T1) What is the design basis for a tsunami at Diablo Canyon Power Plant (DCPP)?

The tsunami design basis at DCPP is based on a deterministic approach using historical observations of distant tsunamis, local tsunamis, and storms and tides along the central coast. Distant tsunamis are caused by large earthquakes located 100s to 1000s of km from DCPP. Local tsunamis are caused by either local submarine landslides or offshore earthquakes.

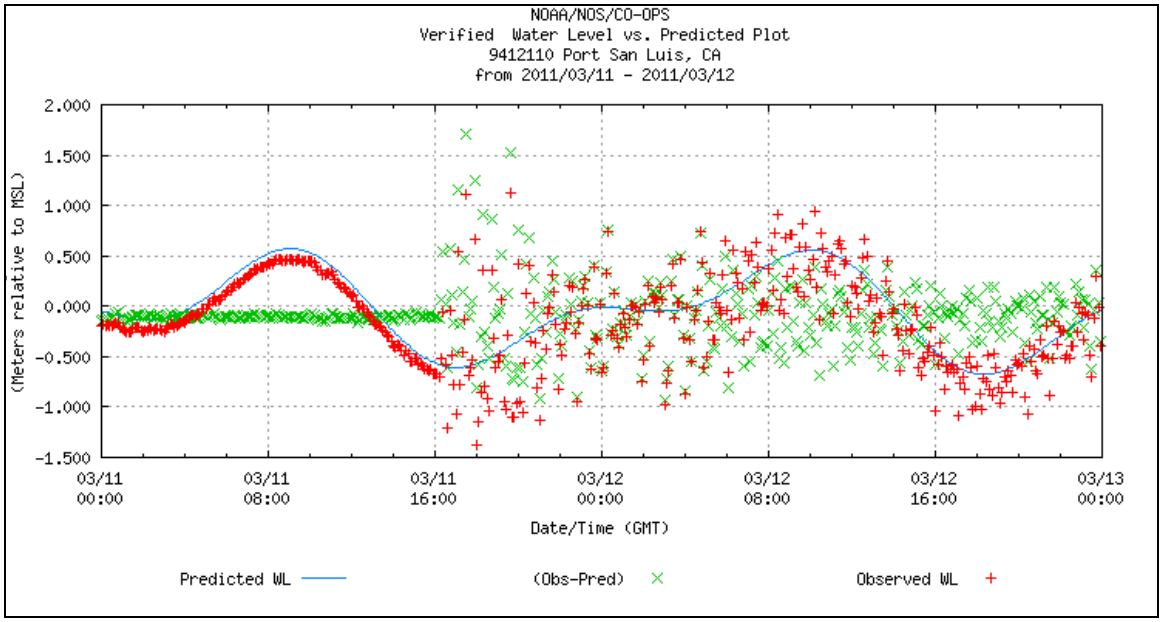
For the distant tsunami, a wave height of 6.1 m was used based on the largest observed wave heights along the California coast (Crescent City) from distant earthquakes. This wave height is larger than anything observed in the vicinity of Diablo Canyon, and it is combined with storm waves and tides to give a total wave height of 8.4 m above mean sea level. For the local tsunamis, a tsunami wave height of 2.6 m was estimated based on modeling of tsunamis generated from local offshore earthquakes. It is combined with storm waves and tides to give a total wave height of 9.8 m above mean sea level. The 9.8 m height is the design basis.

T2) A magnitude 9 earthquake on Cascadia could generate 30 meter waves in Oregon and Northern California. How big will the waves be at Diablo Canyon, and will this exceed the design basis?

Tsunami wave heights are controlled by local bathemetry, the direction of the waves, and the distance a wave travels before it reaches shore. PG&E modeled the tsunami wave heights from a M9 earthquake on the Cascadia subduction zone at Diablo Canyon with numerical models calibrated using observations from past tsunamis. The models show that the waves attenuate, or die out, as they move through northern and central California, resulting in approximately 1 meter waves at Diablo Canyon. This will not exceed the design basis.

T3) How big was the tsunami wave from the Japanese earthquake at DCPP?

