Memo to: **Robert E. Sanchez, U.S. Government Accountability Office**

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From: **Robert H. Gilkeson, Registered Geologist**

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Date: **January 24, 2013**

Re: **Follow Up to our meeting with the GAO in Albuquerque on January 7, 2013 about the GAO Questions to us for Review of the National Nuclear Security Administration's (NNSA) Interim Plutonium Strategy.**

We provide the following new concerns from our meetings with Congressional Staff and Agencies in Washington, D.C. on January 8 through 11, 2013.

1. The 40-year old Plutonium Facility PF-4 at the Los Alamos National Laboratory (LANL) is vulnerable to structural collapse from the design basis earthquake (DBE) with an offsite lethal plutonium release of 900 rem from a spill, impact and fire. A very serious issue is that the DBE of ~0.5g is a great underestimation of the destructive power of ground motions that may occur at the PF-4 and the "next door" proposed CMRR-NF. See Concerns 2 and 3 below.

The 900 rem offsite release of plutonium to the public was described in the November 23, 2012 weekly LANL report by the Defense Nuclear Facilities Safety Board (DNFSB) – http://www.dnfsb.gov/sites/default/files/Board%20Activities/Reports/Site%20Rep%20Weekly%20Reports/Los%20Alamos%20National%20Laboratory/2012/wr_20121123_65.pdf Generally, there is a delay of about four weeks before the reports are posted on the dnfsb.gov website.

The pertinent excerpt from the November 23, 2012 weekly report follows:

> **Plutonium Facility – Seismic Safety:** LANL recently submitted a safety basis addendum to the site office that addresses the Unreviewed Safety Question associated with facility structural performance (see 10/19/12 weekly). Static non-linear seismic analysis performed by LANL earlier this year indicates that the probability of failure for multiple structural components exceeds the performance goal identified in the safety basis. <u>The safety basis addendum identifies a worst case offsite consequence of approximately 900 rem for a seismic collapse scenario that includes spill, impact and fire release mechanisms.</u> The addendum does not identify new controls or compensatory measures that mitigate the potential consequences for this accident scenario [Emphasis supplied].

> LANL has developed conceptual design upgrades for two vulnerable structural components, the basement captured columns and facility roof girders. The addendum indicates that upgrades for these components will be complete in FY 13 and FY 14, respectively.

The Nuclear Regulatory Commission (NRC) describes a lethal dose (LD) as follows – http://www.nrc.gov/reading-rm/basic-ref/glossary/lethal-dose-ld.html – "The dose of radiation expected to cause death to 50 percent of an exposed population within 30 days (LD 50/30). Typically, the LD 50/30 is in the range from 400 to 450 rem (4 to 5 sieverts) received over a very short period."

The 900 rem dose released from the collapsed PF-4 is roughly double the NRC lethal dose.

We met with the DNFSB in Washington, D.C. on January 9, 2013. In their evaluations of safety issues at the LANL PF-4 nuclear facility, the DNFSB has expressed dissatisfaction for the past five years, pointing out that the structural upgrades that were installed are inadequate to prevent a total collapse of the building and a very large release of plutonium in the air pathway to expose the public. The DNFSB sent a letter on this issue to the Department of Energy (DOE) Secretary Chu on January 3, 2013 – http://www.dnfsb.gov/sites/default/files/Board%20Activities/Letters/2013/ltr_201313_21016.pdf

From the DNFSB January 3, 2013 letter to Secretary Chu:

> The Defense Nuclear Facilities Safety Board (Board) remains deeply concerned with the seismic safety posture of the Plutonium Facility (PF-4) at Los Alamos National Laboratory. The Board believes a recent analysis performed by the laboratory's contractor demonstrates that PF-4 is vulnerable to structural collapse. <u>The **large plutonium inventory of PF-4**, coupled with the facility's proximity to the public, creates the potential for very high offsite dose consequences if the building were to collapse</u>. Structural upgrades necessary to fix the PF-4 vulnerabilities are currently projected to take several years to complete. In the interim, the potential for very high dose consequences remains [Emphasis supplied].

We share the deep concern of the DNFSB for the seismic safety posture of the PF-4. <u>We request that the 40-year old nuclear facility be immediately shuttered.</u> LANL was aware for many years that the PF-4 was vulnerable to structural collapse but has not taken measures to prevent the potential for very high <u>lethal</u> dose consequences to the workers and the public.

The seismic safety posture at LANL under the management of Los Alamos National Security (LANS) is shown to be not careful for the protection of workers, the public and the environment and is reason to immediately shutter the operations at <u>*all*</u> LANL nuclear facilities, including especially the 40-year old PF-4, the 60-year old CMR and the new CMRR Radiological Laboratory, Utility and Office Building (RLUOB).

