Union of Concerned Scientists

SEISMIC SHIFT

DIABLO CANYON LITERALLY AND FIGURATIVELY ON SHAKY GROUND

Five years ago, Pacific Gas and Electric (PG&E) informed the Nuclear Regulatory Commission (NRC) about a newly discovered fault offshore from its Diablo Canyon nuclear plant that could cause more ground motion during an earthquake than the plant was designed to withstand. In other words, there was a gap between seismic protection levels of the plant and the seismic threat levels it faced.

When similar gaps were identified at other nuclear facilities in California, New York, Pennsylvania, Maine, and Virginia, the facilities were not permitted to generate electricity until the gaps were closed. The electricity generation gaps did not trump the seismic protection gaps: the need for safety was deemed more important than the need for electricity and its revenues. But the two reactors at Diablo Canyon continue operating despite the seismic protection gap.

In the former cases the NRC would not allow nuclear facilities to operate until they demonstrated an adequate level of safety through compliance with federal regulations. It wasn't that evidence showed disaster was looming on the horizon. Instead, it was that evidence *failed* to show that the risk of disaster was being properly managed. At Diablo Canyon the NRC has flipped the risk management construct. Despite solid evidence that Diablo Canyon does not conform to regulatory requirements, the nuclear version of the "no blood, no foul" rule is deemed close enough to let its reactors continue operating.

This seismic shift places Diablo Canyon's two aging reactors literally and figuratively on shaky ground. If an earthquake occurs, it may result in more damage than the nuclear plant can withstand, with dire consequences for tens of thousands of Californians. And the tragedy of that situation will be magnified by the fact that it could have been avoided had the NRC simply handled the situation the same way it handled virtually identical situations at other facilities—by putting public safety ahead of financial safety.

This report describes the federal requirements governing seismic risks at nuclear power plants, the regulatory requirements specifically applied to Diablo Canyon, the identified seismic hazards that may exceed the mandated seismic protection levels, and the precedents at nuclear facilities in California and elsewhere in the United States in which the NRC took steps to protect people from undue risks—in other words, the measures the NRC is now sidestepping at Diablo Canyon.

The NRC's regulations draw lines between safe and unsafe, acceptable and unacceptable. But they only increase public safety if they are enforced. In 1979 Harold Denton, then Director of the NRC's Office of Nuclear Reactor Regulation, indicated that safety regulations must not only be enforced when danger is imminent. In discussing five reactors the NRC was investigating because of seismic protection levels, Denton said:

> *I think the real likelihood given an earthquake of a major pipe break and no cooling is low. We did conclude that without the proper analysis, these plants do not meet the Commission's regulations.* (NRC 1979b)

Because they did not meet the Commission's regulations, he ordered the five reactors shut until they met the regulations.

There seems little doubt what Denton would do about Diablo Canyon. Why is the NRC not doing it?

Federal Requirements on Seismic Hazards

Two levels of regulatory requirements are intended to protect nuclear power reactors in the United States against seismic hazards. The first level is the Operating Basis Earthquake (OBE):

> *The Operating Basis Earthquake is that earthquake which, considering the regional and local geology and seismology and specific characteristics of local subsurface material, could reasonably be expected to affect the plant site during the operating life of the plant; it is that earthquake which produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional.* (NRC 2013)

The Safe Shutdown Earthquake (SSE) is the second level:

> *The Safe Shutdown Earthquake is that earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake which produces the maximum vibratory ground motion for which certain structures, systems, and components are designed to remain functional. These structures, systems, and components are those necessary to assure:*
>
> *(1) The integrity of the reactor coolant pressure boundary,*
>
> *(2) The capability to shut down the reactor and maintain it in a safe shutdown condition, or*
>
> *(3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of this part.* (NRC 2013)

The values of OBE and SSE for a particular site are part of the "design basis" of the plant, which determines what the plant must be designed to withstand. The design bases ensure nuclear power reactors survive incidents and accidents like occupants in automobiles do. The OBE is like a fender bender. Occupants are expected to survive a fender bender with the vehicles continuing to be useable, albeit needing minor repairs. Similarly, a nuclear power reactor is expected to withstand an OBE and be able to restart after minor repairs.

A more serious accident might render the vehicles inoperable, and yet not be so severe that it leads to fatalities thanks to safety features like seatbelts and airbags. Likewise, nuclear power reactors should be capable of withstanding SSEs that may damage the plant to the point that it cannot resume operating, but not to the point that significant amounts of radioactivity escape to the environment.

Earthquakes causing ground motion above the SSE level can overwhelm the plant's safety systems and cause disaster.

The OBE and SSE are not one-size-fits-all values, but vary from plant to plant based on local earthquake history and the local geology. They are also not one-moment-in-time values, but can change if new faults are found nearby and when new assessments are made of the seismic activity. It is important to keep in mind that two assessments must be done to assure safety of a plant in response to earthquakes. First, an assessment must determine that level of seismic activity based on local geology and other factors the plant must be able to withstand; this defines the SSE and sets the safety bar. A second assessment must determine the level of seismic activity (i.e., ground motion) the plant as built can actually withstand. For the plant to operate safely, its protection level must meet or exceed its SSE level.

