

<h2>Can U.S. Nuclear Plants Flood?</h2>	<h2>Are Hydrogen Explosions Uncommon?</h2>
<p>Robert Youngberg Sustainable Development / International March 16, 2011 MST</p> <p>The earthquake damage, flooding and subsequent explosions at the Fukushima Daiichi Nuclear Power Plants in Japan begs the question:</p> <h3><u>Can this happen in the U.S?</u></h3> <p>Examples from Nebraska - a long way from the ocean or major earthquake zones</p>	<h3><u>Hydrogen Explosions</u></h3> <p>In the case of the Fukushima Daiichi Nuclear Power Plant, tsunami flood water damaged the cooling water pumping equipment and controls. This resulted in the lack of ability to cool the nuclear reactor core.</p> <p>Under normal atmospheric pressure, at 2,200 degrees centigrade, water separates into hydrogen and oxygen. Overheating of the Daiichi nuclear reactor cores generated hydrogen which migrated to the surrounding buildings, and exploded, causing significant damage.</p> <p>Hydrogen explosions typically do not usually cause direct damage to the nuclear reactor core containment, but can cause destruction of the equipment and system controls, which prevents operation of the cooling system and results in an ever increasing temperature in the reactor and eventual meltdown of the core.</p>
<h3><u>Fukushima Daiichi Nuclear Power Plant</u></h3>	
<p>There are 55 nuclear reactors in Japan, 1 out of every 6 in the world. The U.S. has 104. Nebraska has 2. Eleven of the Japanese plants went off-line after the earthquake on Thursday, March 10. All 6 Fukushima Daiichi Nuclear Power Plant reactors were shut down and at least 3 developed cooling problems, resulting in overheating of the reactor cores and several hydrogen explosions.</p>	
<p>The 9.0 magnitude earthquake in the ocean offshore of the Daiichi power plants may have caused direct damage to the structure of the Daiichi nuclear containment structures, but the major damage resulted from the lack of electrical power to the plant/water pumps, flooding of the back-up generators, inadequate back-up batteries for the pumps, and other water supply and pump issues. This resulted in the inability of plant managers to operate the Reactor Core Isolation Cooling (RCIC) pumps, and severe overheating of the cores in at least 3 of the 6 Fukushima Daiichi Nuclear Power facility reactors, repeated fires at a 4th reactor, hydrogen explosions, partial melting of the reactor cores, and possibly a core collapse in one or more of the reactors.</p>	
<p><i>Disaster in Japan: March 17 Live Blog GMT+9</i> http://blogs.aljazeera.net/live/asia/disaster-japan-march-17-live-blog</p>	
<h3><u>U.S. Earthquakes and Nuclear Facilities</u></h3> <p>There are 104 nuclear power plants and 36 other nuclear facilities in the U.S. Proximity to earthquake faults is fairly common. An example is the two nuclear power plants on the Diablo Canyon in California designed to withstand a 7.5 magnitude earthquake from faults, including the nearby San Andreas fault. By the time of the plant's completion in 1973 the Hosgri fault, had been discovered 10 offshore. Geological research and exploration indicates this fault had an estimated 7.1 magnitude quake on November 4, 1927. The structural integrity of the plant has since been improved.</p>	 <p>Diablo Canyon Nuclear Plant in California is within the most active earthquake zone in the United States. (Photo: emdot/Flickr)</p>
<p>The San Francisco earthquake of 1906 that struck San Francisco, California, and the coast of Northern California on April 18, 1906 was an estimated magnitude of 7.9.</p>	

Q. Can natural disasters result in flooding of U.S. nuclear power stations?

A. It has already happened... Examples from Nebraska - a long way from the ocean:

The extensive cooling systems that are required for nuclear plant operation dictates these facilities are built close to large water supplies – rivers, lakes, and oceans, and consequently are often built in flood plains.

All nuclear plants are built in close proximity to large bodies of water, and by the very nature of these locations, many are built in the 100 year flood plain – a 1% chance of a flood in any single year.

If you have spent any time calculating odds in a casino, or have bought a lottery ticket, you know 1:100 is very good (or bad) odds. The average age of the nuclear power plants in the U.S. is over 30 years. The 100 year flood can happen at any time, you don't have to wait 100 years for the 100 year flood, and like the throw of the dice, it can happen two years, or even 2 days, in a row.

Nebraska Cooper Nuclear Power Station

The Cooper Nuclear Power Station was built on a 100-year flood plain and first put into operation in July 1974. In mid-July 1993 rapidly rising flood waters on the Missouri River near Brownville, Nebraska forced the operator to shutdown the reactor. The dikes and levees collapsed around the site closing many emergency escape routes in the region.

Fortunately the flood water did not get directly into the below grade Reactor Core Isolation Cooling (RCIC) pump room, however ground water seepage caused damage to electrical cables, equipment, and caused circuitry to ground out.^[1]

Hmmm – collapsing dikes and levees – does that sound familiar?