Indeed, the LANL seismic safety posture has not complied with the four national consensus Industry Standards that require accurate knowledge of the earthquake danger at LANL. For example, accurate values for earthquake ground motions at the PF-4, the RLUOB, and the proposed CMRR-NF do not exist. See Concerns 2 and 3 below.

We asked congressional offices to request a review by GAO of the amount of funding provided over the last two decades for upgrades at PF-4 and what has actually been completed.

2. The incorrect low values for ground motions used in the design basis earthquake (DBE) for the structural upgrades of the LANL PF-4 nuclear facility, the construction of the RLUOB and for the estimated cost of the proposed CMRR-NF.

Figure 1 is an aerial view of the locations of the PF-4, the RLUOB, and the proposed CMRR-NF. There are many reasons the DBE (of 0.47g for horizontal ground motions and 0.51g for vertical ground motions) that was used for the structural upgrades to the PF-4 and for the design of the proposed CMRR-NF is incorrect and much too low. Most of the reasons the ground motion values are too low were described in the memo we presented to the GAO on January 7, 2013.

The construction of the RLUOB was based on even lower horizontal and vertical ground motion values of 0.33g from the LANL 1995 PSHA Report. The proposal in the National Nuclear Security Administration’s (NNSA) Interim Plutonium Strategy to greatly increase laboratory operations at the structurally unsafe RLUOB must be stopped.

A new very important reason the ground motion values are too low is that the 900 rem plutonium release from the seismic collapse of the PF-4 requires DOE and LANS to treat the PF-4 as Seismic Design Category 5 (SDC-5) with structural upgrades designed for the large ground motions from a 10,000 year recurrence earthquake instead of the current design for a 2,500 year recurrence.

An additional very important reason is that the DBE of ~0.5g was based on only faults exposed at land surface at large distances away from the three nuclear facilities (see Figure 2) and did not include the two north-south trending concealed active faults that are located close to the PF-4, the RLUOB and the proposed CMRR-NF (see Figure 3). The two concealed faults greatly increase the ground motions above the DBE of ~0.5g.

At our meeting on January 9, 2013, we asked the DNFSB to provide the design basis earthquake (DBE) in the current Documented Safety Analysis (DSA) for the PF-4. Staff person Mr. Tim Dwyer informed us that the DBE in the current DSA was ground motions of

~0.5g for an earthquake return period of 2,500 years. The finding in the DNFSB letter of January 3, 2013 and staff weekly report of the November 23, 2012 that the PF-4 is vulnerable for structural collapse is based on ground motions of 0.5g.

A very serious mistake is the current treatment of the PF-4 as a seismic design category 3 nuclear facility (SDC-3). The consensus industry standards identify the PF-4 as an SDC-5 nuclear facility because the seismic collapse will result in an offsite release of 900 rem and death to the workers and the public. From Table 1 **– SDCs based on the unmitigated consequences of SSC failure** in the Industry Standard ANSI/ANS 2.26-2004:

Category SDC-5 – Unmitigated Consequence of SSC Failure

Worker – Radiological/toxicological exposures that may cause loss of life of workers in the facility.

Public – Radiological/toxicological exposures that may possibly cause loss of life to an individual at the exclusion area boundary for an exposure of 2 hours.

Environment – Environmental monitoring required and potentially permanent exclusion from selected areas of contamination.

The 900 rem offsite dose from the current operations to manufacture plutonium triggers at the PF-4 is a requirement to design structural upgrades for an SDC-5 nuclear facility because of the long-term plans into the foreseeable future to manufacture 50-90 plutonium triggers per year at the facility (see page 282 in Senate Report 112-173). The manufacture of 50-90 triggers compared to the present capability to manufacture 6-10 triggers per year will greatly increase the large inventory of tritium that is now in the facility.

In addition, the proposed future programs, such as the Surplus Plutonium Disposition program, will bring an additional 2.5 metric tons of plutonium to LANL annually for at least the next 20 years. Further, it may be that the ARIES Project at LANL is currently using two metric tons of plutonium annually for work with surplus plutonium under the LANL Site-Wide Environmental Impact Statement.

The requirement to classify nuclear facilities with large inventories of plutonium as SDC-5 is described on page 4 in the Industry Standard ANSI/ANS 2.27-2008 as follows:

> **seismic design category (SDC):** A category assigned to an SSC (structure, system and component) that is a function of the severity of adverse radiological and toxicological effects of the hazards that may result from the seismic failure of the SSC on workers, the public, and the environment. SSCs may be assigned to SDCs that range from 1 through 5. For example, a conventional building whose failure may not result in any radiological or toxicological consequences is assigned to SDC-1; <u>a safety-related SSC in a nuclear material processing facility with a large inventory of radioactive material may be placed in SDC-5</u> [Emphasis supplied].

