DOCKETED

Docket Number:	21-ESR-01
Project Title:	Energy System Reliability
TN #:	244853
Document Title:	Brian Hanley Comments - Save Diablo Canyon Power Plant
Description:	N/A
Filer:	System
Organization:	Brian Hanley
Submitter Role:	Public
Submission Date:	8/12/2022 2:27:46 PM
Docketed Date:	8/12/2022

Comment Received From: Brian Hanley
Submitted On: 8/12/2022
Docket Number: 21-ESR-01

Save Diablo Canyon Power Plant

Additional submitted attachment is included below.

I am PRO-NUCLEAR, PRO-CLEAN ENERGY, PRO-CLIMATE ACTION AND MOVING CALIFORNIA IN THE RIGHT DIRECTION, PRO-DIABLO CANYON, PRO-ENVIRONMENTAL TRAILER BILL

I am the author of "Radiation – Exposure and its treatment: A modern handbook" [1]. This book has over 400 citations, and makes clear that virtually everything the common mind thinks about radiation is wrong. The biology of how humans and animals deal with radiation is the foundation of the nuclear controversy. I was an anti-nuclear activist many years ago. I handed out leaflets, and people asked me questions I couldn't answer. So, I went to the UC Berkeley library to learn the answers. This was the beginning of finding out that those leaflets were lies.

Let's start with a basic fact---the ocean has approximately 13 tons of uranium per cubic mile. Do the math, and there is enough U-235 in San Francisco Bay to make 4 or 5 Hiroshima sized atom bombs. Diablo Canyon pumps 2.5 billion gallons per day of seawater. There are 1.101 x 10^12 (1.1 trillion) gallons in a cubic mile. Do the math, and it takes 440.4 days to pump a cubic mile of seawater. In other words, in its lifetime, Diablo Canyon has pumped 29.86 cubic miles of seawater containing over 388 tons of uranium. That tonnage included around 2.7 tons of U-235. (U-235 is ~0.72% of unrefined uranium.) If we assume 5% enrichment, then this seawater pumped through Diablo Canyon contained the equivalent of 54 tons of reactor fuel. Confirming this, Japan demonstrated extraction of uranium from seawater at approximately double the cost of yellowcake uranium mined on land.

Every anti-nuclear activist I know of believes sea-salt is best, and happily prefers this solid hyper-concentrate of seawater on and in their food. Think about that. You cannot have it both ways. You cannot say Diablo Canyon is some horrific threat to civilization if anything radioactive gets into the ocean, and at the same time say that sea-salt is just fine. The fact is, sea salt is fine, although it contains other pollutants, and more plutonium than mined salt. I have had people say, "Well, it's so diluted in the ocean that it doesn't matter." To that, I said, "Exactly so." Reality is that if we took all of the fissile radionuclides that the human race has and dropped it into the ocean, it would have no meaningful effect.

Why does the ocean have so much uranium? Because it is ubiquitous at low concentrations in rocks and even soil. The top 3 feet of a square mile of land, anywhere has 1 to 3 tons of uranium. Uranium oxidizes as well as iron, and is highly soluble in water. So, it leaches out, and evaporation from the world ocean slowly concentrates it. The result is that there is roughly 4.2 billion tons of uranium in the ocean, representing ~3.4 billion curies.

I am also a co-author of a recent PNAS letter criticizing the economics of climate change [2]. And I am working on a new, much more comprehensive paper on climate change economics. The truth about climate change should terrify anyone reading this. And I tell you flatly, the primary reason we have a climate problem is anti-nuclear activism [3]. I also tell you that the fantasy of solar and wind has been thoroughly debunked [4]. I note that Mark Z. Jacobson got all of his funding for his entire career from oil company cutouts, and a $70 million donation went to Stanford after he published his fantasy paper. I will mention just one ridiculous assumption Mr. Jacobson made: All reservoirs and water systems will always have plentiful water throughout the year.