The next section explains how this local information affected the OBE and SSE values applied to the Diablo Canyon nuclear power plant.

Diablo Canyon's Seismic Requirements

At the time Pacific Gas and Electric applied to the Atomic Energy Commission (AEC, the precursor of the NRC), the AEC employed a two-step licensing process. First, owners applied for a construction permit. After completing the plant's construction, owners applied for an operating license. Table 1 gives the construction permits and operating license dates for the two reactors at Diablo Canyon.

Table 1	Unit 1	Unit 2
PG&E applied for construction permit	Jan. 16, 1967	June 28, 1968
AEC issued construction permit	April 23, 1968	Dec. 9, 1970
NRC issued operating license	Nov. 2, 1984	Aug. 26, 1985

In its construction permit applications PG&E proposed an OBE of 0.2g and an SSE of 0.4g (NRC 1991, page 1-1).[1] The AEC and its consultants on seismic issues—the United States Geological Survey (USGS) and the United States Coast and Geodetic Survey—agreed with these values (NRC 1975).

[1] These values refer to ground acceleration at the reactor due to an earthquake. Here "g" stands for the acceleration due to gravity, which is 32.17 feet per second squared. Thus, an SSE of 0.4g means ground motion causing acceleration of 12.87 feet per second squared. For Diablo Canyon, the OBE is sometimes termed the Design Earthquake (DE) while the SSE is called the Double Design Earthquake (DDE).

In parallel with the plant's construction, the AEC reviewed material submitted by PG&E supporting its application for operating licenses. The centerpiece of PG&E's materials was the preliminary safety analysis report (PSAR) that summarized the results from studies and evaluations performed to show how the plant's design conformed to AEC's regulatory requirements. The AEC reviewed the PSAR material, and the answers to many follow-up questions it asked PG&E. The AEC documented the results from its reviews in a series of Safety Evaluation Reports (SERs) that provided the basis for issuing the operating licenses. When the AEC released its first SER for Diablo Canyon on October 16, 1974, it lacked an assessment of the seismic hazard and associated protection (NRC 1975). PG&E revised its PSAR for Diablo Canyon to incorporate applicable information from the additional studies and evaluations it performed to answer AEC's questions. PG&E submitted the Final Safety Analysis Report (FSAR) to the AEC in support of its application for operating licenses for the two reactors.

The Hosgri Fault

The Energy Reorganization Act of 1974 divided the AEC into the Nuclear Regulatory Commission (NRC) and what is today called the Department of Energy (DOE). The NRC issued a supplement to the Diablo Canyon SER on January 31, 1975, containing its preliminary assessment that the plant's SSE should be 0.5g rather than 0.4g. However, that same day the NRC received a report from the USGS concluding that an SSE value of even 0.5g was inadequate for the seismic potential at Diablo Canyon (NRC 1975 and NRC 1977, page 12).

The seismic shift from an SSE value of 0.4g to one of at least 0.5g resulted from a paper published in January 1971—after AEC issued the construction permits for the reactors at Diablo Canyon—by Hoskins and Griffiths about their surveys of offshore regions for an oil company. They identified a fault, labeled the Hosgri fault, lying about 3 ½ miles offshore of the Diablo Canyon site (NRC 1977, page 5). PG&E had not surveyed the offshore area prior to the AEC's issuance of the construction permits for Diablo Canyon (NRC 1977, page 5). Figure 1 reveals how close the Hosgri fault is to the Diablo Canyon site. The NRC likely saw increasing the SSE level from 0.4g to 0.5g as a response to the discovery of the new fault that would not require modifications of the plant because it believed the plant had been conservatively designed and could withstand ground motions of 0.5g (NRC 1977, page 12).