In summary, the SDC-5 category is required for the structural upgrades to the PF-4 because of the large inventory of plutonium and the 900 rem offsite release that is calculated to be the consequence of a seismic collapse, spill and fire at the facility. Further, the SDC-5 category is required for the engineering design and cost estimate of the proposed CMRR-NF because the facility will store six metric tons (13,228 pounds) of plutonium.
The requirement of the SDC-5 seismic hazard protection at the LANL PF-4 and the proposed CMRR-NF is described on page 11 in Industry Standard ANSI / ANS 2.26-2004 as follows:

> The SSC (structure, system and component) target performance goals are given in Table A.1. [Table A.1 and A.2 are below this excerpt]. These goals and the SSC failure consequence criteria in Table 1 of this standard [Table 1**– SDCs based on the unmitigated consequences of SSC failure –** is discussed above on page 3] have been selected to support development of seismic design loads and SSC design criteria that will protect the public, the environment, and the worker from hazards resulting from damages that might occur in nuclear facilities during earthquakes. The target performance goals are used in ANSI / ASCE / SEI 43-05 to establish the design criteria as a function of the SDC level for SDC-3, SDC-4, and SDC-5. The mean seismic failure probability of building structures designed to the IBC [International Building Code] is estimated to be <1 X 10^{-3} / year [1,000 year earthquake return period]. The design requirements in ANSI / ASCE / SEI 43-05 for SDC-3, SDC-4, and SDC-5 have been selected to be more demanding than the building codes. The objective is for SSCs designed to SDC-3 criteria to have the probability of failing to perform their safety function to be <1 X 10^{-4} / year [10,000 year earthquake return period]. . . Although unmitigated consequences of SSC failures in the facilities addressed by this standard are expected to be much less than those in nuclear power plants, the unmitigated consequences in category SDC-5 are severe enough that it is reasonable for SSCs placed in this category to have a target performance goal of <1 X 10^{-5} / year [100,000 year earthquake return period] [Emphasis supplied].

Table A.1 on page 12 in ANSI / ANS 2.26-2004

Table A.1 – Target performance goals used in ANSI/ASCE/SEI 43-05

Seismic design category	Target performance goals
SDC-3	10^{-4}/year
SDC-4	4×10^{-5}/year
SDC-5	10^{-5}/year

Table A.2 on page 12 in ANSI / ANS 2.26-2004

Table A.2 – DBE used with design methods in ANSI/ASCE/SEI 43-05

Category	Frequency of DBE
SDC-1	U.S. Geological Service (USGS) 2500-year return period map and the IBC
SDC-2	USGS 2500-year return period map and the IBC
SDC-3	Use ANS-2.29, and select uniform hazard response spectrum (UHRS) at 4×10^{-4}/year (mean), per ANSI/ASCE/SEI 43-05
SDC-4	Use ANS-2.29, and select UHRS at 4×10^{-4}/year (mean), per ASCE/SEI 43-05
SDC-5	Use ANS-2.29, and select UHRS at 10^{-4}/year (mean), per ASCE/SEI 43-05

It is very important to note that Table A-1 requires SDC-5 nuclear facilities to survive a 100,000 year earthquake with minimal damage. However, Table A.2 allows an earthquake return period of 10,000 years to be used for the engineering design and cost for new SDC-5 nuclear facilities such as the proposed CMRR-NF or for structural upgrades in existing SDC-5 nuclear facilities such as the PF-4.

There is a concession in the Industry Standards that a design for the 10,000 year earthquake will provide minimal damage from a 100,000 year earthquake. Therefore, it is a very important requirement to use ground motions for the 10,000 year earthquake instead of the current scheme to use the much lower ground motions from a 2,500 year earthquake for the structural upgrades to the PF-4 and the design for the proposed CMRR-NF.

From page 5 in the Industry Standard ASCE / SEI 43-05:

> The intent of this Standard is to achieve the Target Performance Goals, P_F, defined in Table 1-3, for not exceeding the Limit States defined in Table 1-4.

Table 1-3 in the Standard ASCE / SEI 43-05 describes the Target Performance Goal for SDC-5 nuclear facilities such as the PF-4 to be structurally safe for ground motions from an earthquake return period of 100,000 years and Table 1-4 in the Standard requires the PF-4 to suffer “Limited permanent distortion – *minimal damage*” from ground motions for a 100,000 year earthquake recurrence.

However, the DNFSB letter of January 3, 2013 describes not “*minimal damage*“ but instead, the structural collapse, spill and fire at the PF-4 with a lethal dose release of 900 rem plutonium in the air pathway for ground motions of 0.5g from an earthquake return period of 2,500 years. The ground motion values were from the LANL 2009 PSHA report for a single simultaneous earthquake based on mapping of only the faults that produced ruptures at land surface great distances away from the PF-4 (see Figure 2 compared to Figure 3 for the concealed active faults close to the PF-4).

