The Deficiencies in Knowledge of the Seismic Hazard for the Engineering Design of the Proposed Chemistry and Metallurgy Research Replacement Nuclear Facility (CMRR-NF) at the Los Alamos National Laboratory (LANL) Technical Area 55 Require Congress to Stop All Funding for the proposed CMRR-NF - Version August 04, 2011 - By

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Fact Sheet

Intensive seismic research by Robert H. Gilkeson, an independent Registered Geologist, has revealed simple calculation errors, omissions, and under reporting of the seismic hazard at LANL in general, and the proposed location for the estimated $6 billion CMRR-Nuclear Facility to store 6 metric tons (13,228 pounds) of weapons grade plutonium.

The data in the current LANL Seismic Hazard Report – the LANL 2007 Probabilistic Seismic Hazard Analysis (PSHA) Report – show that the youthful and growing Pajarito Fault System (PFS) at LANL is now capable of a minimum magnitude **M 8.0** earthquake – a Great Earthquake - with power for extensive damage to existing LANL nuclear weapon facilities with release of special nuclear materials including plutonium and tritium.

Because of calculation mistakes, the LANL 2007 PSHA Report greatly underestimates the seismic hazard at LANL to be from earthquakes with a maximum power of **M** 7.27.

The DOE 2011 draft Supplemental Environmental Impact Statement (SEIS) for the CMRR-NF incorrectly reports the young and growing PFS as capable of earthquakes ranging from **M** 6.5 – 7.0.

According to the USGS, a **M** 8.0 earthquake produces 31 times more power than a **M** 7.0 earthquake and more than 20 times more power than a **M** 7.27 earthquake.
< http://earthquake.usgs.gov/learn/topics/richter.php >< http://www.iris.edu/edu/onepagers/no3.pdf >

Due to the increasing seismic risks on the Pajarito Plateau from a dynamic network of faults that the LANL reports describe as youthful and growing in power, it is time to remove all special nuclear materials from LANL facilities which do not meet a minimum **M** 8.0 earthquake design. Congress must demand the removal now.

At LANL, the horizontal and vertical peak ground motions (PGAs) for 1). the design of the proposed CMRR-NF and 2). the seismic hazard upgrades for the existing nuclear weapon facilities are incorrectly based on a **M** 7.27 earthquake instead of the required engineering design for ground motions from a minimum **M** 8.0 earthquake.

	Incorrect values In the LANL 2007 PSHA Report	**Corrected values calculated from data in the LANL 2007 PSHA Report**
- Maximum Moment M	**M 7.27**	**M 8.0 – A Great Earthquake**
- Horizontal PGA	**0.52 g**	**0.91 g (75% increase)**
- Vertical PGA	**0.3 g**	**1.05 g (250% increase)**

An important contradiction in the LANL 2007 PSHA Report is that the text and Figure 7-53 in Section 7 describe synchronous earthquakes to produce 75% greater ground motions than simultaneous earthquakes as follows on page 7-3:

> The [seismic] 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.

Nevertheless, the incomplete calculations in Table 5-11 in Section 5 show the synchronous earthquakes to produce less power than the simultaneous earthquakes. Table 5-11 only calculated the estimated maximum moment **M** for the individual subevents and not the much larger combined **M** for the synchronous ruptures. The table below illustrates the simple but very important mistake in the LANL 2007 PSHA Report to omit the large combined moment for the synchronous ruptures compared to analogous historic earthquakes for the PFS provided in that report.