Photo: Diane Krogh/Lighthawk

The photo above shows the 1993 flood on the Missouri River as it recedes from Nebraska's Cooper Nuclear Power station at Brownville, NE. Notice the flood water on all sides of the facility.

Are hydrogen explosions uncommon? Apparently not...

The first close call. The Brownville, Nebraska Cooper Nuclear Power Plant: On November 5, 1975 the plant had been operating a year and a half. Hydrogen gas leaking from the reactor core exploded from an air sampler spark and injured and contaminated two workers, and damaged the plant boiling water reactor and an auxiliary building.^[2]

The second close call. On January 7, 1976, two months after the hydrogen gas explosion that injured two men, an ice plug formed at the top of the 325 foot off-gas stack, producing a back pressure and build up of hydrogen in the building. The building was evacuated, and shortly thereafter an explosion completely demolished the building; the reactor was shut down immediately. There were no personnel injuries. There was some release of radioactivity on site, but it did not reach the site boundary. "...levels of activity at the site boundary were below maximum permissible concentrations throughout the accident."^[2]

The third close call. A news release in mid-September, 1999 described a hydrogen gas explosion at the Cooper Nuclear Power Plant, causing the shutdown of the reactor. An electrical problem in sump pumps at the base of the plant's gas release towers caused the hydrogen explosion.^[3]

A Failed Nuclear Power Station

The Hallam Nuclear Generating Station – Entombed Atomic Reactor. In addition to the above flooding problems and hydrogen explosions, Nebraska has had other problems with its nuclear power program. In 1958 construction started on an experimental graphite-moderated sodium cooled reactor. It was located near Hallam, about 25 miles southwest of Lincoln, the state capital.

The graphite moderator was clad in stainless steel. There were issues with the cladding, corrosion and stress cracking led to the failure of the cladding cans. In 1964, after 2 years of operation, the Atomic Energy Commission ordered the plant decommissioned as the stainless steel skins of several of the plant's moderator elements had cracked, allowing sodium to come in contact with the graphite, halting the nuclear process.

The plant was decommissioned and the nuclear components sealed in concrete. Radioactive monitoring of the site will continue through at least 2090 by the Department of Energy (DOE) under an agreement with the Nebraska Department of Health.^[4]

The above series of events are not typical of the performance of the Nebraska Public Power District and other public electric utilities in operating the various Nebraska coal, natural gas and nuclear power facilities and providing low cost electricity for Nebraska. Nebraska is a 'public power' state, i.e. all electrical power is publically owned by municipal or state sanctioned entities, but like the Fukushima Daiichi Nuclear Power Plant, these facilities are often operated by third parties. The management of these events which prevented a more serious situation is a testimony to the operation of these facilities. Nebraska utilities have a 35+ year history of research and demonstration programs for renewable energy and currently have an aggressive program to develop wind and photovoltaic energy. The current large scale wind projects are in the 3.5 cent per kWh range, far below the cost of a new conventional energy project.

Personal Note:

I love Nebraska. I was born there and lived there the first 45 years of my life. We still have the family farm – for 120 years. For about half my time in Nebraska I lived in Lincoln, which is less than an hour drive from the Brownville and Hallam nuclear sites. For 8 years, starting in 1978, I was the Director of the University of Nebraska Solar Energy Research and Policy office. On March 28, 1979 my office was sponsoring a solar conference at the Hilton Hotel in Omaha, Nebraska.

This was 12 days after the release of the movie – 'The China Syndrome', and the same day as the Three Mile Island nuclear accident. The local news media descended on the solar event. I hastily arranged a news conference on the steps of the Hilton Hotel, with a podium, a dozen microphones, reporters, and cameras.

I was young, dressed in a 3 piece suit, and not well experienced with the news media. But somehow I got through my prepared statement and the reporter's questions. In the background a large crowd from the solar conference was shouting: "Nuclear is dead! Nuclear is dead!"

That evening we were on the local TV news and the next day my picture was on the front page of the Omaha World Herald... Those were heady times; my son was 6 months old, we were changing the world.



President Jimmy Carter, a former nuclear engineer, seen leaving the Three Mile Island Nuclear Generating Station on April 1st, 1979

Sources:

[1] Nuclear Information and Resource Service article "Natural Disasters and Safety Risks at Nuclear Power Stations" November 2004 by Paul Gunter

<http://www.nirs.org/factsheets/naturaldisaster&nuclearpower.pdf>

[2] "Descriptions of Selected Accidents that Have Occurred at Nuclear Reactor Facilities" Nuclear Safety Information Center, April 29, 1980. Department of Energy's (DOE) Information Bridge: DOE Scientific and Technical Information. <http://www.osti.gov/bridge/>

[3] Environment News Service Ameriscan: September 21, 1999 <http://www.mail-archive.com/nativenews@mlists.net/msg04368.html>

[4] "State's First Nuclear Plant Buried Near Lincoln – Hallam Nuclear Power Facility", Nebraska Energy Office: http://www.neo.ne.gov/winter97/win97_12.htm

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