Subject: Re: Holtec UMAX system
From: Donna Gilmore <dgilmore@cox.net>
Date: 10/21/2015 1:44 PM
To: Dave Lochbaum <DLochbaum@ucsusa.org>
CC: Edwin Lyman <ELyman@ucsusa.org>

What about the issue of through-wall cracks in the thin canisters? This appears inevitable, sooner in marine environments and there does not appear to be any solutions to this for either early detection, inspection, repair or any mitigation plans. With the Koeberg plant component failing in 17 years in a similar environment, I'm concerned this could happen at San Onofre within a few short years. Mother nature is our biggest "terrorist" threat right now and it's not an "if", but a "when".

Regarding loading errors, there are many more steps and places for human errors when loading thin canisters, although I agree both thin and thick casks can have failures. Making sure there are redundencies in cranes and better inspections of aging materials in cranes should be mandatory.

Regarding the number of fuel assemblies, there are thick casks that hold more fuel assemblies, although I'm not convinced that is a good idea for transport or storage.

Regarding the licensing issue, there are NRC licenses for thick casks currently in the TN series. The biggest problem is forcing utilities to choose them. The fact that we cannot be aligned on this issue hurts that effort. I also think the thick casks should have double independent lids. I don't think all of them do.

If you have some scientific information to support there will not be radiation leaks in existing thin canisters and that there is a way to detect these prior to them happening and there is a remediation plan in place to deal with this, I would be very interested in knowing what these are. I keep looking for answers, but not finding any. And now they want to destroy the pools when they are empty, eliminating the only available method for dealing with failing canisters.

Also, we have large amounts of damaged fuel assemblies at San Onofre (over 95 damaged assemblies in storage already). And high burnup fuel can degrade fuel cladding after dry storage.

> **Ductile-to-Brittle Transition Temperature for High-Burnup Zircaloy-4 and ZIRLO™ Cladding Alloys Exposed to Simulated Drying-Storage Conditions** M.C. Billone, T.A. Burtseva, and Y. Yan Argonne National Laboratory September 28, 2012.
>
> > *"...the trend of the data generated in the current work clearly indicates that* ***failure criteria for high-burnup cladding need to include the embrittling effects of radial-hydrides for drying-storage conditions*** *that are likely to result in* ***significant*** *radial-hydride precipitation...A* ***strong*** *correlation was found between the extent of radial hydride formation across the cladding wall and the extent of wall cracking during RCT [ring-compression test] loading."*
> > *http://pbadupws.nrc.gov/docs/ML1218/ML12181A238.pdf*

Also, the higher the burnup, the higher the oxide thickness, the higher the cladding failure.

https://sanonofresafety.files.wordpress.com/2013/06/higherburnupcladdingfailurechart1.jpg

And even 5% oxygen in helium can cause zirconium hydride powder to ignite. Any mechanical or chemical process that reduces the [zirconium] cladding to turnings, chips, granules, or powders can generate a pyrophoricity or flammability hazard.
https://sanonofresafety.files.wordpress.com/2014/12/4410914explosivezirconiumdivofmines.pdf

Zirconium Hydride can ignite at 270 degrees C.
http://www.espimetals.com/index.php/msds/780-zirconium-hydride

Thanks,
Donna

On 10/21/2015 11:21 AM, Dave Lochbaum wrote:

> Hello Donna:
>
> We disagree about thick cask technology being better than thinner canisters.
>
> To me, the primary hazards from dry storage are (1) the risk of dropping a canister as it is being lowered into or lifted out of a spent fuel pool, and (2) the risk of someone attacking a dry storage facility and breaching the integrity of one or more canisters. I view the hazard from a canister, thin or thick, to be substantially lower than either of these hazards.
>
> Thick casks cannot hold as much spent fuel. Thus, to unload the spent fuel pools requires more thick casks to be used than thin canisters. While measures are taken to guard against dropping a cask/canister over the spent fuel pool, these measures are not 100 percent reliable (as the March 31, 2013, drop of a 525-ton stator at Arkansas Nuclear One reminds us). To me, any benefit of the thick casks relative to the thin canisters on the corrosion degradation side is more than offset by the greater chance of dropping a heavy load over the spent fuel pool.
>
> Additionally, the NRC currently does not require above-ground dry storage to be protected against sabotage. As I outlined in my April 2015 presentation to the California Energy Commission, UCS advocates robust dry storage. The underground storage proposed by Holtec is not invulnerable to sabotage, but it requires considerably more skill and effort by the bad actor(s). Thus, the underground ground provides better protection against sabotage than thick casks on open pads provide.
>
> Thick casks are not presently certified for use in the US and not likely to be certified in the foreseeable future. As long as the NRC certifies thin canisters, vendors are unlikely to apply to the NRC for certification of more costly thick cask systems. Even if they obtained certification, these vendors would unlikely find customers willing to pay more for them.
>
> It's impossible for me to advocate thick casks when (a) none are likely to be certified for use in the US and (b) even if certified and available, thick casks increase the two dominant hazards from dry storage.
>
> The longer one waits for thick casks to appear on the US market, the longer irradiated fuel remains in