Another fantasy that is treated as if it is real is that we can simply cut energy use and have minimal economic effect. Tim Garrett has shown that there is a lockstep relationship between money and energy at 9.7 ± 0.3 milliWatts per inflation-adjusted 1990 US dollar [5, 6]. This relation is through the accumulation of products (cumulative GDP). Production of goods and services, in other words, has inertia. We can think about this by taking an extreme case. If production stops, the world does not immediately grind to a halt. There are houses, cars, roads, bridges, aircraft, computers, etc, that are already built and will last for some period time. Even in winter or summer, if power goes off during a cold snap or a heatwave, a home will not immediately get cold or heat up. The problem is though, that maintenance of a particular level of an advanced economy requires upkeep. Turn off electricity, and computer, cell phone and cell phone tower batteries only last a few hours or days. Factories stop making cars or their parts. The net result is a slide into poverty. This is why in the real world, it is so hard to cut energy use. Politically, except in time of war, it is political suicide. Bluntly put, energy = wealth. And in the real world, wealthy nations are secure and stable nations.

Let us now circle back to nuclear power and talk about accidents. Yes, they will happen from time to time. Chernobyl is held up as the terrible disaster that we cannot allow. And yet, Chernobyl had a total of 50 deaths over 25 years from over 50 tons of reactor material. Most of the burned uranium fell within miles of the plant turning the area orange for a while. The area is full of wildlife and very little effect has been seen. The initial calculations using the linear no threshold (LNT) model predicted 4,000 to 8,000 cancer deaths. The LNT model was pushed in the 1940's and 1950's by Rockefeller. Today, we know the LNT model is wrong and Chernobyl is the final proof of that [7]. After Chernobyl, 9 excess deaths occurred in 25 years from cancer, all of them thyroid cancers [8]. The only reason those cancers occurred was consumption of fresh dairy products grazed on contaminated land. Mammary glands concentrate iodine in milk, and this is the only way to get enough radio-iodine to matter. No excess leukemias or lymphomas appeared and other solid cancers declined slightly [8]. Fukushima was much less of a discharge. In both cases, the primary killer by orders of magnitude was the evacuation itself.

Compare those figures with the deaths from coal which are guaranteed [9]. The entire death toll from Chernobyl was less than 2% of the minimum deaths expected from one coal fired power plant over its 30 year lifespan [9]. It is literally true that if we generated all of our energy from RBMK (Chernobyl type) reactors, trained operators badly enough to guarantee a Chernobyl every year, and learned nothing from every event---after 30 years we would not get to 2/3rds of the deaths from one coal fired plant.

We are facing global collapse of civilization. Shutting down any nuclear plant when there is not already an abundant surplus of zero-CO2 energy amounts to participating in a genocidal attack on global civilization on a scale never contemplated before in history. This is not hyperbole in the least. That is what we face.

I have attached some figures for reference, and a pdf copy of this email at the end.

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	Uranium/liter[1]	liters/Km^3	Uranium/Km^3	Km^3 of ocean[2]	Uranium in ocean	Km^3/mile^3	Uranium/mile^3
Grams	0.0000032	1,000,000,000,000	3,200,000	1,332,000,000	4,262,400,000,000,000	4.168181825	13,338,182
English	*3.2 micrograms*	*1 trillion liters*	*3.2 million grams*	*1.332 billion cubic Km*	*4.26 quadrillion grams*		*13.34 million*
Tons			**3.20**		**4,262,400,000**		13.34
English			***3.2 tons***		***4.26 billion tons***		*13.34 tons*

San Franciso Bay is 400-1600 square miles depending on what part is used[3]. For this calculation 1000 square miles will be used.
Depth of San Francisco Bay varies, but its average is 15 feet deep.
15 ft ÷ 5280ft/mile = 0.00284 miles deep.
0.00284 x 1000 square miles = 2.84 cubic miles of seawater.

Seawater averages 13.34 tons of natural uranium per cubic mile.
2.84 cubic miles x 13.34 metric tons uranium/cubic mile = 37.8977 metric tons of uranium
Using 2204.622 lbs per metric ton, there are 83550.16 lbs of uranium in San Francisco Bay.

0.72% of natural uranium is U-235, suitable for making bombs. (Ignoring U-234)
0.0072 x 83550.16 lbs = 601.56 lbs of U-235 in San Francisco Bay.