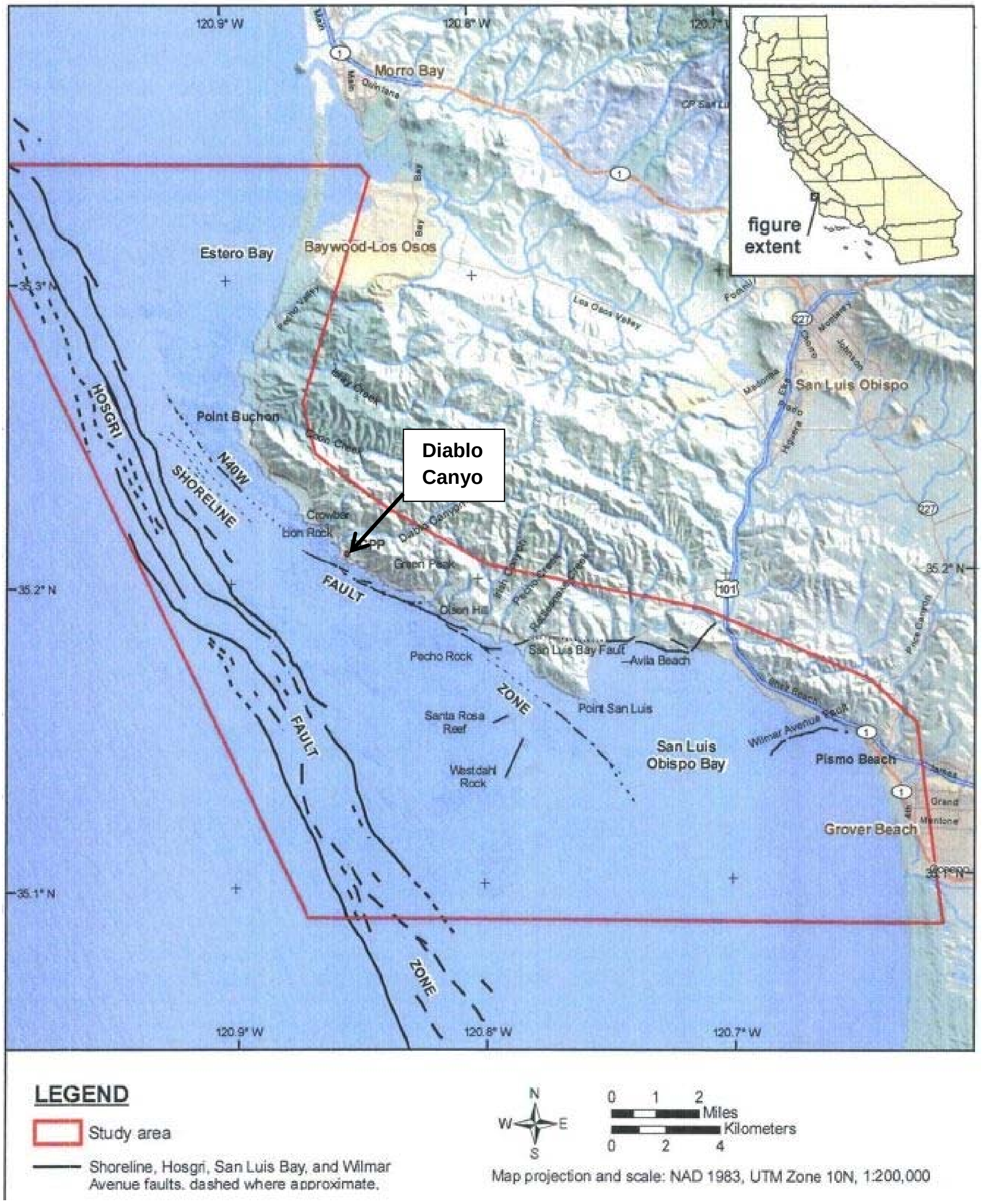

Figure 1 Source: PG&E 2011a

As the NRC anticipated, PG&E responded to the January 1975 SER supplement with information explaining how Diablo Canyon's design enabled it to survive ground motion of 0.5g without modifications to the plant (NRC 1977, page 13).

However, the USGS reviewed PG&E's information and provided another report to the NRC in December 1975 reaffirming its position that a value of 0.5g for the SSE was inadequate (NRC 1977, page 13). This means that since the mid-1970s there have been questions about whether the safety bar for Diablo Canyon is set at the right height.

Despite the USGS concerns regarding the Hosgri fault, the NRC ultimately left the SSE for Diablo Canyon at 0.4g—the value it determined before it knew about the Hosgri fault (PG&E 1996). But the NRC was obviously concerned because it took the rare precaution of requiring Diablo Canyon to have sensors that cause the reactors to automatically shut down when ground motion exceeds 0.35 to 0.43g (NRC 2005). Other U.S. nuclear power plants have equipment monitoring ground motion and procedures that direct operators to manually shut down the reactors when appropriate.

In addition, the NRC required PG&E to evaluate the plant's response to 0.75g ground motion resulting from an earthquake occurring on the Hosgri fault (PG&E 2011b, slide 5, NRC 1991, page 1-2 and NRC 2009, page 2).

The NRC issued a full-power operating license to PG&E for Diablo Canyon Unit 1 on November 2, 1984. The operating license contained a provision requiring PG&E to re-evaluate the seismic design basis for the plant; to do so PG&E established its Long Term Seismic Program (LTSP).

Based on its LTSP study, PG&E updated the Final Safety Analysis Report (PG&E 1988). According to PG&E:

> *The LTSP contains extensive databases and analyses that updated the basic geologic and seismic information in this FSAR Update. However, the LTSP material does not alter the design bases for DCPP* [Diablo Canyon Power Plant] (PG&E 2010, page 3.7-1).

In other words, PG&E's evaluation concluded that the new seismic information did not require a value of SSE larger than 0.4g. It also concluded that the Diablo Canyon reactors could withstand earthquakes larger than SSE, and in particular could withstand seismic activity up to 0.75g.

However, while the NRC required PG&E to conduct the Hosgri and LTSP evaluations, these evaluations did not meet the high standards that the NRC requires of a rigorous analysis performed to determine the SSE value. The Hosgri and LTSP evaluations were performed to answer "what if" questions, but were not intended to officially determine whether the reactors met federal regulations. In particular, the Hosgri and LTSP evaluations used non-standard methods and non-conservative assumptions.