Figure 4 is a graph from the LANL 2009 PSHA that illustrates the ground motions from the single simultaneous earthquake as a function of earthquake recurrence period. The peak horizontal ground motions are 0.47g, 0.8g, and 1.45g for earthquake recurrence periods of 2,500, 10,000 and 100,000 years, respectively. The industry standards require the structural upgrades for the PF-4 to provide minimal damage from ground motions of 1.45g.

Nevertheless, the industry standards provide a concession for structural upgrades for the PF-4 to be based on ground motions of 0.8g; a value much higher than the 0.5g value that is currently used. But given the plutonium inventory stored at PF-4, and the increased inventory required for manufacture of up to 90 triggers per year, we believe that the 100,000 year earthquake recurrence should be used with ground motions of 1.45g.

3. The LANL 2007 PSHA Report describes synchronous earthquakes to produce much larger ground motions that simultaneous earthquakes.

A very serious issue is that the DBE for the structural upgrades to the PF-4 are 0.5g for a single earthquake on a return period of 2,500 years, whereas the LANL 2007 PSHA Report describes the field investigations that determined the more destructive multiple synchronous earthquakes have occurred at LANL. The computer model in Figure 7-53 in the LANL 2007 PSHA Report predicts synchronous earthquakes for the 2,500 year recurrence to produce 75% greater ground motions at a value of ~0.9g. Figure 7-53 predicts synchronous earthquakes for a return period of 10,000 years to produce ground motions at ~1.2g which is a value 140% greater than the 0.5 g value in the DBE (See Figures 8 and 9 that were provided at our meeting with the GAO in Albuquerque on January 7). The larger ground motions at LANL from synchronous earthquakes were described on page 7-3 in the 2007 PSHA as follows:

> The hazard from synchronous versus simultaneous rupture (Section 5.1.1) is shown on Figure 7-53. The hazard is higher for synchronous rupture because the ground motions will be larger from seismic slip involving two subevents versus more uniform slip in a single albeit larger simultaneous event.

The available information shows that it is essential for the DBE in the DSA for the PF-4 to be based on the much larger ground motions from multiple synchronous earthquakes instead of the current DSA that uses a value of 0.5g for ground motions for simultaneous ruptures from a single earthquake with a return period of only 2,500 years. The actual value for ground motions at the PF-4, the RLUOB and the proposed CMRR-NF are not known but the available information demonstrates that they are certainly at least 1g.

Nevertheless, the DNFSB letter to DOE Secretary Chu on January 03, 2013 described the finding of the DNFSB that the PF-4 is ***still*** vulnerable to structural collapse for ground motions of 0.5g. This collapse is after very large amounts of money were spent over the past several years for structural upgrades. Further, the DNFSB letter describes that the required structural upgrades for ground motions of 0.5g are expected to take several years to complete.

As stated above on page 3, we asked congressional offices to request a review by GAO of the amount of funding provided over the last two decades for upgrades at PF-4 and what has actually been completed.

We have a concern that the very expensive structural upgrades that are proposed to be performed over several years into the future will *still* leave the PF-4 vulnerable to collapse from the large ground motions of 0.9g that are calculated for synchronous earthquakes on the 2,500 year return period and the large ground motions of 0.8g from simultaneous and 1.2g from synchronous earthquakes for the 10,000 year return period.

We learned that the use of the lower ground motions from a 2,500-year earthquake is a concession because of the very high cost for the structural upgrades to the PF-4 for the large ground motions from a earthquake return period of 10,000 years. The cost concession is described in the Commentary Section of the Industry Standard ASCE / SEI 43-05 on page 45 as follows:

> For most regions of the United States, the maximum considered earthquake ground motion is defined with a uniform likelihood of exceedance of 2% in 50 yr (return period of about 2,500 yr). While stronger ground motions than this can occur, it was judged that it would be economically impractical to design for such rare ground motions and the selection of the 2% in 50 yr likelihood as the maximum considered earthquake ground motion would result in acceptable levels of seismic safety for the nation.

The authors of ASCE / SEI 43-05 make the “judgment” to lower the seismic safety of nuclear facilities such as the PF-4 and the proposed CMRR-NF to a design for seismically unsafe lower ground motions because it would be economically impractical to design the facilities for the much higher ground motions from the Target Performance Goal earthquake return period of 100,000 years for SDC-5 facilities. Indeed, the citizens of the United States and certainly the citizens living in New Mexico and the Southwest may not accept the risk of very high offsite dose consequences if the nuclear facilities were to collapse because of the compromised design in order to save money.

More important is the very high offsite dose consequences to the sovereign tribal nations located close to LANL because of the unsafe structural upgrades for the PF-4 and for the design of the proposed CMRR-NF to save cost. The large release of nuclear contamination from the collapse of the PF-4 and the proposed nuclear facility could drive the tribes from their native lands and destroy the culture.

