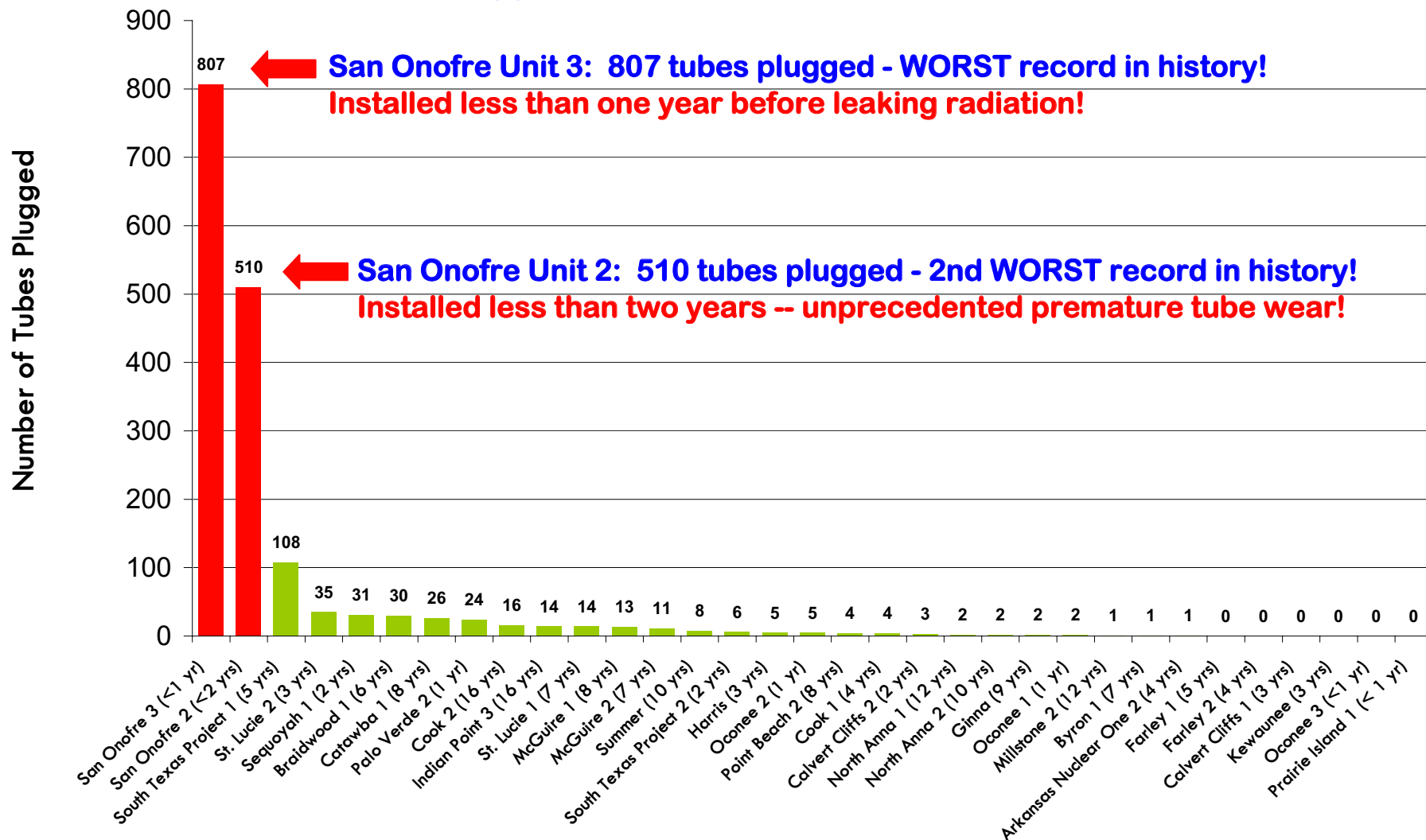


U.S. Nuclear Reactors: Replacement Steam Generators Tubes Plugged to Avoid Radiation Leaks



← **San Onofre Unit 3: 807 tubes plugged - WORST record in history!**
Installed less than one year before leaking radiation!

← **San Onofre Unit 2: 510 tubes plugged - 2nd WORST record in history!**
Installed less than two years -- unprecedented premature tube wear!

Nuclear Reactors (years of replacement steam generator operation before tubes plugged)

NUCLEAR REGULATORY COMMISSION: www.nrc.gov/info-finder/reactor/songs/tube-degradation.html#data,

<http://pbadupws.nrc.gov/docs/ML0723/ML072330588.pdf>, <http://pbadupws.nrc.gov/docs/ML1127/ML11270A015.pdf>

FAIREWINDS: http://fairewinds.org/sites/fairewinds.org/files/reports/Edison_RSGs@SO_US_Worst_2012-7-11_FairewindsRptFOE.pdf

San Onofre Steam Generator Problems

Why is San Onofre shut down?

San Onofre has been shut down since January 31, 2012 due to a radiation leak in defective replacement steam generators and unprecedented wear in all four generators.

- **Generator failure can cause uncontrolled radiation leaks.** Generators are critical for cooling the reactors.
- A generator tube in reactor Unit 3 leaked radiation into the air after being installed less than a year.
- All four generators (2/reactor) show **unprecedented premature tube wear** less than 2 years after installation. (9727 tubes/generator = 38,908 tubes).
- **These cost ratepayers almost \$700 million.** Before they failed, Edison said the design changes would result in the generators lasting 40+ years.

Can the steam generators be safely repaired?

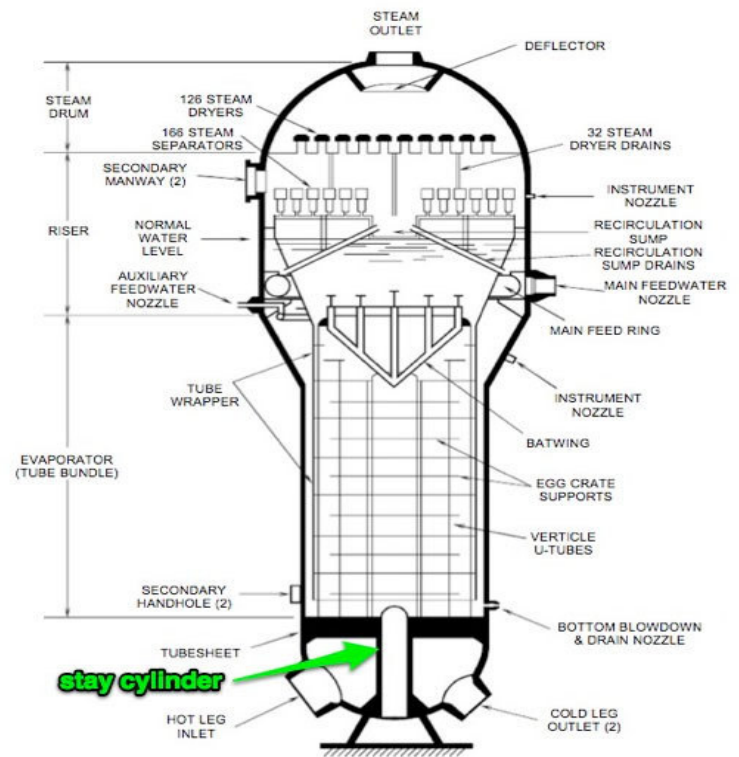
Independent Nuclear Engineer Arnie Gunderson¹ said the safest option is to replace the steam generators.

NRC Investigation Chief, Greg Werner², said

- **The only way to determine generators are failing is if they leak radiation³** or when inspected off-line.
- **Technology doesn't exist to test steam generators.** They rely on computer design simulations. The simulations were off by 300-400%. Engineers under predicted the velocities of steam and water inside the generators.

What are the significant design changes?

- **Edison's design changes resulted in tube vibrations and extensive premature tube wear.**
- The original generators had a unique tube support to prevent vibration – these supports were changed in the new design and 377 tubes added to each generator. This was done to increase profits.
- The main structural **stay cylinder** was removed (see diagram). This support cylinder was designed to secure the generator and prevent vibration – exactly the kind of vibration that seems to be causing tube degradation.
- All of these changes necessitated pressure and flow changes in the generator's operation.



Typical Combustion Engineering Steam Generator

What is the impact of the design changes?

- The tubes are now “at risk of bursting in a main steam accident and spewing radioactivity into the air”.
- The top of the new steam generator is now “starved of water, therefore making tube vibration inevitable”.

Will plugging tubes and reducing power help?

- **No. Reducing power will not change the pressure inside or outside the tubes. Previously damaged tubes will continue to vibrate, damaging surrounding tubes and tube supports and worsen the existing damage.**
- Vibration is the result not the root cause of the steam generator problems at San Onofre. Plugging tubes cannot repair design changes that cause the tubes to collide with each other.
- Reducing power does not remedy the underlying structural problems that are creating the vibration that has damaged and will continue to damage the tubes.
- Lower power might create a resonate frequency at which vibration might increase without notice.
- Historical evidence at other reactors has shown that operating at lower power has not been an effective solution.

¹<http://fairewinds.com/content/san-onofre-bad-vibrations>

²<http://sciencedude.ocregister.com/2012/06/18/nrc-steam-flow-too-high-in-san-onofre-units/173005/>

³<http://pbadupws.nrc.gov/docs/ML0037/ML003740256.pdf> (page 2, second column)