Synchronous Earthquakes	**First Event Moment**	**Second Event Moment**	**Combined Events Moment**
- 1932 Cedar Valley, Nevada	**M 6.8**	**M 6.6**	**M 7.2**
- 1959 Hebgen Lake, Montana	**M 6.3**	**M 7.0**	**M 7.3 – 7.5**
- Pajarito Fault System Table 5-11 (RS-e)*	**M 7.02**	**M 7.08**	**Not Listed** **[estimated @ M 7.8 – 8.0]**

*** (RS-e) - Rupture Source e. The maximum moment M for simultaneous ruptures for Rupture Source e was M 7.27.**

****[estimated @ M 7.8 – 8.0] The maximum moment M 8.0 for synchronous ruptures for Rupture Source e is based on the measured moments for the 1959 Hebgen Lake synchronous earthquakes.**

The current 1997 Nuclear Regulatory Commission (NRC) Seismic Hazard Report < http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6372/vol1/index.html > in Volume 1, Chapter 4 describes why the LANL 2007 PSHA Report is not usable to calculate the seismic hazard because the field studies to collect accurate data on 1). near surface active fault locations, 2). buried active fault locations, 3). fault geometries, 4). fault interactions, 5). fault displacements, 6). fault recurrence rate, and 7). maximum moment **M** for the PFS have not been performed. Indeed, the LANL 2007 PSHA report acknowledges that the above 7 key data requirements were based on assumed values.

Because of the great uncertainty in the assumed values that were used in the LANL 2007 PSHA Report, the NRC requires LANL to use the historic **M** 7.5 1959 Hebgen Lake earthquake as an appropriate analog to the PFS and to add ½ **M** for a minimum **M** 8.0 Great Earthquake power for the design basis earthquake for the proposed CMRR-NF and the other nuclear weapon facilities at LANL. The NRC requires the minimum **M** 8.0 earthquake for the seismic hazard at LANL because the LANL 2007 PSHA Report describes the PFS as a youthful network of faults that are growing in power. A pertinent excerpt from page ES-4 in the report is below:

> The new [2007] PSHA shows that the horizontal surface PGA [peak ground acceleration] values are about 0.5 g at a return period of 2,500 years. The 1995 horizontal PGA values for a return period of 2,500 years are about 0.33 g. The estimated hazard has increased significantly (including other

> spectral values) from the 1995 study [an increase of 57%] due to the increased ground motions from the site-specific stochastic attenuation relationships and increase in the activity rate of the PFS [Emphasis Supplied].

The LANL 2007 PSHA Report describes the increase in activity rate of the PFS as one factor responsible for the 16% increase in slip rates for the data collected for the 2007 PSHA compared to the data collected for the 1995 study as follows on page 9-6:

> Sensitivity studies show that these higher [slip] rates have a significant impact on the [seismic] hazard and so ***we know that increased rates on the PFS likely contributed measurably to the increase in hazard*** **for this study, but we cannot specify exactly how much** [Emphasis Supplied].

In 2009 the LANL Seismic Hazards Geology Team published a paper in the peer reviewed Journal *Geosphere* that described the physical processes that are responsible for the growing power of the youthful PFS at LANL. The 2009 paper recognized that the LANL 2007 PSHA Report was not usable to calculate the seismic hazard at any of the LANL facilities < http://geosphere.geoscienceworld.org/cgi/content/abstract/5/3/252 >. A pertinent excerpt from page 252 in the 2009 paper by the LANL scientists follows:

> Despite the importance of understanding the geometry of the fault system and potential linkage among faults for purposes of seismic hazard analysis, a robust kinematic model of the fault system is lacking.

The current 1997 NRC Seismic Hazard Report (page 53) requires accurate maps of fault locations and fault three- dimensional geometries for all faults within 100 km (60 miles) of LANL. However, LANL reports describe that accurate maps of fault locations do not exist at LANL or within 60 miles of LANL because the necessary field investigations have not been performed. *Please see* discussion below.

An important omission is that the calculation of the seismic hazard for the proposed CMRR-NF did not include the locations of buried active faults close to the proposed NF in the 2004 LANL report by LANL scientist Dr. Kenneth H. Wohletz. LA-UR-04-8337. The fault locations used for the seismic hazard at the proposed CMRR-NF are on Figure 1 and the active faults identified by the detailed field mapping by Dr. Wohletz are on Figure 2. The faults displayed on Figure 1 do not include the active faults identified by Wohletz (2004) at locations 800 ft west, 1600 ft north and 2500 ft east of the proposed CMRR-NF. The faults mapped in Wohletz (2004) were identified from detailed field mapping of zones of intense fractures which is a common practice in the assessment of seismic hazard.

