



# Nuclear Power Safety in California

California hosts four operating nuclear power reactors and three others that are no longer operating. The two reactors at Diablo Canyon Nuclear Power Plant near Avila Beach and two operating reactors at San Onofre Generating Station near San Clemente generated nearly 16 percent of California's electricity in 2010.

Humbolt Bay, Rancho Seco, and San Onofre Unit 1 are no longer operating.

The Nuclear Regulatory Commission (NRC), the federal agency that oversees the U.S. commercial nuclear fleet, is aware of safety shortfalls at these plants but has no plans to resolve them any time soon. As a result, Californians are exposed to unnecessarily high risks from these plants.

Much is at stake for residents of the region. While local and state officials can monitor the reactors in their state, they have no control over plant safety. Federal law grants that authority exclusively to the NRC. But local and state officials, as well as state residents, can take steps to compel the NRC to ensure adequate protection.

## Fire Hazards

Neither the Diablo Canyon nor the San Onofre reactors comply with the NRC's fire protection regulations and therefore they both pose an increased risk of accident. Because a fire can destroy a nuclear plant's main and backup emergency systems, it is the most likely way in which a reactor core can be seriously damaged and result in a release of radioactivity. Fire poses a threat essentially equal to all other threats combined. According to the NRC, "Approximately one-half of the core damage risk at operating reactors results from accident sequences that initiate with fire events."<sup>1</sup>

**Fire poses a threat essentially equal to all other threats combined.**

**Diablo Canyon and San Onofre are not in compliance with NRC fire protection regulations.**

Fire can defeat the defense-in-depth approach to nuclear safety. Defense-in-depth relies on redundancy and diversity of emergency systems as well as multiple barriers between radioactive material and the environment. A fire can damage electrical cables used to power and control primary systems and their backups, rendering them useless. Likewise, a fire can disable systems that cool the reactor core and those needed to prevent releases of radiation.

A disastrous fire that erupted in the control room of Alabama's Browns Ferry Nuclear Plant in 1975, for example, disabled all of the reactor's emergency core cooling systems. To avoid a meltdown, workers took heroic actions to temporarily re-power the equipment they used to avoid a meltdown. To lessen the chances of another Browns Ferry, or worse, the NRC adopted stricter fire protection regulations in 1980.



*Diablo Canyon Nuclear Power Plant*



*San Onofre Nuclear Generating Station*

## *NRC Revision of Fire Regulations*

To minimize damage caused by a fire, the NRC's 1980 fire regulations stipulate that the electrical cables for primary systems and their backups must either be physically separated (i.e. at least 20 feet apart) or one of the cables must be wrapped in fire retardant material qualified to protect the cable long enough for the plant's fire suppression systems to extinguish the fire. The regulations sought to build fire protection into the design of the plant while retaining worker actions as the safety net.

Twenty years later, the NRC discovered that dozens of reactors failed to meet those regulations and were therefore being operated with undue risk of serious damage from fires. In response, the NRC adopted an alternative set of fire protection regulations in 2004. The 1980 regulations remained on the books, so plant owners had the option of meeting either the 1980 or the 2004 fire protection regulations. Whereas the 1980 regulations provide uniform rules for compliance, the 2004 regulations rely on computer modeling of fires inside nuclear power plants to allow for the development of site-specific fire protection measures.<sup>2</sup>

## *Diablo Canyon and San Onofre Not in Compliance*

To date, owners of 51 nuclear reactors in the United States, including Diablo Canyon and San Onofre, have notified the NRC that they intend to comply with the 2004 regulations, but only four reactors have completed the transition. The remaining 47 reactors, including Diablo Canyon and San Onofre, still do not comply with either set of fire regulations more than 30 years after the regulations were first put on the books. Moreover, in June 2011, four of the five NRC commissioners voted to extend until 2016 the deadline for compliance.

## **Spent Fuel Storage Hazards**

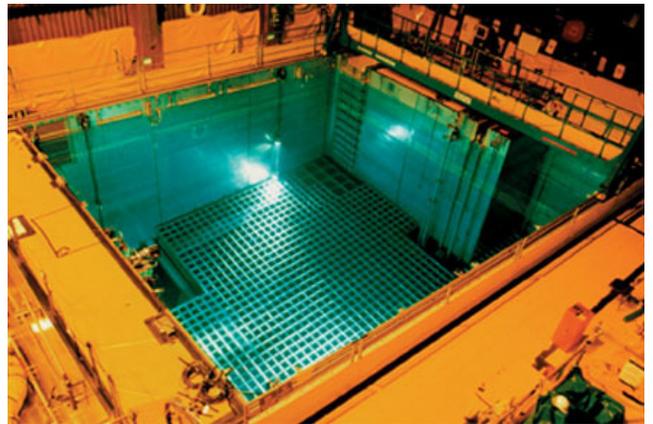
Spent fuel refers to nuclear fuel rods that have been removed from a reactor core after producing power. Today nearly 3,000 metric tons of spent fuel is stored in California. Two-thirds of that spent fuel is stored in large pools of water called spent fuel pools, which are equipped with systems to cool the water that surrounds the hot fuel rods.