It took 140 lbs of 80% enriched uranium to make the Hiroshima atomic bomb.
Since that U-235 wasn't pure, we need to calculate how much 601.56 lbs of pure U-235 would be at 80% enrichment.
601.56 lb of U-235 ÷ 0.80 = 751.95 lbs of 80% enriched uranium.

751.95 lbs ÷ 140 lbs per bomb = 5.371 bombs.

On a normal day, San Francisco Bay has enough U-235 dissolved into it to build at least 5 Hiroshima sized bombs.
All that U-235 is naturally present.

And yet, because it is dissolved in the ocean, you can swim in it. It is safe. You can eat the fish.

The ocean is big. Even a bay is huge.

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[1] http://www.lbl.gov/abc/wallchart/chapters/15/3.html
[2] http://darchive.mblwhoilibrary.org:8080/bitstream/handle/1912/3862/23-2_charette.pdf?sequence=1
[3] http://en.wikipedia.org/wiki/San_Francisco_Bay

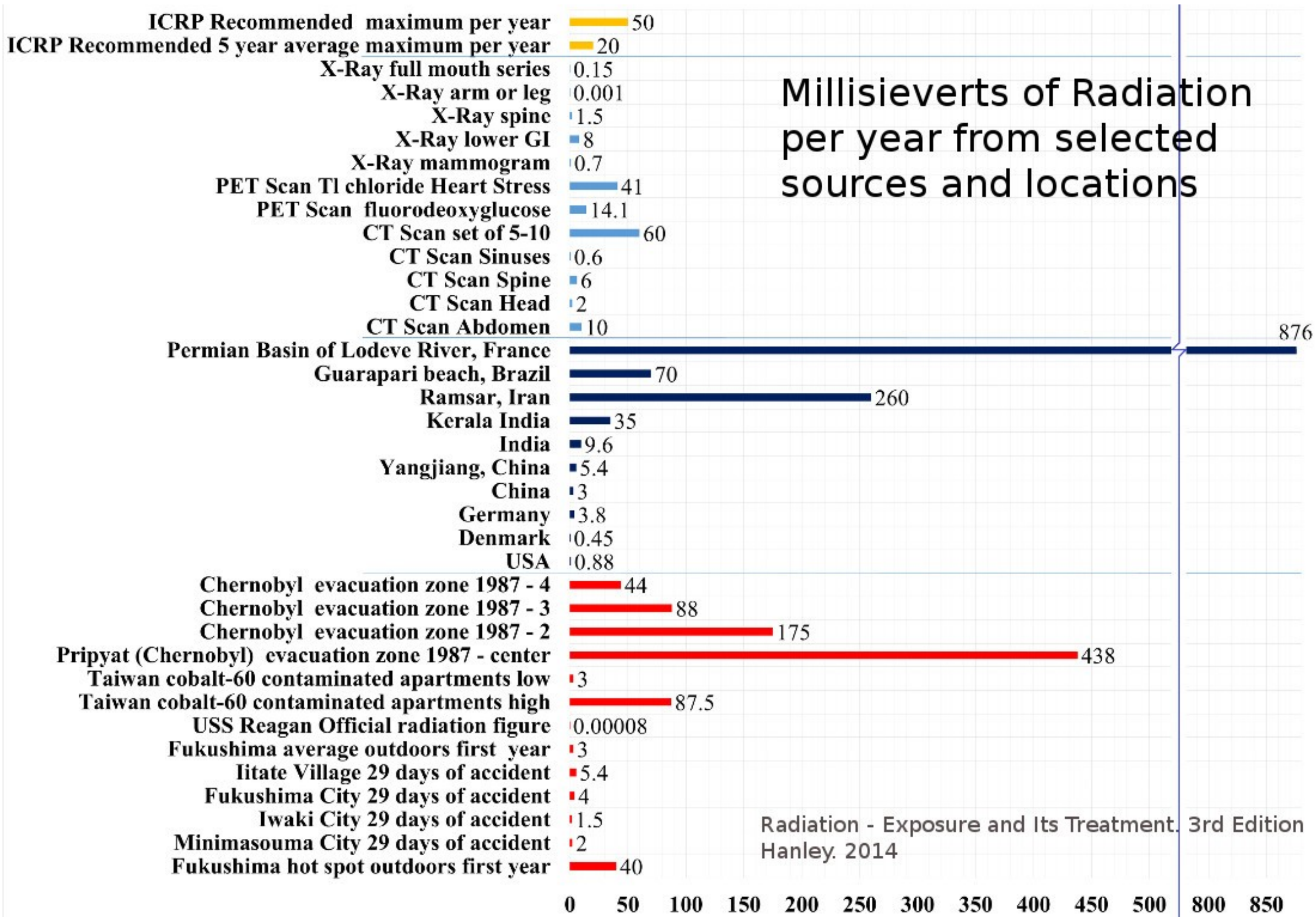

Figure 1: This figure compares relative gross radiation from medical procedures, natural locations, and human-caused locations. Compare to ICRP radiation recommendations.