The data from the Port San Luis station (Station ID: 9412110) shows that the observed maximum wave heights following the March, 11 earthquake in Japan were just over 1 meter relative to mean sea level. The observed wave heights are shown in the plot below as the red plus signs.



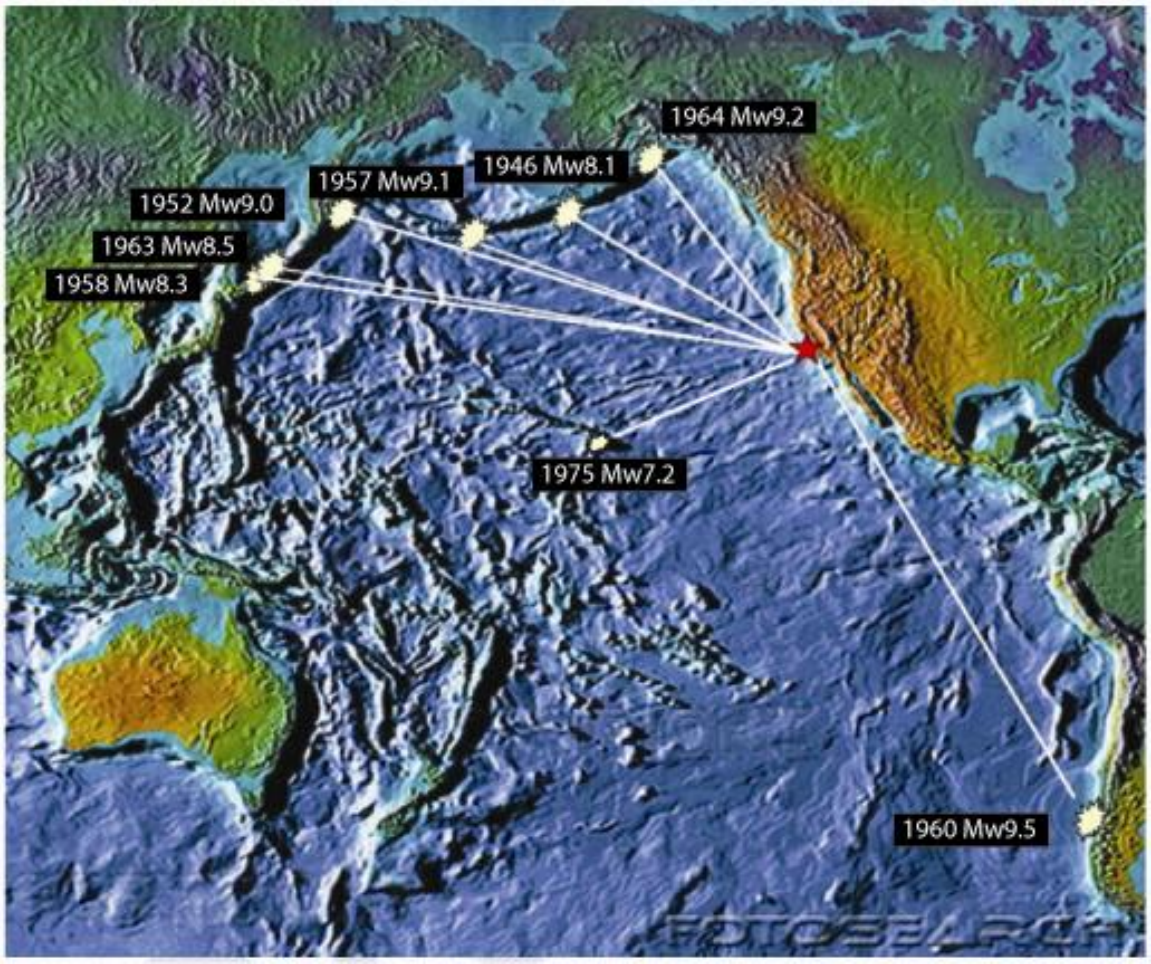
Data for this tide station and others can be found on the NOAA website:
http://www.tidesandcurrents.noaa.gov/

T4) How big are the past tsunamis at DCPP?