In 1992, and reinstated in 2006, Accord Agreement with Santa Clara Pueblo, Santa Clara Pueblo comments on the Draft Site - Wide Environmental Statement for Continued Operation of Los Alamos National Laboratory, New Mexico, September 28, 2006, states,

> *"Department of Energy agreed that it will consult with the Pueblo about the potential impacts of proposed actions on the Pueblo and it's cultural, religious and environmental resources and will avoid unnecessary interference with traditional practices".*

Consultation with Santa Clara Pueblo and the other Accord Tribes San Ildefonso Pueblo, Jemez Pueblo and Cochiti Pueblo have not occurred concerning the compromised seismic safety of the LANL nuclear facilities to save cost.

The Senate Report 112-173 on page 282 requires the GAO to answer 5 questions about the NNSA Alternative Plutonium Proposal. Question 4 follows

> (4) what is the estimated cost and time of building an entirely new facility accomplishing both the functions of CMRR-NF and PF-4 at the least costly location in the NNSA complex?

The Senate Report 112-173 on page 282 statutorily imposed a cost ceiling of $3.7 Billion for the construction of the CMRR-NF at LANL at the location close to the PF-4 displayed on Figure 1. The $3.7 Billion cost is not technically defensible because it was based on earthquake ground motions of 0.5g for the faults mapped at land surface great distances away from the CMRR-NF on Figure 2. The actual cost will be much higher than $3.7 Billion because of

(1) the close locations of the concealed active faults displayed on Figure 3 and

(2) the requirement to design for the greater ground motions for a SDC-5 nuclear facility because of the very large inventory of plutonium.

In addition, the calculated cost for structural upgrades to the PF-4 are much too low because the PF-4 is

(1) an SDC-5 nuclear facility because of the large inventory of plutonium,

(2) earthquake ground motions of 0.5g will cause collapse of the PF-4 with a 900 rem release that will kill workers and the public, and

(3) the PF-4 is located close to the concealed active faults which greatly increase earthquake ground motions above the value of 0.5g that is currently used to estimate costs for structural upgrades.

The required detailed field investigations for accurate knowledge of the seismic hazard at the locations of the PF-4, the RLUOB, and the proposed CMRR-NF have not been performed. We estimate the required field investigations will take a minimum of 5 years to perform and report after the date that Congress provides funding. In the meantime and in order to protect workers, the public and the environment, all LANL nuclear facilities, including PF-4 and the CMRR-RLUOB must be shuttered.

Additional information and testimony--contact preparers of this report:

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Figure 1. Aerial view of the 40-year old TA-55 Plutonium Facility (PF-4), the Proposed CMRR-NF Site, and the newly constructed Radiological Laboratory / Utility / Office Building (RLUOB).