The 2007 Kleinfelder Geotechnical Report for geotechnical studies at the proposed CMRR-NF included a discussion of Wohletz (2004) on page 42 as follows:

> Recent fracture mapping by LANL (Wohletz, 2004) in the north wall of Mortandad Canyon north of the CMRR site documented fracture clusters that were interpreted as southward extensions of the RCF and GMF, passing south-southwest along the west boundary of TA-55 and through TA-63 to the west and east of CMRR, respectively.

The omission of the active faults identified in Wohletz (2004) in the DOE 2011 draft SEIS (see Figure 1 and Figure 2) is a serious issue because the faults greatly increase the seismic hazard at the proposed CMRR-NF and at the existing TA-55 plutonium facility.

The 2009 paper in *Geosphere* by the LANL scientists (Lewis et al., 2009) described the need for field investigations to determine the distance of the key Guaje Mountain fault (GM on Figure 1 below from the proposed CMRR-NF SEIS):

> The southern extent and amount of displacement of the GMF are not well characterized (p. 257).
>
> **Conclusions. . .** The southern end of the GMF has not been mapped in detail, but its southern termination is likely to be similar to that of the Rendija Canyon fault (p. 268).

The LANL scientists have a concern that the GMF may be located close to the proposed CMRR-NF but the seismic hazard was calculated with an assumption that the distance from the NF to the GMF was 2 ½ miles (see location of the GM fault on Figure 1). The accurate calculation of the seismic hazard at the proposed CMRR-NF requires accurate knowledge of the location and physical properties of the GMF. This knowledge does not exist and requires detailed field investigations.

The LANL 2007 PSHA Report described the need for detailed field mapping in the northern region of the PFS in the 3-mile gap between the PAF and Santa Clara Canyon (SCC) faults as follows:

> One key insight is that, although the PAF and SCC segments form the main western margin of the Espanola basin, there appears to be a large gap (about 5 km) between presently mapped traces of each segment. This gap is coincident with a major change in strike of the PFS from northerly to northeasterly. <u>Additional high-precision mapping should be done at the southern end of the SCC to confirm this gap</u> (p. 5-10).
>
> More displacement data and more detailed mapping are sorely needed to better define deformation patterns on the SCC, but landowner access restrictions have hampered study of the SCC to date (p. 5-11).

In addition, the DOE 2011 draft SEIS described the poor knowledge of fault locations over large regions of LANL as follows on page 3-22:

> Large eastern and southern areas of LANL have not yet been mapped in detail for seismic hazards.

Accurate knowledge of fault locations and fault properties is fundamental to calculation of the seismic hazard from the youthful and growing PFS. Accurate knowledge of the seismic hazard is essential for the proposed CMRR-NF that will store six metric tons (13,228 pounds) of weapons grade plutonium. <u>The LANL scientists recognized In Lewis et al., 2009 that it is not acceptable to use assumed values for the PFS instead of accurate values calculated from detailed field investigations as follows on page 252</u>:

> Despite the importance of understanding the geometry of the fault system and potential linkage among faults for purposes of seismic hazard analysis, a robust kinematic model of the fault system is lacking.

We estimate the required field investigations to collect data with interpretation for accurate calculation of the seismic hazard at the proposed CMRR-NF and the existing nuclear weapon facilities at LANL will require between ten to twenty years if Congress provides the funding.

Figure 1. Mapped Faults in the Los Alamos National Laboratory Area.
Source: Figure 3-5 in the DOE 2011 SEIS for locating the proposed CMRR Nuclear Facility at LANL TA-55.