There are three categories of tsunami sources at Diablo Canyon: tsunamis from large distant earthquakes, tsunamis from local offshore earthquakes, and tsunamis from landslides. The data we have gathered for each category is summarized below.

Large Distant Earthquakes

The figure below shows the locations of many of the large distant earthquakes with respect to the Diablo Canyon site, and the table lists the records of the generated tsunami waves near DCPP.

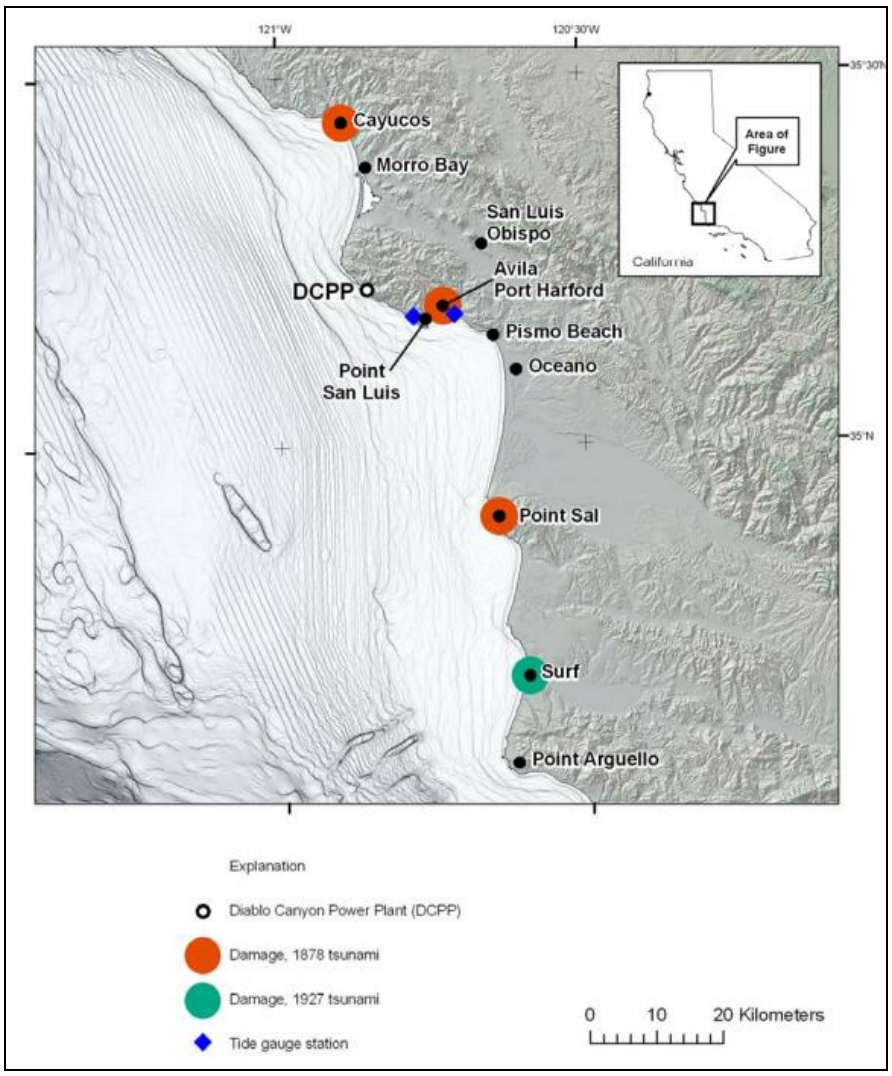


Earthquake-generated Tsunami			Wave Height (m)				
Date	Location	Magnitude	Port San Luis	Avila Beach	Morro Bay	San Luis Obispo	Pismo Beach
04/01/1946	Aleutians	8.1		1.3	1.5	1.3	
12/20/1946	Japan	8.1		0.1			
11/04/1952	Kamchatka	9		1.4			
03/30/1956	Kamchatka	+		0.1			
03/09/1957	Aleutians	8.6		0.5			
11/06/1958	Kuriles	8.3		0.1			
05/22/1960	S. Chile	9.5		0.9			1.4
10/13/1963	Kuriles	8.5		0.3			