For example, the differences between a rigorous SSE evaluation and PG&E's Hosgri and LTSP evaluations include (PG&E 1996):

- An SSE evaluation uses the minimum specified values for the material properties of concrete, support steel, piping, and other components whereas the Hosgri and LTSP evaluations used values obtained by tests. The Hosgri and LTSP evaluations thus assumed concrete and other materials were stronger and more resistant to earthquake forces than assumed in an SSE evaluation.

- The Hosgri and LTSP evaluations assumed that the building's foundation absorbed four to five percent of the ground motion energy while an SSE evaluation conservatively assumes that all this energy was applied to structures and components.

- An SSE evaluation assumes that vibrations caused by the earthquake would be dampened by two to five percent whereas the Hosgri and LTSP evaluations assumed seven percent damping. In other words, the Hosgri and LTSP evaluations assumed the plant had larger "shock absorbers" that lessened the duration and magnitude of shaking—and damage resulting—from the earthquake.

- An SSE evaluation assumes that steel supports and piping remained rigid during the event while the Hosgri and LTSP evaluations assumed that some components would bend. Rigid components transfer force to walls, floors, and whatever else to which they are connected. The force assumed to bend a component lessens the force applied on its neighbors.

So while PG&E's Hosgri and LTSP evaluations concluded that the reactors could withstand ground motion up to 0.75g, these results are not reliable measures of Diablo Canyon's ability to safely withstand such earthquake forces. And the NRC cannot officially rely on these results to gauge the regulatory compliance of the Diablo Canyon reactors.

It is important to recognize that even if Diablo Canyon were designed to withstand ground motions of 0.75g—which has not been shown using a robust, rigorous, and legally acceptable way—Californians would be at risk since larger earthquake can occur. Extending the vehicle safety/nuclear plant seismic protection analogy one final time, designing the plant to withstand the seismic acceleration equal to the SSE does not protect a nuclear plant from all earthquakes any more than seatbelts, airbags, and other safety features protect occupants during every crash. Diablo Canyon and other nuclear power reactors are vulnerable when faced with hazard levels greater than the design basis they are protected against.

In particular, the chance of an earthquake causing ground motion at Diablo Canyon greater than 0.75g is 3.9×10^{-3} per year (NRC 2011).[2] Put another way, such an earthquake is likely to happen once every 256 years. To put this value in context, the Diablo Canyon reactors are more than 10 times more likely to experience an earthquake larger than they are designed to withstand than the average U.S. reactor.[3] Of the 100 reactors currently operating in the U.S., the two at Diablo Canyon top the NRC's list as being most likely to experience an earthquake larger than they are designed to withstand.[4]

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[2] The NRC report (NRC 2011) giving these results incorrectly uses a value of SSE for the Diablo Canyon reactors of 0.75g. If the actual SSE value (0.4g) had been used, the probability of an earthquake producing ground motions larger than the SSE would be much larger.

[3] The average likelihood of a reactor in the United States experiencing an earthquake larger than its SSE is $3.05E^{-4}$ per year, or one event every 3,275 years (NRC 2011).

[4] The NRC also tracks the likelihood that an earthquake would damage the reactor core. Diablo Canyon's reactors are 16th and 17th in the nation with odds of 4.2×10^{-5} per year of incurring reactor core damage due to an earthquake, or roughly one such meltdown every 23,810 years. Diablo Canyon is nearly double the risk of the average nuclear power reactor in the U.S., which is 2.05×10^{-5} per year or one meltdown every 48,780 years (NRC 2011seimic).

Another way to look at this risk is that the chance such a large earthquake will occur at Diablo Canyon over the 40-year lifetime of the plant is 40 divided by 256, or about 1 in 6—which is a toss of a die.

As shown in Figure 2, dozens of earthquakes have occurred at or near the Diablo Canyon site. These past earthquake do not mean that Diablo Canyon will experience an equal number of earthquakes in the future. They also do not mean that Diablo Canyon will avoid earthquakes of greater magnitude and/or proximity in the future. They mean that Diablo Canyon sits on ground that frequently shakes a lot and its seismic risks should be evaluated very carefully.