the spent fuel pools at San Onofre. The hazard from irradiated fuel in spent fuel pools is higher than the hazard from it in non-robust, aboveground thick casks, which is in turn a higher hazard than from it in robust thin canisters. So, I gladly endorse SCE's plans because they provide the better risk management of the spent fuel hazard onsite.

Thanks,
Dave Lochbaum
UCS

From: Donna Gilmore [dgilmore@cox.net]
Sent: Monday, October 19, 2015 7:50 PM
To: Dave Lochbaum
Cc: Edwin Lyman
Subject: Re: Holtec UMAX system

Dave,

We both agree the pools are dangerous. We both agree the fuel should be moved to dry storage. We both agree none of the dry storage solutions are "invulnerable" and therefore, must have early detection and a system that is maintainable. The proposed Holtec system does not meet those criteria. Only thick cask technology does and it is available.

Accepting an inferior system that cannot be inspected, repaired or adequately monitored is unacceptable. The issues regarding problems of stress corrosion cracking in stainless steel canisters and with the the problems of the underground concrete system were not sufficiently addressed in your response below.

For example, you mention canisters have been repaired in the past. However, the canister example you referred to is carbon steel and not stainless steel. Carbon steel canisters are not susceptible to stress corrosion cracking which is a more challenging problem and more likely to occur sooner in a corrosive marine environment. Also, your example of replacing seals is an example of thick cask technology, which I support, because, as you state, seals can be replaced.

There is no current technology that can find cracks or depth of cracks in thin stainless steel canisters filled with spent nuclear fuel let alone repair them. And there is no early warning system with thin welded canisters until after a radiation leak. The boroscope technology Dr. Singh proposed, even if it could be developed and is small enough to access the canister through the vents, does not inspect for crack depth. Right now all we have from Dr. Singh is "vaporware" -- promised of future solutions when these are today's requirements.

Edison plans to spend all $1.3 billion (yes billion) allocated for the Spent Fuel Management portion of the Decommissioning Trust Fund with the assumption nothing will go wrong with this system.

The underground concrete portion of the UMAX system cannot be inspected and is subject to corrosion from moisture and chemicals in the ground.

Holtec's warranty is only 10 years on the concrete underground portion of the system and 25 years for the thin canisters.

Allowing these thin canisters to be installed when there are no current solutions to these problems with the hope that these problems will be solved in 20 years is not a feasible solution. And unrepairable

cracked canisters cannot be transported. And when I asked Tom Palmisano where the funds are to replace or relocate this system if the DOE doesn't start picking up the canisters in 2024, he said nothing will go wrong with the system.

See my detailed comments in the appropriate paragraphs in your email below. I've provided links to some of my sources of information. More are available on my website.

Thanks,
Donna Gilmore
SanOnofreSafety.org
949-204-7794

On 10/13/2015 8:11 AM, Dave Lochbaum wrote:

> Hello Donna:
>
> I did consult with local California activists before submitting the letter to the California Coastal Commission. I consulted with the local activists I have been working most often with over the past two decades.

DG: Who are the activists you consulted with? I am the person that has researched the current dry storage issue more than anyone else in California and has been the most actively involved in the dry storage issue at San Onofre. I am intervening on this issue with the CPUC, actively involved with this issue with Edison's Community Engagement Panel, actively involved with staff at the California Coastal Commission, with local, state and federal elected officials and regulators, local and national activists and concerned citizens. And I have consulted with numerous material engineers and other technical people on these issues, both within and outside the NRC.