03/28/1964	Alaska	9.2		1.6			
10/17/1966	Peru	8.1		0.1			
05/16/1968	Japan	8.2		0.1			
11/29/1975	Hawaii	7.2	0.4				
06/22/1977	Tonga	7.2	0.4				
12/03/1995	Kuriles	7.9	0.4				
06/23/2001	Peru	8.4	0.27				
12/26/2004	Sumatra	9.1	0.23				
03/11/2011	Japan	9.0	1.1				

Local Earthquakes and Landslides

The map below shows the locations of damage due to the 1878 and 1927 tsunamis, and the Avila Beach and Port San Luis tide gauge stations. Records of the wave heights near DCPP are summarized in the table that follows.



Local Earthquake-generated Tsunami			Wave Height (m)				
Date	Location	Magnitude	Port San Luis	Avila Beach	Morro Bay	San Luis Obispo	Pismo Beach
11/04/1927	Lompoc	7.0	1.2*				

* Reported (Byerley, 1930); tide gauge not installed until 1972

Local Landslide-generated Tsunami			Wave Height (m)				
Date	Location	Magnitude	Port San Luis	Avila Beach	Morro Bay	San Luis Obispo	Pismo Beach
11/22/1878	San Luis Obispo	++		Damage to old Peoples Wharf	waves higher than sand ridge that divides bay and ocean		

++ Landslide

In addition to the tsunami data presented above, an abstract was presented at the American Geophysical Union Fall Meeting in 2009. The title of the abstract was, "Large California Tsunamis from Central Coast Historians and Central Coast Newspaper Records." While this information does not come from a peer reviewed source, the contents of the abstract are summarized in the table below:

YEAR	TSUNAMI SOURCE	LOCATION	WAVE HEIGHT	DAMAGE DESCRIPTION	INFORMATION SOURCE
1812	Santa Barbara Channel Earthquake	Santa Barbara Presidio	50 ft (15.2 m)	Tsunami waves (5 in total) to the front of the Santa Barbara Presidio	Franciscan Father's Journal
		Santa Barbara near Goleta	48 - 50 ft (14.6 - 15.2 m)	Largest wave was 48-50 feet	Wheeler & Kallman's book "Shipwrecks, Smugglers, and Maritime Mysteries"
08/13/1868	Peruvian Earthquake	San Luis Obispo County	12 ft (3.7 m)		"The History of San Luis Obispo County, California," Thompson & West (1883)
04/16/1877		San Luis Obispo County	12 ft (3.7 m)		"The History of San Luis Obispo County, California,"