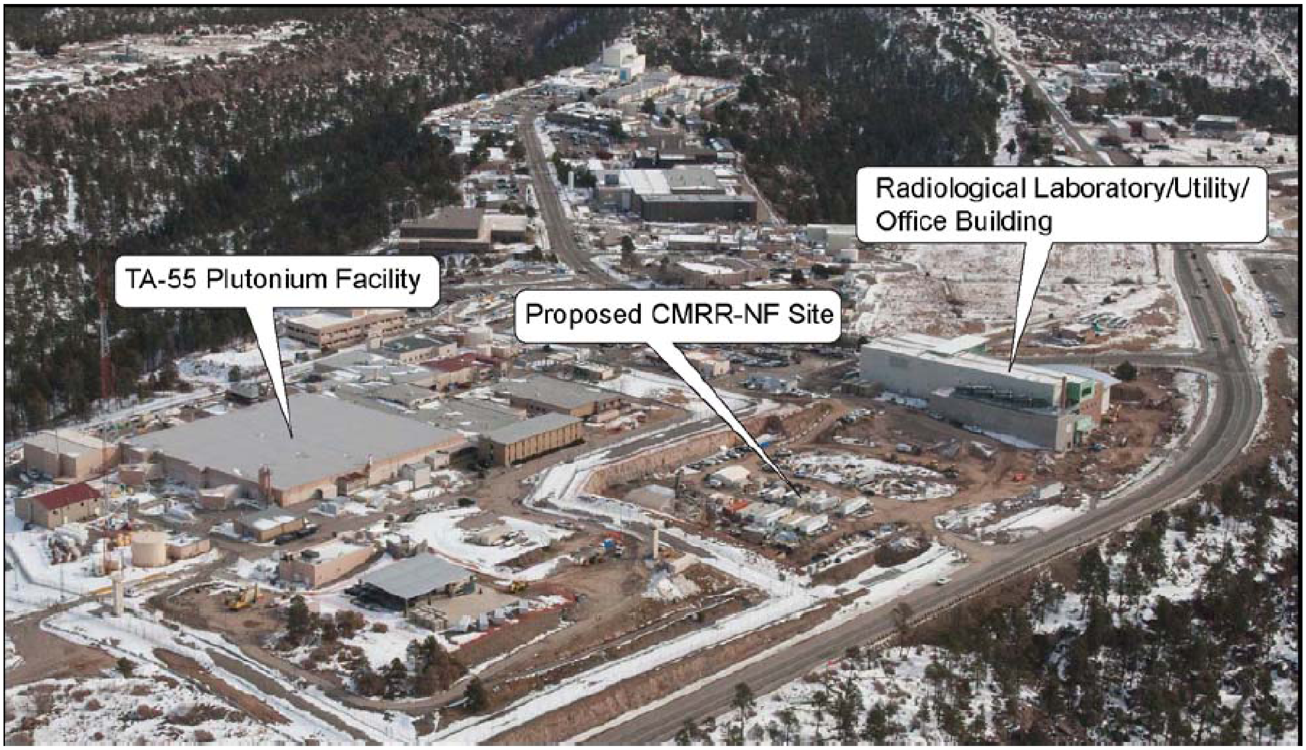


Figure 2. *"Figure 3-5. Mapped Faults in the Los Alamos National Laboratory Area"* in the DOE 2011 final Supplemental Environmental Impact Statement (SEIS) for the proposed CMRR-NF at LANL TA-55. **Note:** The map displays only the faults exposed at land surface. The ground motions in the 2007 and 2009 LANL PSHA assumed the Guaje Mountain (GM) Fault terminated 2 ½ miles north of TA-55. But the map shows the GM fault (GM in Red) is a surface rupture in Los Alamos Canyon 4,000 ft north of TA-55. Also see the extensive concealed active faults as extensions of the RC and GM Faults on Figure 3.