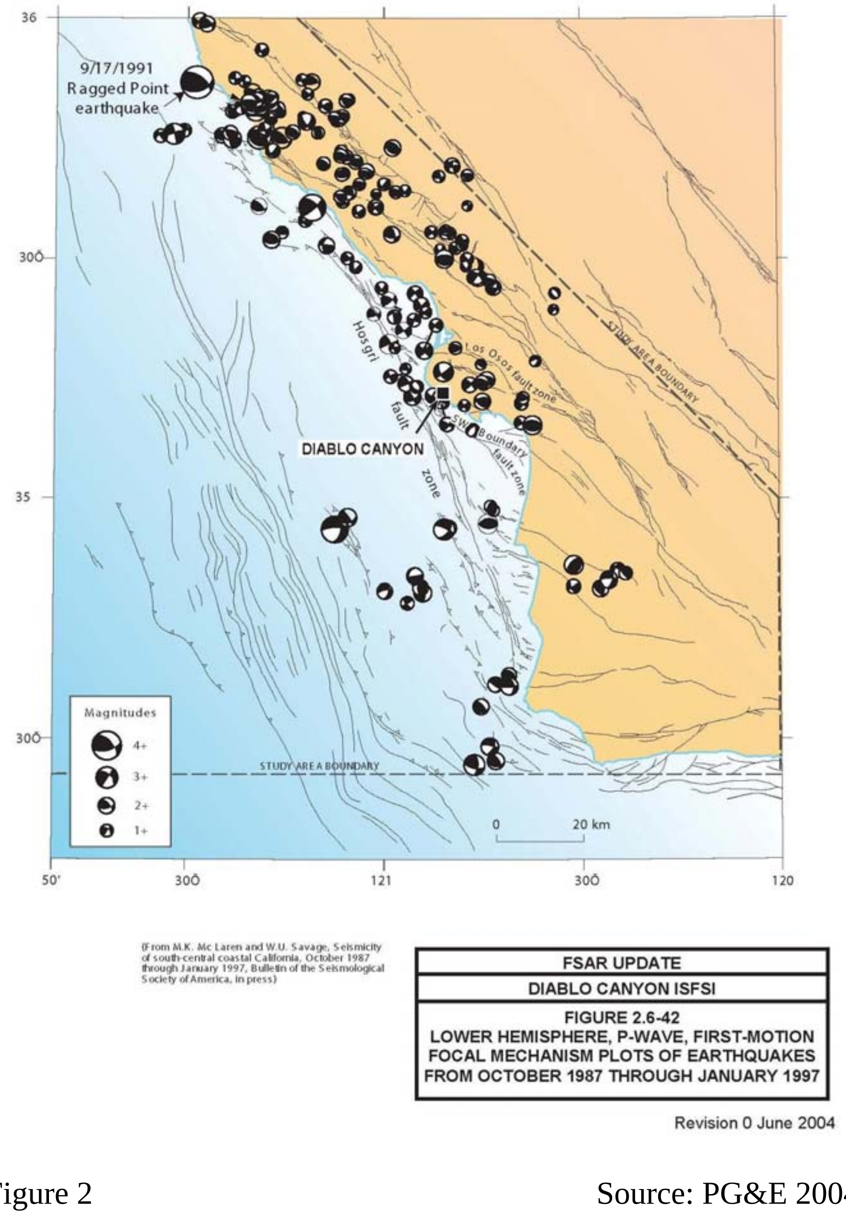

Figure 2 Source: PG&E 2004

The Shoreline Fault

PG&E informed the NRC on November 13, 2008, that a "zone of seismicity that may indicate a previously unknown fault" had been located offshore from the Diablo Canyon site (NRC 2009, page 1). As indicated on Figures 1 and 3, the Shoreline fault lies much closer to Diablo Canyon than the Hosgri fault. The Shoreline fault is about 2,000 feet (600 meters) from the turbine building and only about 985 feet from the intake structure where cooling water is drawn from the Pacific Ocean.