While concerns about nuclear power safety often focus on the fuel in the reactor core, spent fuel stored in pools also can be a major source of radioactivity during an accident. If water drains from the pool for even a few hours or the cooling system is interrupted for several days, the spent fuel could overheat and its cladding could break open, releasing radioactive material. And because the pools are located outside the thick, concrete containment walls, it is more likely that this radioactive material would reach the environment.

## *Safer Storage of Spent Fuel*

Plant owners can reduce the risks associated with spent fuel pools by removing older fuel from the pools and placing it in large containers called dry casks, which are made of steel and concrete and cooled by natural convection (i.e. the "chimney effect").

Although spent fuel is usually cool enough to be transferred to casks after about five years, many plants, including those in California, allow their spent fuel pools to fill to near capacity and only transfer spent fuel to dry casks when extra storage space is needed. As a result, most pools contain many times as much fuel as the reactor cores themselves.



*Spent Fuel Stored in Pool*

*Spent Fuel Stored in Dry Casks*



Part of the fuel in the reactor core is moved to the spent fuel pool and replaced by fresh fuel every 18 to 24 months, so that the entire core is replaced every six years. Since spent fuel is cool enough to remove from the pool after five years, pools should not have more than a core's worth of fuel from each reactor at any time.

The safety and security risks associated with spent fuel can be reduced by transferring the fuel from pools to dry casks. The less fuel remaining in a pool, the longer it would take for the water to heat up and boil away if cooling is lost, thus giving workers more time to solve the problem and restore cooling. And if an accident did occur that led to a radioactive release, less would be emitted than if the pool were full. Unfortunately, the NRC has not required plant owners to transfer their spent fuel to dry casks.

### Spent Fuel in California

California has four operating reactors and three reactors that have been decommissioned. It has 2,000 tons of spent fuel stored in pools at reactors sites and 900 tons of spent fuel stored in dry casks (Table 1).

Reactor	Pool Storage (MT)	Pool Storage (Cores)	Dry Storage (MT)	Fraction in dry storage
Diablo Canyon 1	515	6	114	18%
Diablo Canyon 2	486	6	113	19%
San Onofre 2	514	5	146	22%
San Onofre 3	502	6	138	22%
Humbolt Bay	–	–	31	100%
Rancho Seco	–	–	228	100%
San Onofre 1	–	–	146	100%

The pools at California nuclear plants contain significantly more fuel than is in the reactor cores and therefore pose a significant threat. Table 2 shows approximate amounts of spent fuel at each reactor, and expresses the amount in the pools in terms of the number of cores that represents. That number should be no larger than one core.

**Table 1:** This table shows the amount of spent fuel stored in pools and dry casks for each reactor as of the end of 2011. The third column expresses the amount of spent fuel in the pools in terms of how many cores of material that represents; this number should be no larger than 1. The three reactors in the shaded rows are not operating.

All the spent fuel from three decommissioned reactors—Humbolt Bay, Rancho Seco, and San Onofre 1—has now been moved to dry casks.

### Known Solutions

Measures to reduce fire and spent fuel risks are known, but not employed at many plants. The NRC has two separate sets of fire protection regulations (i.e. the ones adopted in 1980 and the 2004 alternatives) intended to reduce fire hazards to an acceptably low level. Currently, none of the reactors in California meets either set of regulations. Consequently, Californians are not adequately protected from the fire hazard risk at the nuclear plants in their backyards. **The NRC should ensure that plants take steps to comply with fire regulations now.**

The NRC knows that spent fuel stored in dry casks is safer and more secure than that stored in pools. Most of the spent fuel in California is stored in pools, exposing citizens to unnecessarily high risk. **The NRC should require plants to move spent fuel to dry casks once it is cool enough to do so.**

Only the NRC can compel reactor owners to address these known hazards. Local and state officials should write or call the NRC to urge the agency to resolve these known safety threats as quickly as possible. California residents can send letters to the editors of their local newspapers, their local and state officials, and the NRC to urge action on these issues.<sup>3</sup>

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## Notes:

<sup>1</sup> Transcript of Nuclear Regulatory Commission Briefing on Fire Protection Issues, July 17, 2008. Statement of NRC manager John Grobe, page 58 line 22 to page 59 line 1. Available online at: <http://www.nrc.gov/reading-rm/doc-collections/commission/tr/2008/20080717.pdf>

<sup>2</sup> The 2004 NRC fire regulations rely on computer modeling to develop estimates of how long fires will last and how much equipment will be damaged. The regulations are satisfied when the results indicate that sufficient equipment survives these hypothetical fires to ensure adequate cooling of the reactor core.

<sup>3</sup> Names and contact information for the NRC's Chairman and Commissioners is available online at <http://www.nrc.gov/about-nrc/organization/commfuncdesc.html>

You can find more information on nuclear power safety issues at: <http://www.ucsusa.org/nuclearpowertoolkit>

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