Slideshow Script by Molly Johnson:

You will hear me talk about "spent" fuel. That term may make one think that the fuel is no longer harmful. Actually, the reverse is true - this "spent" fuel is much, much more radioactive after it has gone through the fission process in the nuclear reactor. It is, truly, the most toxic and long-lived poison we humans have ever made.

Before I begin my presentation I just want to make one thing clear – There is NO safe way of storing this waste. After over half a century, countless hours of research, and millions of taxpayer dollars no definitive solution has been found. All we can do, at this point in time, is to find and insist upon the very safest method available.

Slides:

1. So, what is Radioactive Waste?

2. The Nuclear Regulatory Commission, NRC, defines radioactive waste as ""Radioactive (or nuclear) waste is a byproduct from nuclear reactors, fuel processing plants, hospitals and research facilities. Radioactive waste is also generated while decommissioning and dismantling nuclear reactors and other nuclear facilities."

3. Fuel for commercial nuclear power reactors is typically made from low enriched uranium fashioned into thumbnail-size ceramic pellets of uranium dioxide. These pellets are fitted into 12- to 15-foot hollow rods, referred to as cladding, made of a zirconium alloy. The rods are then bound together into a larger assembly. A typical reactor holds about 100 metric tons of fuel when operating—generally from 200 to 800 fuel assemblies. Before these fuel rods are used, they are only slightly radioactive and may be handled without special shielding.

4. The uranium in the assemblies undergoes fission—a process of splitting atoms into fragments and neutrons that then bombard other atoms—resulting in additional fission reactions and a sustainable chain reaction that creates an enormous amount of heat and radioactivity in the form of radioisotopes, or radioactive substances. The heat is used to generate steam to turn a turbine, which generates electricity.

5. During the fission process, two things happen to the uranium in the fuel. First, uranium atoms split; creating energy that is used to produce electricity. The fission creates radioactive isotopes of lighter elements such as cesium-137 and strontium-90. These isotopes account for most of the heat and penetrating radiation in high-level waste. Second, some uranium atoms capture neutrons produced during fission. These atoms form heavier elements such as plutonium. These heavier-than-uranium, or "transuranic," elements do not produce nearly the amount of heat or penetrating radiation that fission products do, but they take much longer to decay. Transuranic wastes, sometimes called TRU, account for most of the radioactive hazard remaining in high-level waste after 1,000 years.

6. Radioactive isotopes eventually decay, or disintegrate, to harmless materials. Some isotopes decay in hours or even minutes, but others decay very slowly. Strontium-90 and cesium-137 have half-lives of about 30 years (half the radioactivity will decay in 30 years). Plutonium-239 has a half-life of 24,000 years.

7. All of these radioactive isotopes have the capacity to severely affect and destroy DNA.

- Iodine- 131 concentrates in the thyroid and gets into milk through contaminated grass, causing Thyroid cancer. It also concentrates in ovaries causing birth defects, mutations and miscarriages.
- Tritium is a health risk when ingested, inhaled or absorbed through the skin and is cancer causing.
- Strontium-90 mimics calcium and concentrates in bone. It can cause Leukemia and is most dangerous for pregnant women and fetuses.
- Cesium-137's half-life of about 30 years is long enough that objects and regions contaminated by cesium-137 remain dangerous to humans for a generation or more, but it is short enough to ensure that even relatively small quantities of cesium-137 release dangerous doses of radiation. It causes malignant tumors and shortening of life. It also concentrates in ovaries causing birth defects, mutations and miscarriages.
- Plutonium-239 emits alpha radiation and is highly toxic as well as long-lived. One microscopic speck in the lung will cause lung cancer. Once it enters the body, it stays there forever.

8. Each of Diablo Canyon Power Plant's two reactor units is refueled about every 18 months. Once a reactor core has gone critical, meaning it has been used during a reactor operation, highly radioactive nuclear fission products have formed in the core, and the core has become highly radioactive. Refueling involves taking the expended core out of the reactor and putting in a new core with fresh nuclear fuel. When reactor operators first remove spent fuel from a reactor, it is thermally hot and intensely radioactive and must be immersed in deep pools of water, which cools the spent fuel and shields the environment from the spent fuel. These pools are called "spent fuel pools". The spent fuel pool at Diablo Canyon is an in-ground pool covered by a large metal building.

9. Because of the unavailability of off-site storage for the spent fuel, the NRC has allowed high-density storage of spent fuel in pools originally designed to hold much less. As a result, virtually all U.S. spent-fuel pools, such as the pool at Diablo Canyon, have been re-racked to hold spent-fuel assemblies at densities that approach those in reactor cores. In order to prevent the spent fuel from going critical, the fuel assemblies are partitioned off from each other in metal boxes whose walls contain neutron-absorbing boron. It has been known for more than two decades that, in case of a loss of water in the pool, convective air cooling would be relatively ineffective in such a "dense-packed" pool. (Robert Alvarez)

10. Water loss in the spent fuel pool could lead to a catastrophic spent fuel pool fire. Water could be lost from a spent-fuel pool through leakage, boiling, siphoning, pumping, displacement by objects falling into the pool, or overturning of the pool. These modes of water loss could arise from events, alone or in combination, that include: (i) acts of malice or terrorism by persons within or outside the plant boundary; (ii) an accidental aircraft impact; (iii) an earthquake; (iv) dropping of a fuel cask; (v) accidental fires or explosions; and (vi) a severe accident at an adjacent reactor that, through the spread of radioactive material and other influences, affects the ongoing cooling and/or water makeup to the pool.

