Critique: EPRI Flaw Growth and Flaw Tolerance Assessment for Dry Cask Storage Canisters

The Nuclear Energy Institute (NEI) proposed using a transport cask as an interim solution for a failed (e.g., cracked) canister. However, the Nuclear Regulatory Commission (NRC) has not approved such a use for a transport cask and the nuclear industry has not submitted an application to use a transport cask in this manner. The only current solution is to put a cracked canister back into a spent fuel pool. However, there are technical problems doing this if there is spent fuel already in the pools. Once the pools are empty, the NRC allows the licensee to remove the pools, eliminating the only method available at nuclear facilities to replace failed canisters. Watch Q&A video from NRC's November 2015 annual Nuclear Waste Management Conference. I asked the Areva presenter what the remediation plan is if there is no spent fuel pool. He admits to not having an answer. http://youtu.be/ZpT_fHNnfc0

The NRC and Southern California Edison quote an Electric Power Research Institute (EPRI) report[i] claiming there will not be a through-wall crack for over 80 years. However, this is based on numerous assumptions and conflicts with known data presented by the NRC's own stress corrosion cracking expert, Darrell Dunn at an August 5, 2014 technical meeting. EPRI's report chose to cherry pick relevant operating experience and left out those examples that did not fit its conclusion.

For example, the EPRI report excluded the Koeberg, South Africa refueling water storage tank (RWST) that failed in 17 years with a crack over .60" (15.5 mm) deep, (greater than the thickness of most U.S. thin canisters), yet they call their work "conservative". And EPRI did not mention that crack growth rate would be faster in higher temperature spent fuel canisters. By using the words "in general" and leaving out examples that do not fit their conclusions, they create a misleading view of the facts.

Power Plant Operating Experience with SCC of Stainless Steels

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Plant	Distance to water, m	Body of water	Material/ Component	Thickness, or crack depth, mm	Time in Service, years	Est. Crack growth rate, m/s	Est. Crack growth rate, mm/yr
Koeberg	100	South Atlantic	304L/RWST	5.0 to 15.5	17	9.3×10^{-12} to 2.9×10^{-11}	0.29 to 0.91
Ohi	200	Wakasa Bay, Sea of Japan	304L/RWST	1.5 to 7.5	30	5.5×10^{-12} to 7.9×10^{-12}	0.17 to 0.25
St Lucie	800	Atlantic	304/RWST pipe	6.2	16	1.2×10^{-11}	0.39
Turkey Point	400	Biscayne Bay, Atlantic	304/pipe	3.7	33	3.6×10^{-12}	0.11
San Onofre	150	Pacific Ocean	304/pipe	3.4 to 6.2	25	4.3×10^{-12} to 7.8×10^{-12}	0.14 to 0.25

- CISCC growth rates of 0.11 to 0.91 mm/yr for components in service
  - Median rate of 9.6×10^{-12} m/s (0.30 mm/yr) reported by Kosaki (2008)
- Activation energy for CISCC propagation needs to be considered
  - 5.6 to 9.4 kcal/mol (23 to 39 kJ/mol) reported by Hayashibara et al. (2008)

August 5, 2014 NRC Public meeting with NEI on CISCC RIRP 9

The Koeberg plant is in a similar to environment to West Coast plants (frequent on-shore winds, crashing surf and fog) – known conditions for higher chloride-induced stress corrosion cracking risk. **These conditions were excluded from EPRI's assumptions and calculations.**

Instead, these are examples EPRI chose to include:

> ***3.3.3 Comparison with Relevant Operating Experience*** *(Page 3-16 of EPRI report)* *Operating experience has shown that CISCC can occur due to exposure to marine atmospheric conditions at plants near the seashore.* ***In general,*** *through-wall cracking has typically been identified after a service life of 15-25 years and involves components less than 0.3 inches thick. Specific examples include:*
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> - *16 years after commissioning, leaks due to CISCC were discovered in two pieces of 0.25 inch thick piping in the emergency core cooling system (ECCS) near the refueling water storage tank (RWST) at St. Lucie Unit 2 [32]. The component operated at low temperature and operating stress (30 psig and 120°F). The piping was Class 1 Type 304 piping and the most severe indications occurred in the vicinity of the weld. The leaking piping was located within the RWST trench. Through-wall leaks were not discovered on similar, thicker piping in the same location.*
> - *After being in service for 25 years, leaks were identified in a similar location at San Onofre Units 2 and 3 (in the ECCS suction piping and the piping from the RWST to the charging pumps) [33]. The cracking occurred in the HAZ of the Type 304 components' welds for both NPS 6 SCH 10 and NPS 24 SCH 10 piping (0.13 inch and 0.25 inch thick). At least one of the leaking pipes was located within a tunnel exposed to the atmosphere.*

The EPRI report is 84 pages long and uses assumptive words over 254 times (69 "assume", 38 "expected", 10 "uncertainty", 18 "estimate", 11 "general", 101 "model", and 7 "approximat").

A better way to learn the truth is to listen to NRC technical meetings or read documents from NRC technical staff or other scientific and technical reports. Once information filters through NRC management, the NRC technical facts sometimes disappear and are replaced with "facts" with an entirely different interpretation. Here are links to more detailed papers on dry cask storage. These are highly sourced paper in contrast to Edison CEP Chairman David Victor's Dry Cask report filled with opinion, unsubstantiated facts and unsubstantiated hope.

- Dry Cask Storage Issues (long version), Donna Gilmore, September 23, 2014
  https://sanonofresafety.files.wordpress.com/2011/11/drycaskstorageissues2014-09-23.pdf
- Dry Cask Storage Issues (short version), Donna Gilmore, January 30, 2015
  https://sanonofresafety.files.wordpress.com/2011/11/reasonstobuythickcasks2015-01-30.pdf
- Long Term Storage of Spent Fuel, David Victor, December 9, 2014
  http://www.songscommunity.com/docs/LongTermStorageofSpentFuel_120914.pdf
  http://www.songscommunity.com/docs/AppendixSafetyPaper.pdf

Donna Gilmore
SanOnofreSafety.org

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[i] Flaw Growth and Flaw Tolerance Assessment for Dry Cask Storage Canisters. EPRI, Palo Alto, CA: 2014. 3002002785 *http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?productId=000000003002002785*