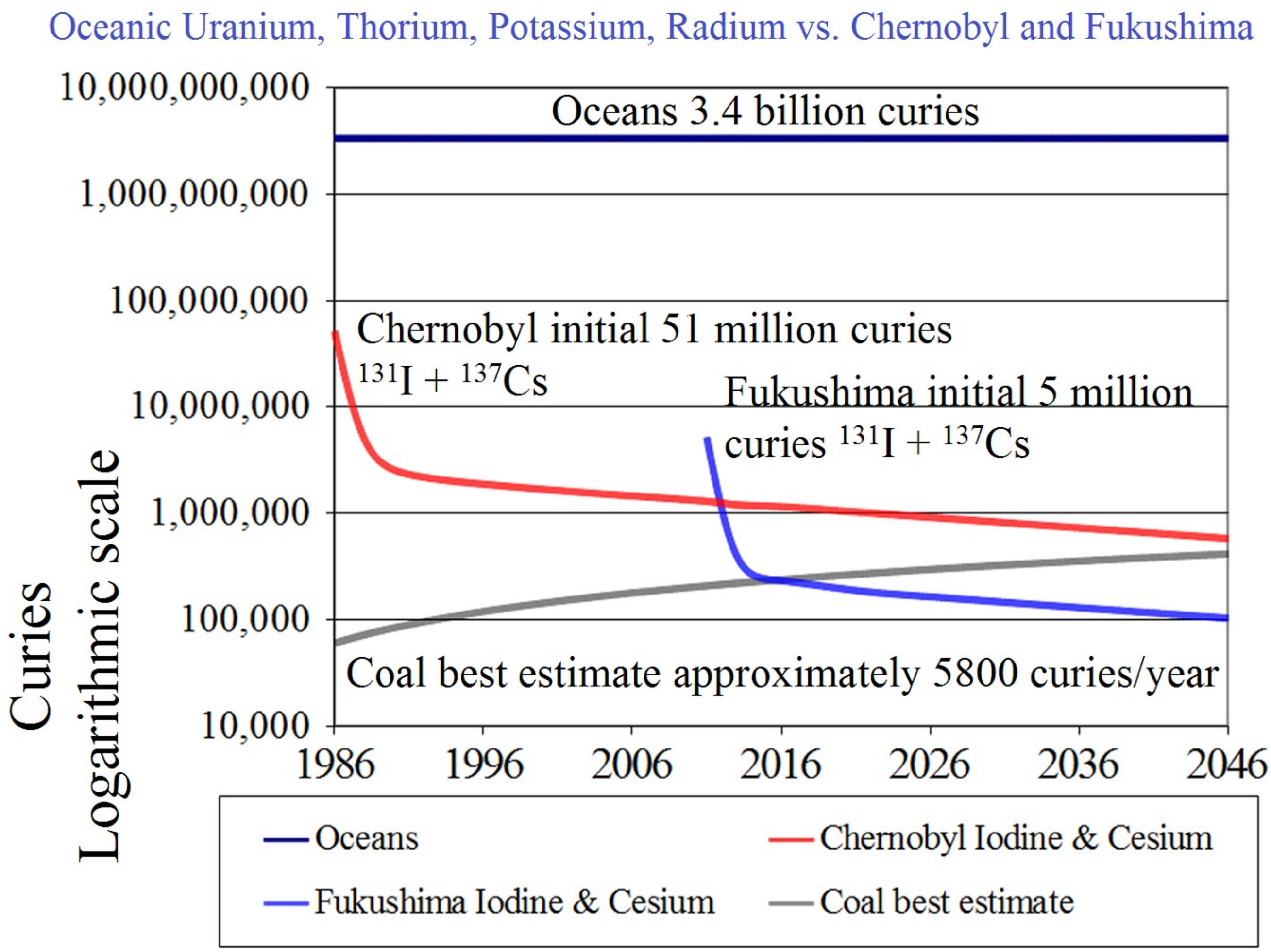

Figure 2: This chart compares gross radioactivity already in the ocean to 2 reactor accidents and radioactivity from coal burning. Because of the log scale, it is possible to see Chernobyl, Fukushima and coal. Without the log scale, nothing would be discernable except for the amount in the ocean.

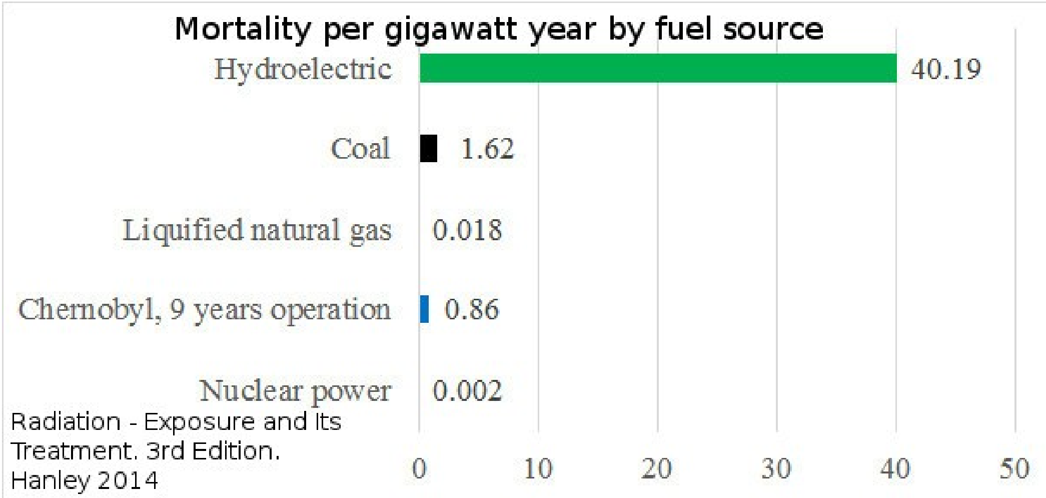

Figure 3: One can quibble about the exact casualties from, for instance failure Banqiao dam and 61 other dams from a typhoon, however, these relative relationships do not change significantly. US dam infrastructure is aging, and extreme weather events are becoming more frequent.

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Fukushima radionuclides into the sea and air

TEPCO reported 18.1 quadrillion Bq (464 thousand Ci) escaping from Fukushima into the ocean, of which 7.1 quadrillion is cesium and 12 quadrillion is short-lived iodine-131(81). An equivalent of 900 quadrillion Bq (23.1 million Ci) of I-131 was released into the air(81). Not everyone trusts TEPCO's numbers, but let's look at the larger picture to get a sense for what these figures mean.

Measuring radiation in Bq is like measuring sugar in the kitchen by the molecule. So let's ask– how much sugar would it be, if every Bq (or one atom of decay) per second was one molecule of sugar? What this does is create an idealized radioactive material that emits the same amount every second and doesn't break down. It's a fiction, but a useful one.

Do the math and 18.1 quadrillion molecules of sugar is about 1/6th of one granule of sugar. 900 quadrillion is about 51 granules of sugar.