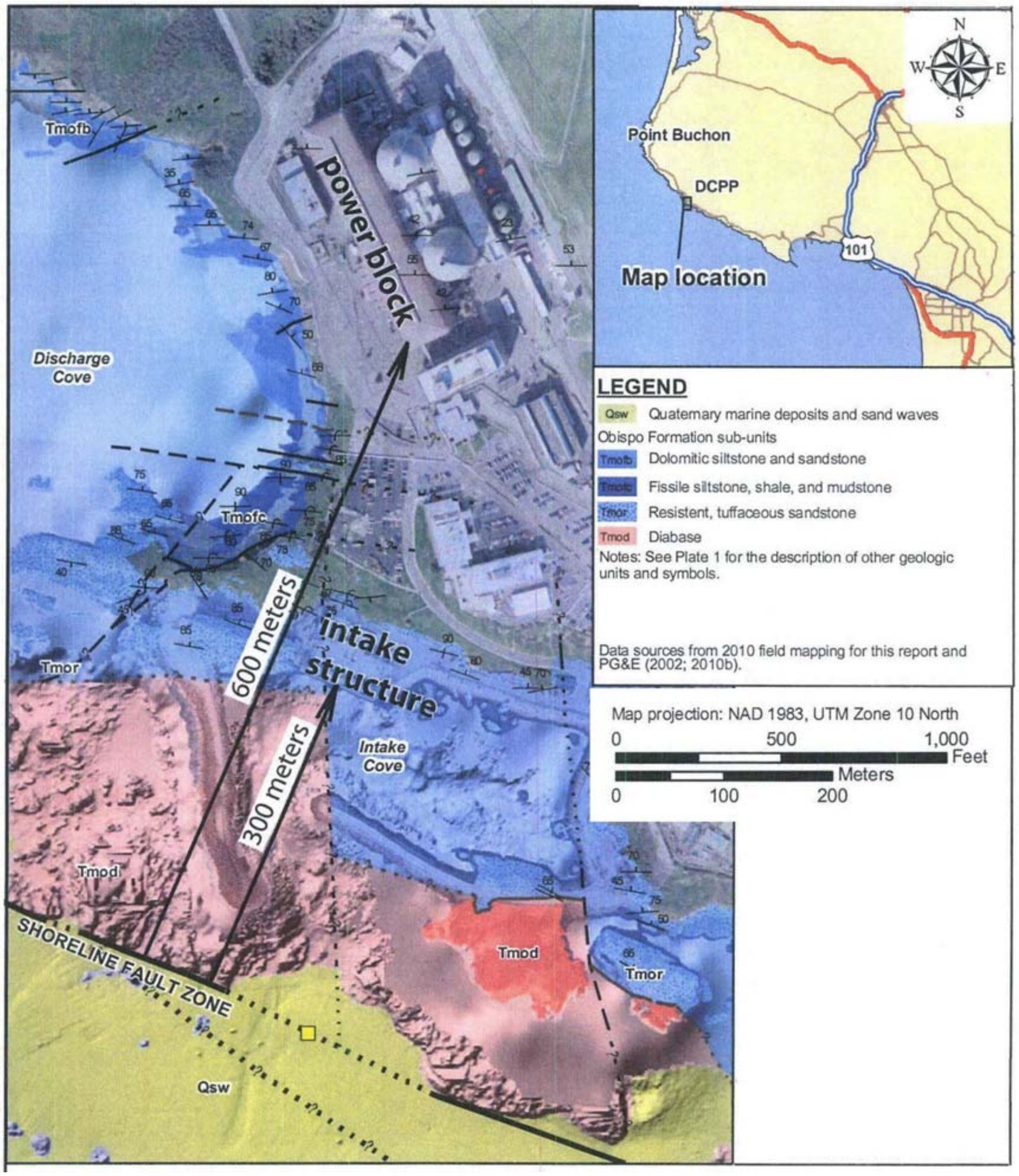

Figure 3 Source: PG&E 2011a

The NRC assessed the ground motion that could be produced at Diablo Canyon from an earthquake on this new fault and concluded that it was less than what would result from a Hosgri earthquake, and therefore was covered by the evaluations PG&E performed in its Long Term Seismic Program (NRC 2009, page 2).

On October 20, 2011, PG&E submitted a license amendment request to the NRC seeking to revise the seismic design bases for Diablo Canyon. Specifically, PG&E requested that the NRC approve increasing the SSE level to 0.75g—the Hosgri earthquake level (PG&E 2011b, slide 2 and PG&E 2011c).

In other words, PG&E sought to have the NRC increase the SSE value to a level PG&E believed its reactors could withstand, but that had not been justified by a rigorous analysis meeting the NRC's regulatory standards. PG&E's motivation was likely that it believed the higher SSE value would cover seismic activity from both the Hosgri and Shoreline faults without the need for costly modifications to the plant. But without rigorous analysis, any increase in safety would be an illusion.

David Copperfield and other magicians get paid when performing such feats of illusion. PG&E also gets paid for its illusion from the revenue generated by the continuing operation of Diablo Canyon's two reactors.

Dissent Within the NRC

Dr. Michael Peck, then the NRC senior resident inspector assigned full-time at the Diablo Canyon site, reviewed actions taken and planned by PG&E in response to the identification of the Shoreline fault. Peck disagreed with preliminary conclusions by PG&E and the NRC that Diablo Canyon could continue operating safely with these seismic issues unresolved. Peck initiated a non-concurrence report using the process within the NRC for individuals to formally disagree with NRC decisions (Peck 2012).

Peck enumerated several reasons why Diablo Canyon was not being operated safely within its legally defined design bases. He contended that the process PG&E used to determine whether its reactors could continue operating despite having a known non-conforming condition (the seismic gap)[5] was inadequate because it:

> … *failed to demonstrate that the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code acceptance limits were met for reactor coolant pressure boundary components at the higher structural stress levels represented by the new seismic information.*
>
> … *failed to demonstrate that all seismically qualified plant SSCs* [structures, systems, and components] *would continue to function at the higher vibratory motion associated with new seismic information in accordance with the [SSE] design basis* (Peck 2012).

[5] There can be no argument that a seismic gap exists. If no gap existed, PG&E would not have applied to the NRC on October 20, 2011 (PG&E 2011c) to close it.

Peck basically contended that PG&E's initial assessment for the Shoreline fault indicated that it could produce ground motion at the Diablo Canyon site that could subject parts of the plant to more force than they were designed to withstand. As a result, the excessive force would damage equipment and structures needed to safely shut down the reactors and protect workers and the public from harm.