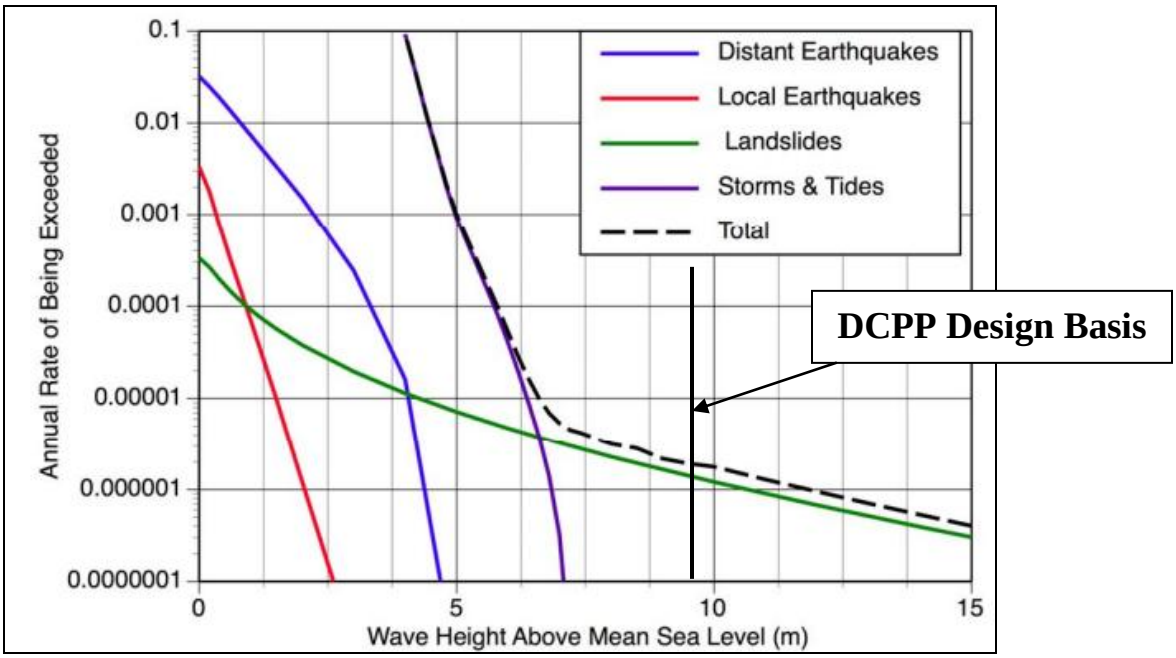
					Thompson & West (1883)
11/22/1878	turbulent water in absence of wind	Morro Bay	estimate based on quad elevations on sand spit from N to S 66 to 97 ft (20.1 to 30 m)	tsunamis broke over Morro Bay sand spit, destroying Avila & Pt. Sal piers and damaging Cayucos pier	
12/9/1907	Japanese Earthquake	Ventura / Shell Beach		The tsunami wrecked the Ventura pier and the Oilport pier at Shell Beach and destroyed the Oilport refinery.	**Ventura pier:** 12-13-1907, SLO Tribune **Oilport pier at Shell Beach:** 12-13-1907, SLO Tribune & 12-6-1976 12-14-1907, Santa Maria Times 12-10-1907 SLO Telegram **Oilport refinery:** Darwin Sainz, personal communication
11/26/1913		Monterey Area	estimate based on current quad sheet elevations of wharf(?) 120 ft (36.6m)	Tsunamis wrecked the Monterey area including waves 10 to 15 ft above the Del Monte wharf. At Seaside, "Immense domes of water and foam. . ." (12-2-1913, SLO Tribune)	(12-2-1919, SLO Tribune)

T5) Has PG&E considered the possibility of a tsunami generating a wave larger than the design basis at Diablo Canyon?

Yes, as part of our Long Term Seismic Program Update in 2010, PG&E considered the probability of a tsunami generating a wave beyond the design basis at DCPP. For the update, a probabilistic tsunami hazard analysis was used, similar to the probabilistic approach used for ground motions. In addition to the earthquake sources, we have considered offshore landslides models and a Hawaii volcanic collapse as potential tsunami sources. The volcanic collapse, however, did not generate large waves at Diablo Canyon due to the geometry of Haiwaii volcano fractures with respect to Central California and was screened out of our final analysis.

The probabilistic hazard results are used to compute the chance that there will be a tsunami wave that is beyond the 9.8 m design basis. The annual chance of beyond design basis tsunami waves is shown below. Large storms are the most likely source of waves up to 5 m. Distant tsunamis less than 5 m occur more frequently than local tsunamis, and they result in moderate wave heights at DCPP. The beyond design basis wave heights could be generated from large offshore landslides, but they are very rare (2 in a million chances per year). Tsunami wave reaching the height of the power block (24.9 m) have about a 1 in 7 million chance per year.

Wave Height Above Mean Sea Level (m)		***Annual Probability of Being Exceeded***
9.8	Design Basis	2.E-06
13.7	Beyond Design Basis (height of snorkels)	4.E-07
24.9	Beyond Design Basis (Height of Powerblock)	1.5E-07



Mean hazard from storms, tides, and tsunamis for the DCPP intake structure

The design basis tsunami was computed based on a rare, large wave, but it is not the worst case. Beyond design basis tsunamis are considered using probabilistic methods.