The Safety and Reliability – or Lack Thereof – of Nuclear Reactors in a Destabilized Climate

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Some Effects of Climate Destabilization:

- **Severe Weather Events and Natural Disasters (Hurricanes, Tornadoes, High Winds, Heat Waves, Droughts, Floods)**
- **Rising Sea Level**
- **Grid Instability**

Intergovernmental Panel on Climate Change (IPCC), 2001:

- "Projected Changes in Climate Extremes Could Have Major Consequences: The vulnerability of human societies and natural systems to climate extremes is demonstrated by the damage, hardship, and death caused by events such as ***droughts, floods, heat waves, avalanches, and wind storms…some extreme events are projected to increase in frequency and/or severity in the 21st century due to changes in the mean and/or variability of climate, so it can be expected that the severity of their impacts will also increase in concert with global warming***…"

---from IPCC, Summary for Policymakers, Climate Change 2001: Impacts, Adaptation, and Vulnerability.

“It's the extreme weather and climate events that will have some of the most severe impacts on human society as the climate changes.”

Jerry Meehl, National Center for Atmospheric Research

[Author of study finding that heat waves will grow more common and more intense: Paris will experience 31% more heat waves in 21st Century, Chicago will experience 25% more heat waves, he predicts.]

What’s the Risk? RADIOACTIVITY!

- Natural disasters and nuclear power plants don’t mix because of the risk of releasing the vast amounts of harmful radioactivity present on-site. Operating reactor cores hold billions of curies of radioactivity. High-level radioactive waste storage pools hold decades worth of waste. Outdoor dry casks each hold over 200 times the long-lasting radiation released by the Hiroshima atomic bomb.
- The risk of catastrophic radiation releases, that could kill or injure tens of thousands downwind and downstream, is increased due to global warming induced severe weather events.

Flooding at Nuclear Reactors:

- Cooper Nuclear Power Station on the Missouri River in southeastern Nebraska, July 1993

(Photo Credit: Diane Krogh/Lighthawk)

Flood at Cooper Nuke Plant:

- Reactor forced to shut down as dikes and levees failed, blocking many emergency escape routes in region

- Although NRC & nuclear utility assured no danger to public during flood, it was later revealed (NRC Information Notice 94-27, March 31, 1994):

→below ground rooms in reactor & turbine buildings were extensively flooded;

→“the floor drain system had backed up so that standing water from within areas known to be radiologically contaminated had migrated out into designated clean areas;”

→plant personnel “had not established measures to divert the water away from important components;”

→flood waters within reactor building had impinged on electrical cables and equipment such as the Reactor Core Isolation Cooling pump room (a critical reactor safety system during station blackout conditions), causing short circuits;

→“This event demonstrates that flooding problems and degradation of equipment may be caused by water inleakage even though flood waters are not above grade elevations.”

Floods at Prairie Island, MN:

Nuke Waste Storage in a Flood Plain?!

Floods at Prairie Island

- Major flood in 1965, just three years before nuclear utility began building reactors without informed consent of Mdewakanton Dakota tribe
- Large floods in mid 1990s required sandbagging and active pumping
- Seasonal floods regularly block only emergency evacuation route from island to mainland
- "The safety significance of one issue from 2005 remains under review. The NRC has identified an apparent violation of the agency's emergency planning requirements which has been preliminarily evaluated to be a "white" finding, one of low to moderate safety significance. ***The NRC found that the plant's emergency plan did not meet the requirements for actions to be taken in the event of flooding at the plant."*** (NRC press release, April 6, 2006)

Tornadoes & Nukes:

- Calvert Cliffs Nuclear Power Plant on the Chesapeake Bay in Lusby, Maryland (April 28, 2002)

- F3 to F5 on the Fugita Wind Damage Scale, with wind speeds from at least 158 to over 260 miles per hour, and damage ranging from “severe” to “devastating” to “incredible,” passed within one mile of the twin reactors (photo credit: Calvert Cliffs Nuclear Plant)

La Plata, Maryland after "Calvert Cliffs Tornado":

Tornadoes & Nukes:

- NRC has reported that F4 & F5 tornadoes can generate winds and tornado “missiles” which can severely damage steel reinforced concrete structures
- F2 to F5 tornadoes can also damage or destroy support systems for onsite irradiated nuclear fuel storage pools, such as offsite power supply, onsite emergency backup power supply, cooling pumps, and make-up water supply

