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To: Leeds, NRR
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Merzke, OEDO

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SUBJECT:

Provides information on a newly created animation of what could happen if San Onofre Nuclear Generating Station Unit 2 is restarted

ACTION:

Appropriate

DISTRIBUTION:

RF, SECY has Ack.

LETTER DATE:

02/11/2013

ACKNOWLEDGED

Yes

SPECIAL HANDLING:

Lead office to publicly release 24 hours after SECY's assignment, via SECY/EDO/DPC.

NOTES:

FILE LOCATION:

ADAMS

DATE DUE:

DATE SIGNED:

Joosten, Sandy

From: Ace Hoffman [rhoffman@animatedsoftware.com]
Sent: Monday, February 11, 2013 6:40 PM
Subject: New animation shows what could happen if SanO Unit 2 is restarted...

2/11/2013

Dear Readers,

I've created a new animation of San Onofre's steam generators and it's available online (it's also available as an executable file for mac or windows; please email the author if you would like a copy emailed to you):

It's written in Adobe Flash. Here's the URL:
<http://www.acehoffman.org/sano/SanOnofreRSGsbyAceHoffman.swf>

Short url:
<http://goo.gl/efJFO>

Illustrated are the main flow paths for the steam, feedwater, and reactor coolant through the steam generator. Mouse over the titles to highlight the parts. Mouse or click on Main Steam Line Break to see what could happen in that scenario. Click on the U-tubes themselves to view an overlay of typical flow velocities.

Here are some of the things that are illustrated in the Main Steam Line Break:

- *MSLB with steam shooting out
- *Increased steam flow rate (hard to see but it's there)
- *Entire contents of tube barrel turns to steam
- *Cascade of tube ruptures with primary coolant flashing to steam as it exits the busted tubes
- *Tube parts fly up and away with the highly radioactive steam
- *Loose parts rise up from the bottom (again hard to see, but it's there!)

At San Onofre, the new steam generators in both Reactor Unit 2 and Unit 3 experienced enormous amounts of unexpected tube wear. But apparently only Unit 3 suffered a rhythmic type of tube vibration and damage known as fluid elastic instability.

Why the difference?

Southern California Edison claims the reason was partly due to sufficient contact forces from the out-of-plane vibration arrestors to prevent in-plane vibrations too. This is just conjecture on their part, though, and it is disputed by experts. But everyone admits there were NO vibration dampers specifically designed to prevent vibration in the in-plane direction. It was assumed that wouldn't happen.

Edison's problem was that they had Mitsubishi build the steam generators to the maximum possible steam output -- except they went way over the maximum safe level, delivering what's known as "higher quality" steam (less water in the mixture) than expected. In fact, the steam was so dry that the thin layer of water normally seen on the outside of the steam generator tubes evaporated -- and there went an important protection against damage if the tubes DO bang into each other.

The reason Unit 2 did not suffer in-plane FEI was NOT because of the restraining system for the out-of-plane direction, it was because the void fraction (dryness) of the steam wasn't as high as in Unit 3, and the flow velocity of the steam wasn't as high in Unit 2 as in Unit 3.

Unit 3 operated for 11 months under conditions that are favorable to FEI, but it is not known by anyone how much of that time it actually spent in FEI. FEI is quite violent and gets progressively worse quite quickly. So it is probable that it did not last long. What did last the whole time the reactors were operating was all the wear and tear that the units were going through from "flow induced vibration." FIV is also due to high flow velocities (among other reasons). FIV may have contributed to how quickly FEI reached a rupture point when it did set in. For example FIV could have weakened the tube metal so that it vibrated more and more easily. Over the course of 11 months, the tubes would have vibrated for tens of millions of cycles. A lot of damage can be done to very hot metals which are flexed tens of million of times.

After the tube rupture January 31, 2012, Southern California Edison pressure-tested (and plugged) over 100 tubes in each unit. Eight tubes -- including the one that leaked -- failed the pressure tests. This was a very significant event: Unexpected and unprecedented in the industry. But in one way it should not have come as a complete surprise: Several of the tubes were adjacent to the one that leaked, and 99% of their tube wall thickness had been rubbed away while the reactor was running! They almost leaked by themselves, and would have soon if another one hadn't reached the breaking point first.

The pressure several of the tubes failed at was well below what can reasonably be expected in a "main steam line break" at San Onofre. This means that these tubes would probably have ruptured in that event, and, combined with a main steam line isolation valve failure (and valves DO fail, and main steam lines DO break), would lead to a rapid loss of cooling capability for the reactor.

But even with perfect steam generators, San Onofre would still have a very big problem on their hands: What to do with the highly radioactive nuclear reactor cores that are piling up on site in deadly "dry casks" and overcrowded spent fuel pools?

The answer to that is not known, but it is known that we don't need to keep adding to the pile of waste that has already been created. We did not have blackouts in Southern California last summer (summer being the peak energy usage period) and don't anticipate any this summer, according to California's official energy grid operators.

Southern California Edison has been unwilling to admit defeat. They cannot fathom that their "cash cow" won't give milk anymore, but it's poisonous main product will remain for hundreds of thousands of years, for multitudes of future generations of citizens to have to deal with somehow.

It would be a tragedy to restart San Onofre when its fuel has been cooling for more than a year, making it less and less dangerous in an earthquake or tsunami, and when there has been no progress on waste disposal for nearly seven decades, with none in sight, and when San Onofre's old parts, its new parts, and its people fail on a regular basis.

San Onofre is a walking dead man. Somebody needs to knock it down and put it out of our misery.

Ace Hoffman
Carlsbad, CA

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