For example, Peck noted that PG&E's evaluation did not show that the reactor vessel and piping attached to it (collectively the reactor coolant pressure boundary) would remain intact when subjected to forces from an earthquake along the Shoreline fault. If the reactor coolant pressure boundary is breached, water ends up on the floor instead of cooling the reactor core and preventing its meltdown. Peck's non-concurrence report expressly pointed out that the NRC's regulations and standards do not permit reactors to continue operating when information shows that equipment and structures would not be capable of performing this vital safety function. Yet Diablo Canyon's reactors continue operating.

On October 25, 2012, PG&E formally withdrew its license amendment request from the NRC (PG&E 2012). This means that the SSE value is still at 0.4g.

Today, Diablo Canyon's reactors continue operating with a gap between the seismic protection levels specified in their design bases and the potential seismic hazards known to exist.

When similar gaps were identified at other NRC-licensed nuclear facilities in California and across the country, the NRC did not allow those facilities to operate until the gaps were closed, as detailed in the following sections.

California Precedents

General Electric Test Reactor (GETR) (Vallecitos, CA)

The AEC issued an operating license for GETR in 1959. It was not used to generate electricity and was primarily used for the production of radioisotopes for medical and industrial use. The NRC ordered that the reactor be shut down in 1977 and not resume operating until a potentially active fault (the Verona fault) passing near the reactor could be thoroughly evaluated and adequately protected against. (Rice 1979 and NRC 2007).

Humboldt Bay (Eureka, CA)

The AEC issued a construction permit on October 17, 1960, to PG&E for Humboldt Bay, and an operating license for the reactor in August 1962. In the early 1970s, oil company geologists exploring for natural gas discovered that the nearby Little Salmon fault was active. Studies prepared by and for PG&E before the plant was built concluded this fault was dormant. On May 17, 1976, the NRC ordered PG&E to upgrade seismic protection at Humboldt Bay before restarting from its next refueling outage (PAR 2003).

On July 6, 1976, PG&E shut down the reactor for refueling and to upgrade its seismic protections. As PG&E neared completion of the seismic modifications a year later, the NRC said the reactor could not be restarted until additional seismic concerns were resolved. PG&E suspended work at Humboldt Bay pending completion of the supplement evaluations. (PAR 2003).

San Onofre Unit 1 (San Clemente, CA)

The AEC issued an operating license for San Onofre Unit 1 on March 27, 1967. Its seismic design bases featured a 0.25g OBE and a 0.5g SSE (NRC 1982, enclosure page 2). In 1973, the plant's owner initiated a program to reevaluate and modify as necessary the capability of Unit 1 to withstand a 0.67g SSE (NRC 1982, enclosure page 2). The plant's owner presented results of their re-evaluations for the 0.67g SSE to the NRC during a meeting in May 3, 1982. The results showed high stress values on certain equipment, piping, and supports. On May 20, 1982, the NRC informed the plant's owner that it would not permit the reactor to resume operating until the gap between seismic protection and seismic hazard was closed (NRC 1982, enclosure page 4).

Other Precedents

Nuclear Fuel Services Reprocessing Facility (West Valley, NY)

The AEC issued a license to Nuclear Fuel Services (NFS) and the Atomic Research Development Authority on April 16, 1966, for the operation of the West Valley fuel reprocessing plant and associated waste storage facilities. NFS shut down the plant in early 1972 for modifications. In May 1972, the AEC informed NFS that the modifications constituted a "material alteration" of the facility that required its formal review and approval. In October 1973, NFS submitted a report to the AEC describing the modifications to the plant and justifying them from a safety perspective. The AEC investigated the seismic activity and geology in the area in 1971 and had calculated the magnitude of the largest earthquake likely to occur. NFS considered this AEC information in developing its 1973 submittal (GAO 1977).

Following additional evaluations of faults near the plant, field studies, and reviews of historical seismic activity in 1976, the NRC concluded that a still more conservative earthquake design was required before the plant could restart safely. Geologists and seismologists hired by NFS agreed that NRC's methodology and conclusions were reasonable. To protect against the increased seismic hazard, NFS proposed construction of a reinforced concrete structure around the chemical separation facility (GAO 1977).

On September 22, 1975, NFS announced the company's decision to retire the plant. NFS President Ralph W. Deuster said

> *…the single most overpowering regulatory change was a drastic increased in the seismic criteria for the West Valley site which created doubt over whether or not the plant could ever be licensed for commercial reprocessing operations* (Severo 1977).

Five Faulty Reactors (Shippingport, PA; Wiscasset, ME; Scriba, NY; and Surry, VA)

On March 13, 1979—roughly two weeks before the partial meltdown of the Unit 2 reactor at Three Mile Island—the NRC ordered five nuclear power reactors (Beaver Valley Unit 1, Maine Yankee, FitzPatrick, and Surry Units 1 and 2) to shut down within 48 hours and to remain shut down until piping systems were re-analyzed for postulated earthquakes and all modifications indicated by the re-analysis were completed (NRC 1979c).

Beaver Valley's owner had notified the NRC on December 8, 1978, that the stress levels for two supports on piping inside the containment had not been calculated using a computer code. As NRC inspectors investigated this report, they identified anomalies in the results from the computer code that was being used to analyze stress levels on piping and components during postulated earthquakes. This code was under-predicting stress levels due to an error (NRC 1979a, page 2, line 18).

