69. The entry vestibule of door (1) is not shown.

4 Results

4.1 1997 UBC Structural Evaluation

TA-50 Building 69 was constructed around 1979. The design drawings are dated October 5, 1979. The engineer of record is James T. Brown of Kruger, Lank, Hutchinson, Brown, Inc. Building 69 is a one-story, light-framed building with a mezzanine. The building's basic structural system consists of walls with light-gauge metal studs and tension-carrying straps attached to the studs. The lateral-force resisting system for the building consists of horizontal diaphragms that distribute out-of-plane wall forces and story shears to the tension-carrying straps embedded in the light-gauge walls. There is a mezzanine that occupies a portion of the building, which has its own independent lateral-force resisting system. The total square footage for the first floor and the mezzanine is approximately 2,200 and 750, respectively. The roof is constructed of steel decking and concrete with rigid insulation and membrane roofing on the top. The shear walls are built on continuous strip footings.

Figure 4–1 presents a plan of the structure at the roof level. Numeric identifiers (1–4) were assigned to the lateral-force resisting shear walls in this facility.

4.1.1 PC 2 Evaluation

The facility is evaluated to PC 2 seismic criteria by following the seismic provisions of the 1997 UBC, in accordance with DOE-STD-1020 (Ref. 6), and the LANL facility ESM (Ref. 5). According to Ref. 6, the seismic design or evaluation of PC 2 and lower SSCs is based on model building-code seismic provisions. In these criteria (Ref. 6) the current version of the UBC will be provided. Ref. 10 supersedes Ref. 6, and recommends the evaluation of PC 1 and PC 2 structures with the International Building Code (Ref. 11); however, the contractual agreement between the University of California and the DOE for operating LANL still endorses the use of DOE-STD-1020-94 (Ref. 6) and the 1997 version of the UBC (Ref. 8).

The static lateral force procedure of UBC, Section 1630, was used because TA-50-69 may be classified as a regular structure under 240 feet in height with a lateral-force resisting system (Light steel-framed bearing walls with only tension-bracing) that is provided in UBC Table 16-N. Base shear, vertical distribution of base shear, and horizontal distribution of base shear were performed in accordance with UBC, Section 1630, considering the relative rigidities of the supporting shear walls. The roof was considered to be rigid for purposes of distributing horizontal shears and torsional moments. The roof is constructed of steel decking with a reinforced-concrete deck. Details of the calculation (with assumptions and results) are provided in Ref. 1.

Figure 4-1.
Floor/Plan, TA-50 Building 69.

4.1.2 PC 2 Seismic Evaluation Results

Table 4–1 summarizes the resulting seismic demand-to-capacity ratios for the four main components of the lateral force-resisting system indicated in Fig. 3–1. It can be noted that the demand-to-capacity ratios in the tension, considering only straps, are in excess of unity. These results demonstrate that the structure does not meet the PC 2 criteria for seismic loads.

Table 4-1. Summary of Demand/Capacity Ratios of the Tension-Bearing Straps from PC 2 Seismic Evaluation, TA-50-69

Wall ID	Factored Capacity (kips)	Earthquake Demand (kips)	Demand/Capacity
1	6.87	20.1	2.93
2	6.87	20.3	2.96
3	9.67	18.3	1.89
4	19.98	19.1	.96

4.1.3 PC 2 Wind Evaluation Results

For PC 2 structures at Los Alamos, Ref. 5 indicates a three-second wind gust speed of 96 mph and the use of ASCE 7–98 (Ref. 9) for the design of wind loads. “Method 1 – Simple Procedure” (Section 6.4) of ASCE 7–98 was used to determine the wind loads of the building because WCRR met all the requirements for using this procedure.

The structural components resisting lateral loads caused by wind are the same as the components to resist the lateral forces resulting from seismic loads. Similarly to Table 4–1, Table 4–2 (next page) summarizes the resulting lateral wind demand-to-capacity ratios for the four main components of the lateral-force resisting system indicated in Figure 3–1. In this case, the demand is much less than the capacity of the straps, indicating that the structure does meet the PC 2 criteria for wind loads.

The PC 2 wind requirements produce an uplift pressure of approximately 27 psf. The first story roof is constructed of 4 in. of reinforced concrete; therefore, the uplift pressure is resisted by the dead weight of the concrete acting by itself. Because the facility has reported no wind damage over its 22-year life, it is judged that the roof is adequate for wind effects. It is recommended however, that the roof be inspected to determine if there are positive attachments between the roof and the supporting steel bar joists.

Table 4-2. Summary of Demand/Capacity Ratios of the Tension-Bearing Straps from PC 2 Wind Evaluation, TA-50-69

Wall ID	Factored Capacity (kips)	Wind Demand (kips)	Demand/Capacity
1	6.87	4.8	0.70
2	6.87	5.2	0.75
3	9.67	4.4	0.45
4	19.98	4.9	0.24

4.2 Components Evaluation

As reported in Section 3.3, the evaluation was performed by seismic capability engineers trained to the SEP for Equipment in U.S. DOE Facilities (Ref. 3). The review was largely based on the SEP and consisted mainly in a walkdown of each component in the field. The results are summarized in Table 4-3. Photographs of the glove box are provided in Figure 4-2. The seismic capacity of each component was determined using engineering judgment. The performance of similar components in real earthquakes shows that the glove box and the lift rack meet all the requirements of safety and have the proper anchorages and bracings to resist the seismic forces. At the initial walkdown, both seismic capability engineers agreed that the seismic capacity of each of the components was judged to be high; therefore, no follow-on calculations were required. Additionally, no significant II/I component interactions were found in the walkdown.

Table 4-3. Summary of Components Evaluation, TA-50-69¹

Component	Safety Category (Ref. 3)	Seismic Capacity Bin	Anchorage Calculations Required?	Any II/I Concerns?
Glove Box	None	High	No	No
Lift Rack	None	High	No	No

1. Components were evaluated using DOE-EH545 (Ref. 3) as adapted by LANL for use in the evaluation of systems and components. Those systems and components judged to lie in the high capacity bin are screened from further review.

(a)
Hydraulic lifts holding drums in place.

(b)
Glove box
(note lift station to the right)

(c)
Glove box lift station

(d)
Typical expansion anchor bolt for glove box
anchorage to cast-in-place floor

Figure 4-2. Components, TA-50-69.

5 Conclusions and Recommendations

A seismic and wind vulnerability assessment of the TA-50-69 building was performed. Structures, systems, and components were categorized as NPH Performance Category 2.

It was shown that the TA-50-69 structure does not meet the seismic PC 2 requirements, but does meet the PC 1 requirements if there are tension-carrying straps on both sides of each wall.

The glove box and lift rack adjacent to it meet the PC 2 requirements.

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