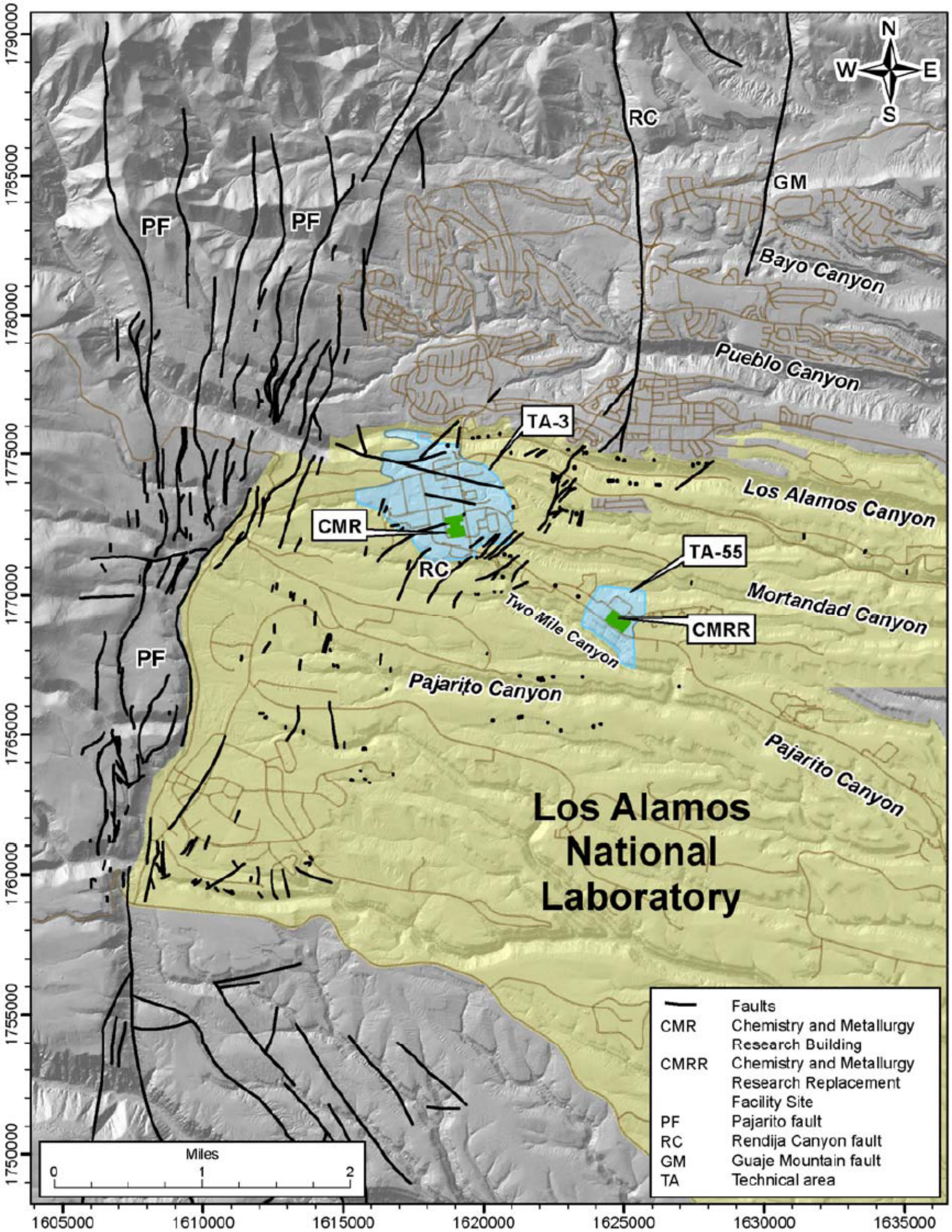
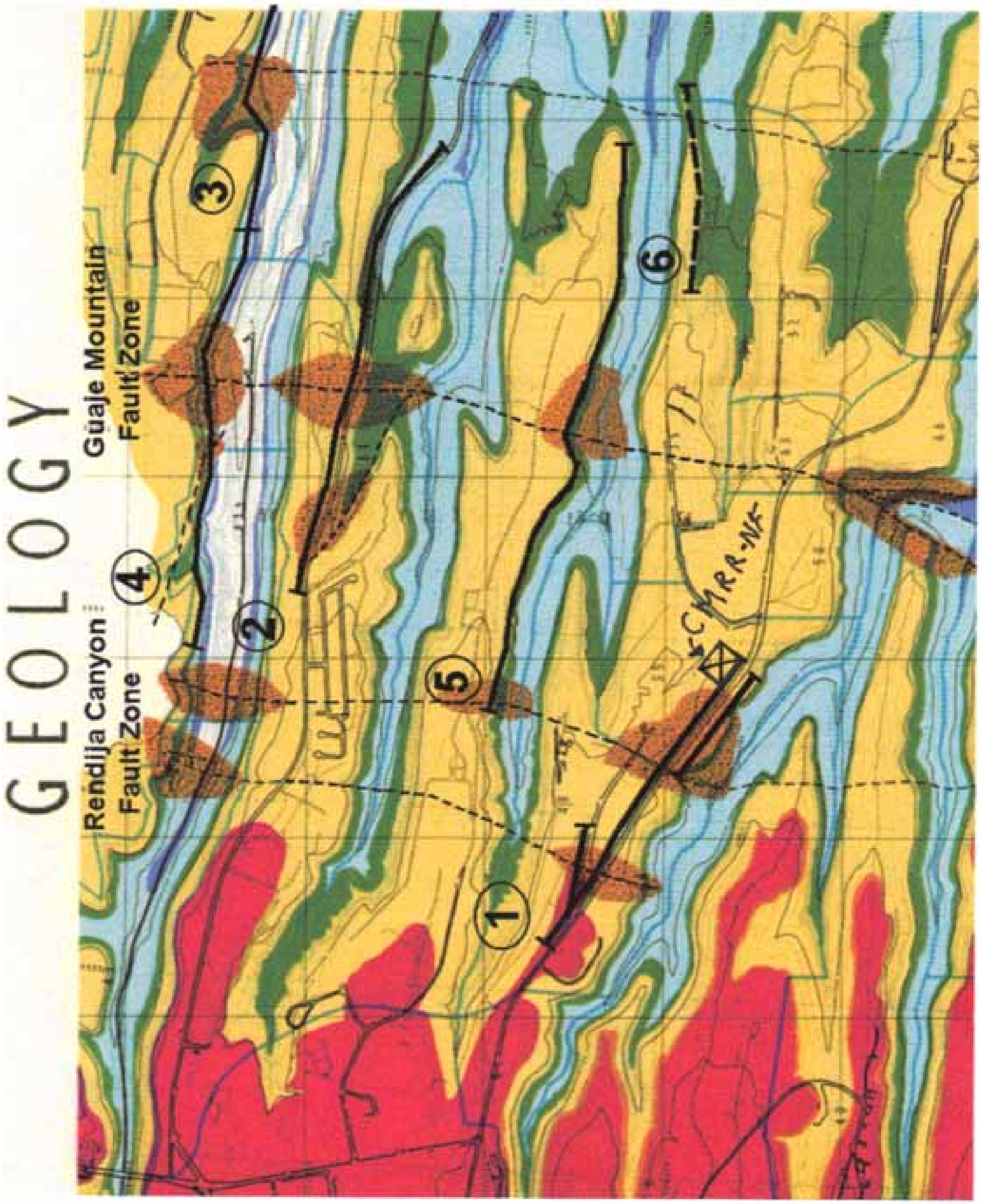


Figure 2. Map in 2004 LANL Report by Wohletz showing proposed location of Rendija Canyon Fault along the western boundary of LANL TA-55 and Guaje Mountain Fault 2500 feet east of the eastern boundary of TA-55.
Source: Figure 14 in Wohletz, 2004 (LA-UR-04-8337)



Scale 0--------------------1950 feet

- **Black X inside rectangle is location of proposed CMRR-NF**
- **Dashed black lines show trend of inferred active faults - - - - - - - - -**
- **Brown patches along dashed black lines are zones of intense fractures**
- **Circled numbers 1 to 6 have no relation to intense fracture zones.**