Calculate how much sugar 18.1 quadrillion molecules would be

Sugar is 342 grams per molecular weight. Atomic weight is what is used to figure out molecular weights and count atoms. Add up the atomic weight of all the atoms in a molecule and you have the molecular weight. Weigh that out in grams and you have the same number of molecules (or pretty close). A molecular weight has a fixed (and outrageously large) number of molecules in it (Avogadro's number).

Avogadro's number is 602,214,130,000,000,000,000,000 (over 602 sextillion). It's a big number. It is 1.5 trillion times the number of stars in our galaxy.

So now we will divide 18.1 quadrillion sugar molecules by Avogadro's number. The result is very, very small.

$$\frac{18{,}100{,}000{,}000{,}000{,}000}{602{,}214{,}130{,}000{,}000{,}000{,}000{,}000} = 0.0000003005575$$

Then multiply 300 billionths of a molecular weight by 342 grams of sugar to get the number of grams of sugar if every one of those 18.1 quadrillion Bq's per second was a sugar molecule.

0.0000003005575 x 342 grams = 0.000103 grams (103 millionths of a gram)

1 granule of sugar is about 0.000625 grams.

You would have to break 1 granule of sugar into about 6 equal pieces, and choose just one of them to put your finger on 18.1 quadrillion sugar molecules. In other words–you would need a magnifying glass to find it on your kitchen counter.

Dissolve that in one cubic kilometer of ocean right offshore of the beach at Fukushima and it's barely detectable with ultra-sensitive instrumentation. A cubic kilometer is 1 trillion liters. There would be 18,100 sugar molecules in a liter. That sounds like a lot, but there are 55 molecular weights of water in a liter, so the number of water molecules per liter is a huge number:

33,427,963,928,398,559,445,093,276 or 33.4 septillion

Could you taste that sugar? No. The threshold for tasting sugar is 10 millimoles per liter (10 thousandths of a molecular weight), and 18,100 molecules is 3×10^{-20} molecular weights, an astronomically smaller amount than required to taste it.

Calculate how much sugar 900 quadrillion molecules would look like

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We can do the same thing for the air release. Do the math and instead of breaking our 1 grain of sugar into 6 pieces, we have 51 granules. You could see 51 granules of sugar, but it's still not very much. There are around 18,100 granules of sugar in a teaspoon. 51 granules is well inside the margin of error in measurement when you measure a teaspoon of sugar.

But keep in mind that the air release of radioactive xenon doesn't matter anyway, even if it was many times that number. Xenon disperses so quickly that it's difficult to detect in seconds or minutes. It's useful for verifying nuclear bomb tests if the detector is close enough. And xenon doesn't react with biological molecules, so it doesn't get into our bodies in any significant way. Radioactive xenon is used as a medical tracer by breathing it in. Natural radon is much more common.

Radionuclides and radiation after Fukushima

After the Fukushima accident cesium-137 was mostly below the limit of detection.

> *Extensive whole-body-counter surveys (n = 32,811) carried out at the Hirata Central Hospital between October, 2011 and November, 2012, however show that the internal exposure levels of residents are much lower than estimated. In particular, the first sampling-bias-free assessment of the internal exposure of children in the town of Miharu, Fukushima, shows that the (137)Cs body burdens of all children (n = 1,383, ages 6-15, covering 95% of children enrolled in town-operated schools) were below the detection limit of 300 Bq/body in the fall of 2012. These results are not conclusive for the prefecture as a whole, but are consistent with results obtained from other municipalities in the prefecture, and with prefectural data. (82)*

This is probably to be expected, because cesium is ingested in food, and Japan monitored carefully for it and set much lower limits than Sweden did, for instance. Sweden's limits after Chernobyl started at 300 Bq/kg, then were relaxed to 1,500 Bq/kg, with a limit of 10,000 Bq/kg for the Sami people who eat reindeer meat(83). Japan's limits were set at 200 Bq/kg for dairy products and 500 Bq/kg for everything else(84).

Similarly, in a study that compared actual dose exposure to estimates derived from aircraft surveys, "*individual doses were about 0.15 times the ambient doses, the coefficient of 0.15 being a factor of 4 smaller than the value employed by the Japanese government*"(85).

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