> As I stated in my letter to the California Coastal Commission, I had safety and security concerns about the underground storage system. One of those concerns dealt with the inspection of the canisters and underground vaults containing them. My concerns were two-fold -- early detection of degradation to the canister should it occur and early detection of flow blockage (such as from sand/debris carried into the vault by the air flow over a long period of time.) As I stated in the letter, Holtec representatives met with me to listen to all my safety and security concerns. They addressed all my concerns to my satisfaction. Regarding the inspection concern, Holtec told me about the temperature monitoring regime for the underground vault. The temperature differential between the incoming and outgoing air flows is trended. If blockage reduced the air flow, the temperature differential will increase. Holtec also committed to including a boroscope and associated inspection procedures to address the canister degradation concern. The boroscope can be lowered into the underground vault to both check for debris accumulation and examine the outer surface of the canister for signs of degradation.

DG: I spent almost an hour with Dr. Singh and he was not able to identify any adequate solutions that exist. A boroscope is inadequate to check for stress corrosion cracks. Even the NRC states this is not adequate to meet their inspection requirements.

DG: I found the following report to be useful to understanding pros and cons of options to inspect for stress corrosion cracks.

Chloride stress corrosion cracking in austentic stainless steel – recommendations for assessing risk, structural integrity and NDE based on practical cases and a review of literature, UK, July 2010
http://www.hse.gov.uk/offshore/ageing/stainless-steels.pdf

DG: Here's a Review of NDE Methods for Detection and Monitoring of Atmospheric SCC in Welded Canisters for the Storage of Used Nuclear Fuel, January 14, 2013, P. 5.3

- Studies by SSM [Swedish Radiation Safety Authority] indicate mean COD [crack opening displacement] of SCC [stress corrosion cracking] flaws is 16–30 µm
- Performance depends significantly on human factors, lighting conditions, surface conditions, and camera specs., and scanning parameters
- Cannot determine through-wall depth of cracks
- Follow-up characterization exams using another NDE method required
- Reliability and effectiveness for detecting atmospheric SCC requires further knowledge regarding COD characteristics of atmospheric SCC flaws

I focused or concentrated on inspection and monitoring because I am skeptical about claims of invulnerability. I am not aware of any cask anywhere that I'd place blind faith in -- hence, the ability to detect degradation, should it occur, as early as possible is a key to successful intervention.

DG: I agree. That's the reason I am opposed to thin canister technology and below ground concrete systems that cannot be inspected or maintained and that do not have the ability for early detection.

You are absolutely correct that the underground vault proposed at San Onofre does not have a ready repair plan should any loaded canister develop problems. But that lack is typical. The lack of a ready repair plan does not mean that a repair plan cannot be developed. For example, a loaded cask developed a problem at Point Beach in May 1995 and was repaired. Likewise, a loaded cask at one of the plants in Virginia (Surry or North Anna, I can't recall exactly which one) developed a seal problem that was remedied.

DG: Your examples of ability to inspect and repair don't apply to stress corrosion cracking of stainless steel canisters and don't apply to underground concrete systems. Carbon steel is used in the VSC-24 canisters. Carbon steel is not subject to stress corrosion cracks. Even Holtec president Dr. Singh said repairing stress corrosion cracks is not feasible in the Holtec stainless steel canisters. In this video he states:

"…It is not practical to repair a canister if it were damaged… if that canister were to develop a leak, let's be realistic; you have to find it, that crack, where it might be, and then find the means to repair it. You will have, in the face of millions of curies of radioactivity coming out of canister; we think it's not a path forward…

…A canister that develops a microscopic crack (all it takes is a microscopic crack to get the release), to precisely locate it… And then if you try to repair it

(remotely by welding)…the problem with that is you create a rough surface which becomes a new creation site for corrosion down the road. ASME Sec 3. Class 1 has some very significant requirements for making repairs of Class 1 structures like the canisters, so I, as a pragmatic technical solution, I don't advocate repairing the canister."

https://youtu.be/euaFZt0YPi4

DG: Also, the VSC-24 welds were repaired prior to loading spent fuel in the canisters. http://pbadupws.nrc.gov/docs/ML1229/ML12290A139.pdf

DG: Regarding seals, I agree seals can be replaced. Therefore, thick casks systems using bolted lids and seals are maintainable. Unfortunately, the welded stainless steel canisters don't use seals and their stress corrosion cracks are not repairable.

To me, when problems are developed as early as possible, it allows time to develop and implement repair plans before safety is compromised. My concerns about untimely awareness of problems were addressed by Holtec's responses about inspections and condition monitoring.