11. If the fuel were exposed to air and steam, the zirconium cladding would react exothermically, catching fire at about 800 degrees Celsius. This type of fire is almost impossible to extinguish. This image captures the spread of radioactivity from a hypothetical fire in a high-density spent-fuel pool at the Peach Bottom Nuclear Power Plant in Pennsylvania. Imagine, if you will, that plume extending from Diablo Canyon. Of great concern is the large amount of cesium-137 in spent fuel pools, which contain anywhere from 20 to 50 million curies of this dangerous isotope. With a half-life of 30 years, cesium-

137 gives off highly penetrating radiation and is absorbed in the food chain as if it were potassium. As much as 100 percent of a pool's cesium 137 would be released into the environment in a fire, according to the NRC.

12. Spent nuclear fuel typically must remain in a pool for at least 5 years to decay enough to remain within the heat limits currently allowed for dry cask storage systems. When spent nuclear fuel is discharged from a reactor at a plant where the spent nuclear fuel pool is at maximum capacity, spent nuclear fuel equal to the amount of spent nuclear fuel discharged from the reactor must be transferred to dry storage. The dry storage systems typically consist of either a thick-walled, bolted steel vertical cask, or a welded steel canister inside a vertical or horizontal steel-reinforced concrete cask.

13. To transfer spent fuel to dry storage, reactor operators place a steel canister inside a larger steel transfer cask and lower both into a pool. Spent nuclear fuel is loaded into the canister, a lid is placed on the canister, and then both the canister and transfer cask are removed from the pool. The transfer cask shields nearby workers from the radiation produced by the spent nuclear fuel in the canister. The water is drained and a lid is welded onto the canister. Then the canister and transfer cask are aligned with a storage cask and the canister is maneuvered into the storage cask. The transfer cask can be re-used.

14. Diablo Canyon is currently using on-site dry cask storage. As you will notice, the casks are placed in the open, bolted to a concrete pad. There is no protection from acts of malice or terrorism, accidental aircraft impact, or other catastrophic events.

15. At Diablo Canyon at least the dry cask storage is placed uphill from the plant itself and a great distance away from the ocean. The dry cask storage at San Onofre is just inches above the waterline and is only 100 feet from the ocean!

16. Isn't there a better way you may be asking? Yes! There is! Hardened on-site storage, or HOSS, allows waste generators to store high level waste as close to the site of generation as possible, thereby exposing fewer people to radiation, as safely as possible. Rather than storing dozens of vulnerable dry-casks next to each other in the open air, the HOSS Principles established by concerned citizens mandate:
    - Irradiated fuel must be stored as safely as possible as close to the site of generation as possible;
    - HOSS facilities must not be regarded as a permanent waste solution, and thus should not be constructed underground and the waste must be retrievable;
    - The facility must have real-time radiation and heat monitoring for early detection of problems with containers;
    - The overall objective of HOSS should be that the amount of releases projected in even severe attacks should be low enough that the storage system would be unattractive as a terrorist target;
    - Placement of individual canisters that makes detection difficult from outside the site boundary.

17. Monitored Retrievable Storage (MRS) or "The German Model" – In Germany, dry casks are stored in reinforced concrete buildings. These buildings were originally designed to provide additional radiation shielding (beyond what is provided by the cask itself) to reduce doses at plant site boundaries to background levels. Some of these buildings are sufficiently robust to provide protection against crashes of large aircraft. The casks are able to be continually monitored and can be repaired robotically. Any leaks or other release of radioactivity would be contained in the building.

18. We in San Luis Obispo County are not the only ones dealing with this issue. There are NPPs that have been closed for quite a while, such a Humboldt & Rancho Seco. There are NPPs that have recently closed, such as San Onofre, Vermont Yankee and Fort Calhoun and NPPs that are scheduled to close such as Diablo Canyon. Each and every one of these facilities have produced thousands of tons of nuclear waste that will have to be kept isolated from the environment and all have tough decisions to make about how to do so in the safest manner possible.

19. The big question remains – how will this waste be safely stored, isolated from the environment, for thousands of years? Is there a final answer? At this time, there is well over 76,000 metric tons of spent nuclear fuel that has been produced at NPPs nationwide – and the inventory is increasing by about 2,200 metric tons per year. In addition, nuclear weapons production and other defense-related activities have resulted in about 13,000 metric tons of spent nuclear fuel and other high-level nuclear waste. This high-level waste is extremely radioactive and needs to be isolated and shielded to protect human health and the environment. It is currently being stored primarily at sites where it was generated. After spending decades and billions of taxpayer dollars to research potential sites for a permanent disposal site, including at the Yucca Mountain site in Nevada, the nation remains without a repository for disposal and future prospects are unclear.

20. It is clear that we have a lot of work to do in order to protect our coastline, ourselves and our future generations from the nuclear waste that will be left behind when Diablo Canyon closes. What we are left with are a lot of questions and a lot of work to do.