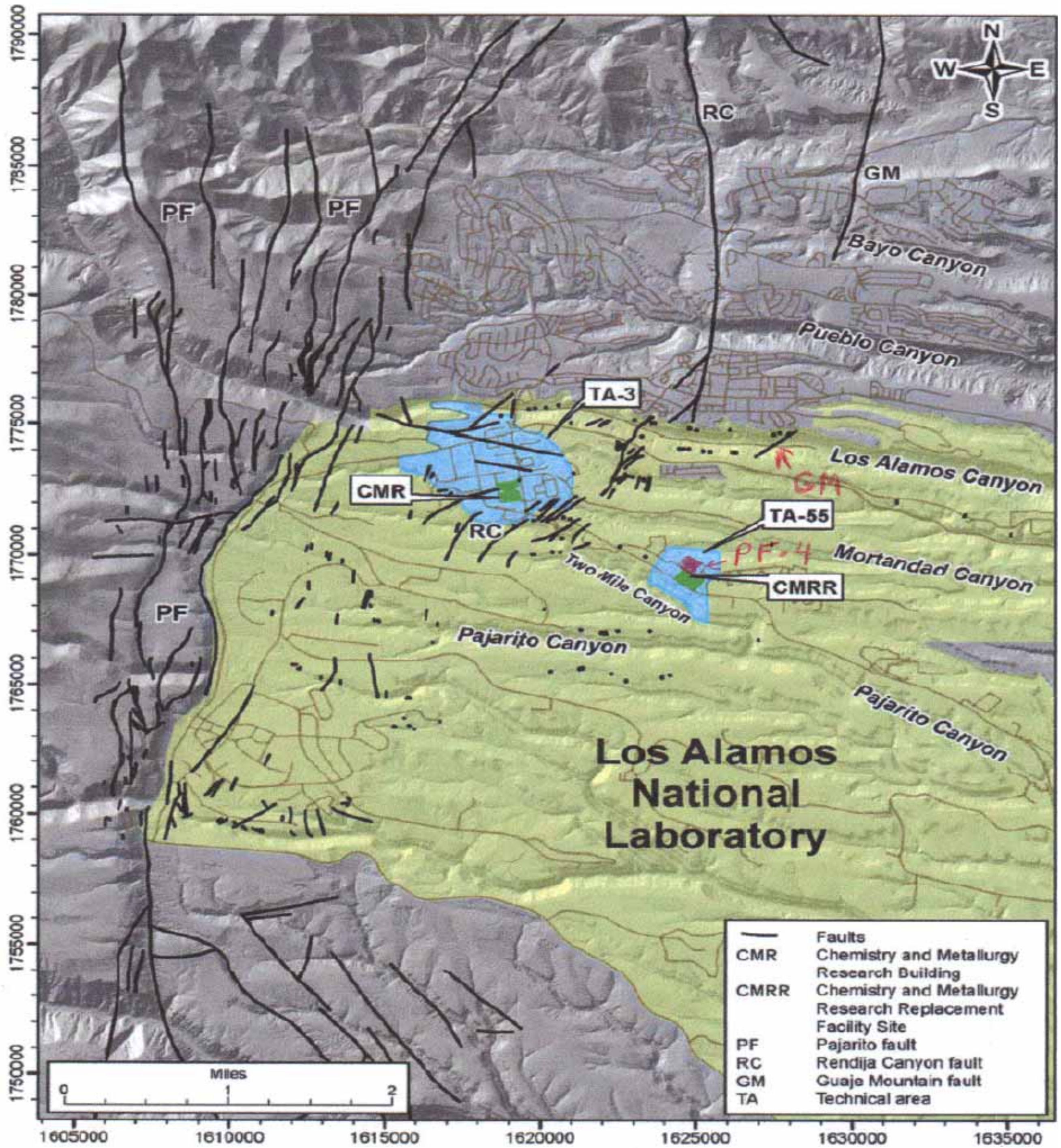


Figure 3. The concealed active RC Fault located ~800 ft west of the PF-4 and the concealed active GM Fault located ~2,000 ft east of the PF-4.

Note: The concealed faults are displayed in red and dashed where inferred. The concealed faults were not included in the structural upgrades for the PF-4, for the construction of the RLUOB, or for the engineering design of the proposed CMRR-NF.