DG: Holtec's temperature monitoring will help alert if the vents are getting clogged. However, there is no warning system for a through-wall stress corrosion crack or any ability to monitor for cracks or crack depth or crack growth rate.

The presentation I made to the California Energy Commission this past April (which I attached to my recent letter to the California Coastal Commission) did address spent fuel pools more than dry storage. There were two reasons for this: (1) spent fuel pools are the much larger safety and security hazards at Diablo Canyon, and (2) spent fuel pools are the much larger safety and security hazards at San Onofre. With respect to San Onofre, I recommended two things in April 2015 that I applied more recently in the letter: (1) transferring fuel from spent fuel pools to dry storage as soon as practical, and (2) protection of the fuel in dry storage from sabotage. The SCE proposal for San Onofre satisfies both of these criterion and is the reason I endorsed it.

I harbor no allusions that dry storage, even the proposed underground system at San Onofre, is absolutely safe. At the same time, I am not aware of any evidence convincing me that the proposed dry storage at San Onfre presents larger safety and security risks than from prolonged storage in the spent fuel pool. Thus, I endorsed a proposal that results in better management of the risks.

DG: The choice isn't between spent fuel pools and inferior thin canister systems. The NRC's Mark Lombard emailed me that the NRC has improved their approval time for spent storage system licensing. It is now only 18 to 30 months. The 30 months is for applications that are incomplete, requiring more question from NRC staff. The fuel at San Onofre needs to cool that long anyway. Lombard said the new reduced timeline is due to increased staffing in their Spent Fuel Management Division. Thick cask technology has been approved by the NRC in the past, so there is no reason to believe it wouldn't be approved now. It can meet or exceed the requirements you've outlined.

> My letter also noted a significant backstop -- the 20-year condition on the California Coastal Commission's approval. SCE would have to come back before the California Coastal Commission with data needed to obtain permission for continued storage as-is. If the data shows that canisters are deteriorating faster than expected, the California Coastal Commission's staff report strongly suggests that SCE might need to repackage or relocate or both. That condition seems like a solid hedge should things not develop as expected.

DG: It's not a realistic option to wait 20 years to address problems. Edison has $1.3 billion allocated for spent fuel management from the Decommissioning Trust Fund. I am an intervenor in the CPUC proceeding where this is being evaluated, so am very familiar with their proposal. Edison's proposal assumes nothing will go wrong with these canisters and DOE will start picking them up in 2024. They are spending all the funds without allocating money for anything to go wrong.

DG: Cracking canisters are not approved for transport.

> NRC Regulation 10 CFR § 71.85 Packaging and Transportation of Radioactive Materials. Preliminary determinations. Before the first use of any packaging for the shipment of licensed material — (a) The certificate holder shall ascertain that there are no cracks, pinholes, uncontrolled voids, or other defects that could significantly reduce the effectiveness of the packaging.
>
> NRC Certificate of Compliance NUHOMS-MP197HB, Certificate 9302, April 23, 2014 (ML14114A099), Page 17, "For any DSC [Dry Storage Canister] that has been used in storage, the condition of the DSC must be evaluated, prior to transportation, to verify that the integrity of the canister is maintained."

DG: Edison plans to destroy the pools, so there will be no way to reload the fuel from failing canisters to new canisters or casks.

DG: Regarding "deteriorating faster than expected", the data at the Koeberg nuclear plant located in a similar environment to San Onofre and using similar materials (per NRC), had cracks up to 0.61" in 17 years. An EPRI partial temperature check and partial surface scraping found temperatures low enough to initiate stress corrosion cracking in a 2-year old Diablo Canyon Canister. They also found magnesium chloride salts on the surface of the canister. All the conditions for stress corrosion cracking in a 2-year old canister. NRC's assumptions of at least 30 years before a chloride-induced stress corrosion crack would initiate was based on the temperature of the canister being too high for salts to deliquesce (dissolve) on the canister. I asked questions at two NRC technical meetings in July and August 2014 where these issues were discussed.

DG: An EPRI report that the NRC and Edison frequently quote, cherry-picked data to reach their conclusion of a longer time period for crack initiation and crack growth rates. They excluded the Koeberg component. They excluded the Diablo Canyon canister data even though EPRI was paid for that project. I prepared the below papers and had them reviewed by metallurgical engineers.