The Unit 1 reactor at Beaver Valley had over 500 supports on piping in safety systems. By early March 1979, workers had examined 70 supports and determined that 50 of them would experience stress levels higher than that allowed by the code in event of an earthquake (NRC 1979b, page 5, line 23). The supports for piping in safety systems at the other four reactors had been analyzed using the same faulty computer code. The NRC's concern was that an earthquake could both break a pipe connected to the reactor vessel allowing cooling water to drain out and also break a pipe or pipes in the emergency systems intended to provide makeup water to the reactor vessel. The NRC was worried about this common mode failure and its potential to breach two key safety barriers (NRC 1979a, page 39, line 6).

On March 13, 1979, the NRC ordered the five reactors to shut down and remain shut down until its concerns about the gap between seismic protection and seismic hazards was closed. Harold Denton, then the Director of the NRC's Office of Nuclear Reactor Regulation, participated in a press conference that afternoon regarding the problem and the solution being sought by the NRC's order. Denton stated:

> *If we had an earthquake of the size for which these plants were designed, there is a potential that the earthquake could both cause a loss of coolant accident by affecting some piping, and also affect the capability of the emergency core cooling systems to perform. So, this is what we refer to as a common mode failure*. (NRC 1979b, page 6, line 21)
>
> *The reason they are being shut down is because they don't meet the Commission's regulation.* (NRC 1979b, page 7, line 19)

When asked if the people living near the plants had been in danger, Denton replied:

> *I think the real likelihood given an earthquake of a major pipe break and no cooling is low. We did conclude that without the proper analysis, these plants do not meet the Commission's regulations.* (NRC 1979b, page 9, line 10)

In other words, the NRC issued the orders not based on signs of pending disaster, but on lack of assurance of continued safety as defined by compliance with federal regulations. The NRC was enforcing its regulations to ensure safety.

These five nuclear power reactors did not restart until the NRC determined the gap between seismic protection and known seismic hazards had been closed. For example:

> *On August 14, 1979, the NRC lifted the shut down order and allowed the FitzPatrick nuclear reactor to restart. The NRC determined that the owner had re-evaluated the OBE and SSE using an acceptable computer code and had completed modifications to all applicable piping supports* (NRC 1979d, attachment page 3).

> *On March 26, 1980, the NRC lifted the shut down order and allowed the Surry Unit 2 reactor to restart. The NRC determined that all necessary re-analysis and modifications had been completed for known seismic hazards* (NRC 1980).

The NRC served the public living around the Beaver Valley, FitzPatrick, Maine Yankee, and Surry nuclear plants well. The NRC did not have information indicating that these people were in harm's way. But the NRC lacked information indicating that these people were adequately protected from harm should it appear. The NRC properly found this situation intolerable and did not allow the reactors to operate until it was convinced that their neighbors were adequately protected from harm.

Conclusion

The recent discovery of the Shoreline fault closely offshore from the Diablo Canyon nuclear plant again raised the question of whether its reactors conformed to the NRC's safety regulations governing seismic protection.

PG&E sought to answer this question by requesting that the NRC formally revise the safe shutdown earthquake (SSE) level to the level the company had evaluated for the Hosgri fault and under its Long Term Seismic Program (LTSP). PG&E believes the plant can withstand the ground motion caused by an earthquake on the Shoreline fault. But it has never performed a rigorous analysis of the Hosgri and Shoreline faults using the methods and assumptions required to legally re-define the seismic design basis. As a result, the NRC does not have the information it needs to determine that Diablo Canyon can operate safely.

Dr. Michael Peck, then an NRC resident inspector at Diablo Canyon, pointed out numerous deficiencies in PG&E's evaluation of the shoreline fault. Peck concluded that more analysis and likely additional modifications would be necessary before anyone could honestly claim that Diablo Canyon was adequately protected from an earthquake originating along the Shoreline fault.

Even if the Diablo Canyon reactors can in fact withstand the level of earthquakes PG&E asserts they can (0.75g), NRC analysis shows that there is roughly a 1-in-6 chance that the reactors will experience an earthquake larger than that over their 40-year lifetime. This suggests that even if the reactors are capable of withstanding 0.75g of ground motion, that may still be inadequate to ensure public safety.

Despite this, the NRC allows the Diablo Canyon reactors to continue operating.

At many other plants, the NRC put safety ahead of other considerations by not allowing nuclear facilities to operate if they had unanswered seismic safety questions. In the present, the NRC allows Diablo Canyon to operate based on unsubstantiated beliefs that the plant can withstand the threat from the Hosgri and Shoreline faults.

At these other plants, the NRC did not rely on luck to protect the public. Instead, it relied on compliance with federal safety regulations to provide that protection. The NRC is betting that the big one won't make Diablo Canyon the next nuclear nightmare. When the stakes involve tens of thousands of Californians, the NRC should stop wagering and resume regulating.

As it has at other plants with similar issues, the NRC should enforce its seismic regulations at Diablo Canyon.

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