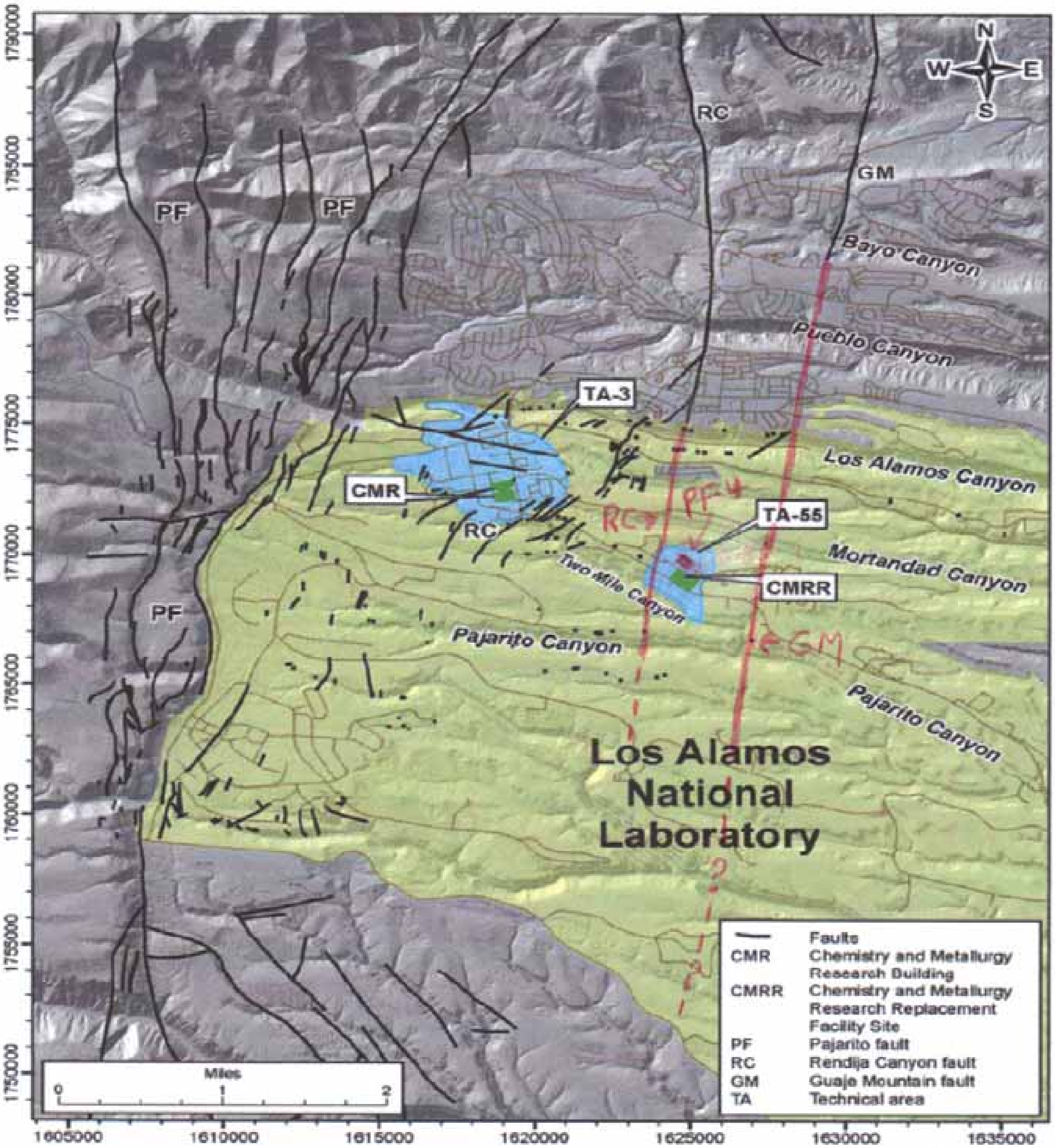
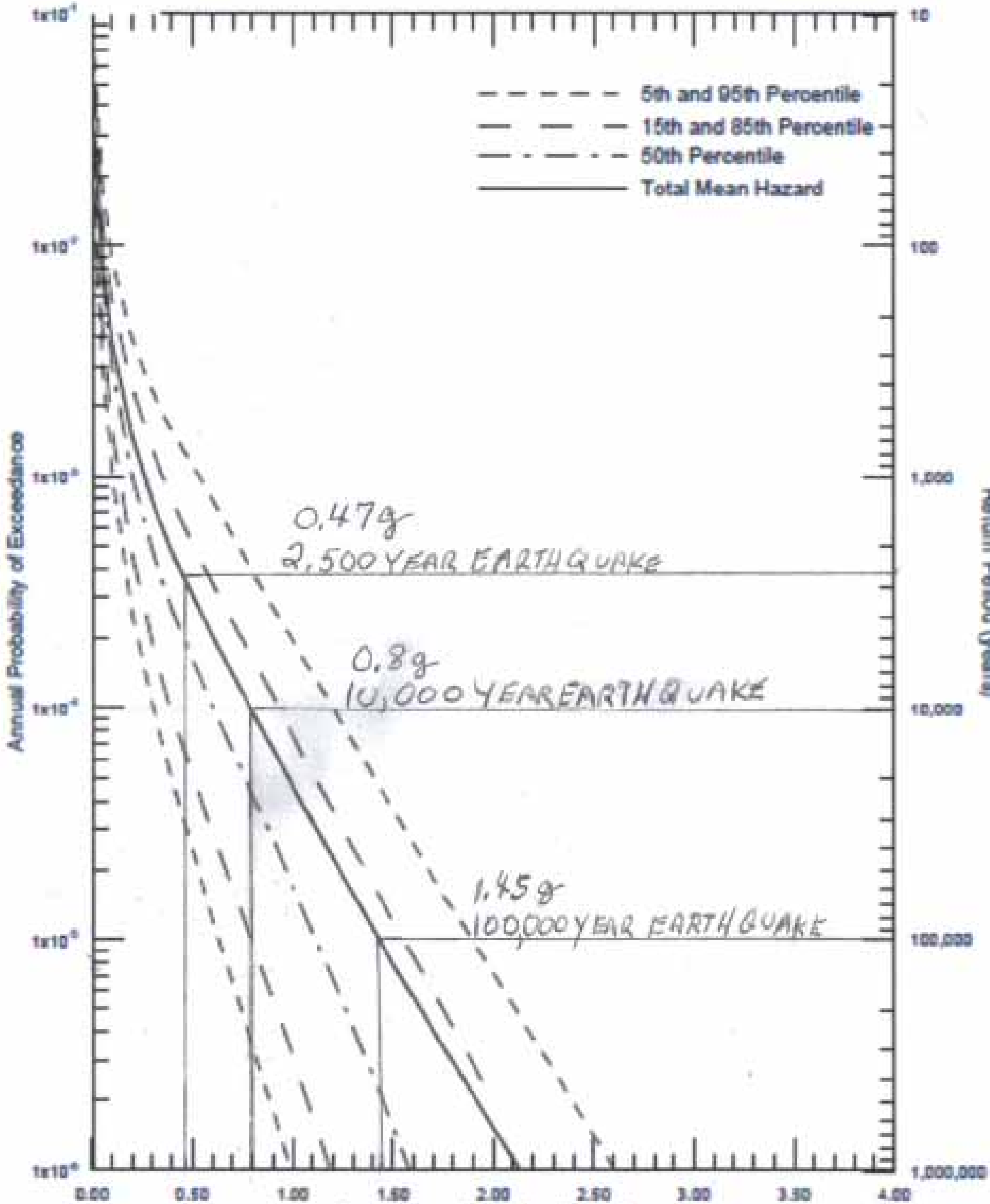


Figure 4. Seismic Hazard Curves For Peak Horizontal Ground Motions From Simultaneous Ruptures From A Single Earthquake At LANL TA-55.
Source: Figure 7 in the LANL 2009 PSHA Report.



Peak Ground Acceleration (g) – 1g is the force of gravity