Critique: EPRI Flaw Growth and Flaw Tolerance Assessment for Dry Cask Storage Canisters, D. Gilmore

https://sanonofresafety.files.wordpress.com/2013/06/epri-critiqueandkoebergplant2015-05-17.pdf

Diablo Canyon: conditions for stress corrosion cracking in 2 years, D. Gilmore
https://sanonofresafety.files.wordpress.com/2011/11/diablocanyonscc-2014-10-23.pdf

Thanks,
Dave Lochbaum
UCS

From: Donna Gilmore [dgilmore@cox.net]
Sent: Saturday, October 10, 2015 4:27 PM
To: Dave Lochbaum
Cc: Edwin Lyman
Subject: Holtec UMAX system

Dave, I see you have recommended and endorsed the Holtec UMAX system for San Onofre. I read your recommendation in the Coastal Commission addendum that wasn't available until the day of the Coastal Commission meeting. I would appreciate it if you would work with local California activists such as myself, prior to advising our California leaders what they should do.
http://documents.coastal.ca.gov/reports/2015/10/Tu14a-10-2015.pdf

I agree that the fuel needs to move out of the pools as quickly and as safely possible. However, I am concerned you would recommend a system that uses thin canisters that can crack and leak from our coastal environment, possibly in even 20 years according to data I have. Neither the canisters nor the underground portion of the system can be adequately inspected or repaired.

Holtec president Dr. Singh admits they can't be repaired. He states, first you have to find the cracks, then in the face of millions of curies of radiation being release from even a microscopic crack, attempt to repair them. He states a repair can introduce a new location for corrosion and cracking.

What data do you have that supports these canisters can be inspected, repaired or that they won't crack for decades? What data do you have that these canisters can be transported with cracks? What data do you have that Edison even has a mitigation plan in place in case they do leak or how they would even be able to attempt this in the face of millions of curies of radiation being release.

Canisters have been loaded at San Onofre since 2003. That gives us 5 years before we could have a leak, similar to the Koeberg component that leaked in 17 years from 0.61" stress corrosion cracks.

You did not address these issues in your recommendation. Most of your focus was on the spent fuel pools, as if the only choices were the pools or the Holtec thin canister system. I am hoping

we can get on the same page or at least know why we have technical differences of opinion. It would be good to know if we're working from the same facts.

The Holtec system as designed for San Onofre has not been reviewed by the NRC. Edison plan to use a different thickness of canisters and to install this system half underground and to install in an extremely moist and corrosive environment (both air and in ground). This has not been evaluated by the NRC for seismic, thermal or other conditions that could affect the safety of this installation.

Are you assuming the above problems will be solved? If so, I would like to know what this is based on. I have considerable data to support that any solution will be inadequate.

Do you believe we cannot get a better storage system? You referenced the Fukushima casks that withstood the earthquake and tsunami. This was a thick cask (Areva TN-24 or similar thick metal cask technology). Do you think it is not possible for us to have better technology in a relatively short period of time?

I would like to be able to work with you, because I think we agree on most issues and you are a nice person who is sincerely trying to do the right thing. However, I live 5 miles from this nuclear plant and I believe, based on data I have, that we're more likely to have a radiation release in a few years and that Edison is not prepared to mitigate even one canister, let along how many might start having through-wall cracks. There is some controversial information about how bad that would be. I would like to see documentation that it will be minor, but what I have so far shows the opposite. It's not an issue of whether the pools or canisters would be worse. Failure of either is unacceptable. With the pools, at least you can add water. With the dry canisters, they have no solutions. With over 2000 of these Chernobyl's located around the country, it's only a matter of time before we're poisoning the air and water and the industry has NOTHING in place today to mitigate this.

I've studied the stainless steel inspection technology options. The best one is to put the a fluid dye inside the canister, which of course they can't do. They also do not have an inspection solution for canisters filled with spent nuclear fuel. Even if they find a way to identify some cracks, then what? I've consulted with numerous corrosion engineers, read numerous technical papers on stress corrosion crack issues, solutions, limitations of solutions, and attended numerous NRC technical meetings on the challenges they face with these thin canisters. What I have found motivates me to work to stop use of this thin canister technology and have the industry switch to thick cask technology that can be inspected, repaired, monitored and has an early warning system prior to radiation leaks and that is transportable. We need a mitigation plan BEFORE these canisters start leaking. Time is running out.

You have a major influence on our California decision makers and you are hurting our efforts here locally to push for a better solution.

See source links at http://sanonofresafety.org/

Donna Gilmore
SanOnofreSafety.org
949-204-7794

On 10/10/2015 12:33 PM, Donna Gilmore wrote: