Good Nukes – *Almost* Good Enough

Spoken Text:

Nuclear energy. What does it mean to you? How safe do you think it really is? What do you think we should do with the waste? What is your connection to nuclear racism? Can we afford it? These High School students are not far off. (1)

Welcome to Good Nukes - Almost Good Enough, a production of the Prairie Island Coalition. This title is inspired by a senior Northern States Power Co. nuclear engineer who told a colleague that due to design and materials flaws, key parts in reactors like Prairie Island are, quote, no better than almost good enough, end of quote.(2)

There are over 100 commercial reactors operating in the United States.(3) About 2/3 of these, including Prairie Island, are pressurized water reactors.(4) There are 14 operating reactor sites in Illinois, Iowa, Minnesota, Nebraska and Wisconsin.

The Prairie Island reactors and nuclear waste storage facility are located 45 miles southeast of Minneapolis/St. Paul, on the Mississippi River. Both are immediately adjacent to the Prairie Island Mdewakanton Dakota Community.

The two reactors each have a generating capacity of 530 megawatts, and began producing electricity in 1973 and 1974. Nuclear energy accounts for about 25% of the electricity used in Minnesota, and about 30% of the electricity produced by NSP.

Society's dependence on nuclear energy creates 5 fundamental problems: 1. Broken Reactor Components 2. Routine Nuclear Emissions 3. No Safe Way to Manage Nuclear Waste 4. Nuclear Racism, and 5. Bad Nuclear Economics

1. Broken Reactor Components

To understand the threat created by broken reactor parts, one must know basically how reactors like Prairie Island work. They use a three-loop water system to produce electricity and nuclear waste.

Heat in the reactor core comes from a chain-reaction of exploding uranium atoms. In the core, primary water is heated above 600 degrees Fahrenheit. Hot primary water is pumped through steam generators, where heat is transferred to secondary water that flashes into steam. Primary water returns to the core for reheating. Very high pressure keeps primary water from boiling.

Prairie Island has four steam generators, two for each reactor. Each is about 25 feet tall, and contains over 3,000 tubes. Secondary water outside the tubes boils. The resulting steam spins turbines to generate electricity. Then, secondary steam is condensed and returned to steam generators. Less then 1/3 of the energy in the core emerges as electricity. The rest of the energy is removed as waste heat in the condenser, and sent to the river and atmosphere.(5)

Problems with steam generator tubes now cause major public health and safety risks.(6) NSP was the 13th electric utility to sue Westinghouse because steam generator tubes sold by Westinghouse have experienced unanticipated and premature degradation.(7) This degradation causes cracks to form and grow, and leak primary water into the secondary loop. It can cause tubes to rupture.(8) Internal nuclear industry documents secured by the Prairie Island Coalition during NSP's lawsuit emphasize the seriousness of tube cracking.

This steam generator diagram identifies some of the tube problems. (9)

Tube degradation tends to concentrate in the following areas: 1.- where tubes are welded to the tubesheet at the bottom of the steam generator; 2. - where tubes pass through support plates; 3. - where interior tubes are bent tightly near the top of the steam generator; 4. - where sludge piles accumulate around the tubes.(10)

Stress and corrosion cause pits, pinholes, and two types of tube cracks: axial cracks run the tube length; circumferential cracks run around the tube. In addition, foreign objects left inside steam generators during inspection and repair can rub and bang against tubes until they rupture. (11)

New cracks are occurring in ways the nuclear industry doesn't understand and can't predict. For example, cracks are appearing in mid-span regions, in between support plates, where there is no ready explanation for their presence.(12)

We now know that steam generators were poorly designed and made out of the wrong metal. Crevices, where corrosion readily occurs, are inherent in vertical steam generator designs. And Inconel, the nickel/chromium alloy used to make the tubes, is more susceptible to crevice-corrosion cracking than stainless steel. To quote the senior NSP nuclear engineer who inspired our title: "So, if we are stuck on inconel and stuck with crevices, then it is virtually a given that we will end up with steam generators that are no better than almost good enough."(13) Emphasis in original. The nuclear industry does not know how to stop the global epidemic of tube cracking. Steam generator leakage can't be prevented. Tube defects cause all steam generators to leak all the time. Even when reactors first come back on-line after being down for repairs, tubes still leak. There have been 14 tube ruptures in the United States, including a rupture at Prairie Island in October, 1979.(14)

At first, leaking tubes were plugged and taken out of service. But there is a limit to how many tubes can be plugged before performance suffers. So, many plugs have been removed and a smaller tube, or sleeve, gets welded inside the original tube. Unfortunately, sleeves and plugs soon leak as well.(15)

The trend of steam generator tube defects at Prairie Island is consistent with the national pattern. As of October, 1996, the four Prairie Island steam generators had almost 600 tubes plugged. Without plugging, each of these tubes could have ruptured.(16)

On February 27, 1996, after PIC had secured internal nuclear industry documentation of steam generator tube problems, the Nuclear Regulatory Commission confirmed our worst fear: steam generator tube degradation is increasingly likely to result in many tubes rupturing at the same time. This will cause a nuclear meltdown.

Of particular concern are circumferential cracks in tubes next to each other. When one circumferentially cracked tube ruptures, the additional stress may cause adjacent tubes to also rupture.

Rules governing reactor operations simply did not contemplate cascading tube ruptures. Therefore, emergency core cooling systems were not designed to prevent a core meltdown if a number of tubes rupture at the same time.

During a cascading tube rupture, radioactive primary water will flash into steam in the secondary water loop. Steam-line pressure relief valves outside the containment vessel will open, and vent radioactive steam to the atmosphere.

As primary water hemorrhages into the secondary loop, primary water pressure will drop. This will cause water in the core to boil. Steam pressure inside the core will force water out, and the core, no longer cooled by water, will melt. Molten fuel will collect at the bottom of the reactor vessel and melt down through the floor and into the ground beneath. This has been called the China Syndrome (17)

During a meltdown, it is virtually certain that molten fuel will contact groundwater under the plant. Resulting steam explosions will spread radioactive fuel particles throughout a wide area. Millions of people could be contaminated.

This map shows the area contaminated by one type of radioactive particle from the Chernobyl explosion. This deposition pattern totally depended on weather conditions at the time of the explosion. Additional radioactivity contaminated much of the globe, including Sami Land, in Northern Scandinavia, where reindeer herds were exterminated after they ate contaminated lichens.

A Chernobyl type explosion can not happen at Prairie Island. But a cascading tube rupture event could not have happened at Chernobyl. The technologies are different. Each nuclear technology, however, is susceptible to catastrophic accidents. Cascading tube ruptures at Prairie Island could contaminate an area similar to the size of the contaminated zone surrounding Chernobyl.

Here, the area contaminated by this one type of radiation from Chernobyl is overlaid on a map centered on Prairie Island. These maps are on the same scale. A cascading tube rupture event at Prairie Island could contaminate an area this size. Evacuation and abandonment will be the only emergency response, and we are ill-equipped for even a safe evacuation.

We are all in the zone.

Cascading tube ruptures are only one of a number of possible events that could cause a meltdown at PI or any other nuclear reactor.