  (NRC, Spent Fuel Pool Accident Risk Study, Oct. 2000)

Tornado hits Davis-Besse, near Toledo, June 24, 1998:

- “Significant” tornado, with wind speeds between 113 and 156 mph – Fugita Scale Category F2 – scored direct hit while reactor at 99% power;
- Station had not been notified of approaching storm, and plant personnel inside facility were unaware of it despite Nat’l Weather Service warnings;
- Lightning and high winds caused a loss of off-site power, automatically shutting down reactor – 11 transmission towers toppled in vicinity;
- 41 “tense hours” of emergency core cooling and communication breakdowns;
- Plant’s main phone system knocked out, including “hot line” to NRC in Washington, delaying alert to emergency management officials;
- Emergency diesel generators supplying power to key safety systems experienced a number of malfunctions for the first 24 hours of the crisis – offsite power was restored in the nick of time to prevent core overheating;
- High-level rad. waste storage pools are not required to be connected to emergency back-up power -- temperature rose from normal level of 110 degrees F to 140 degrees F.

“Nuclear Disaster Averted”

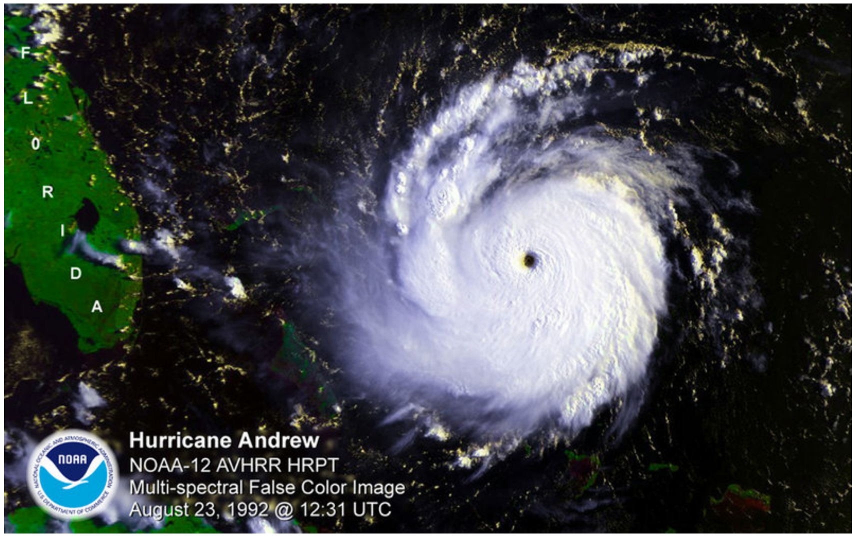
Newspaper headlines re:

Davis-Besse 1998

Tokai-mura, Japan 1999

Hurricanes and Nukes:

- Category 5 Hurricane Andrew that passed directly over the twin-reactor Turkey Point nuclear power plant 30 miles south of Miami on August 24, 1992.



Hurricane Andrew @ Turkey Pt.

- Sustained winds at 145 mph & gusts at 175 mph;
- Reactors lost all off-site power during storm and for five days longer;
- Emergency diesel generators functioned for entire six days, but required diesel fuel be diverted ***away from area hospitals*** to the nuclear plant as a regional safety priority;
- Off-site communications were lost for 4 hours during storm – access to site blocked by debris and fallen trees;
- Radiological monitoring equipment destroyed, which would have significantly hampered emergency operations and civilian evacuation in the case of a radiation release, as its intensity and direction could not have been determined.

Fire Danger @ Turkey Pt.

- Reactors' fire protection system destroyed when winds and "missiles" toppled water tower holding 100,000 gallons, also puncturing adjacent water storage tanks holding 1,250,000 gallons;
- Collapse also destroyed fire protection water pumps;
- Hurricane also stripped fire-resistant coating from reactor emergency shutdown electrical cables;
- Adjacent fossil fuel plant's fuel oil storage tank ruptured, spilling 100,000 gallons of combustible fuel oil and spewing it onto the nuclear site.

Coastal Reactors Vulnerable to Hurricanes

What you *ARE NOT* supposed to know:

1. **It doesn't take an accident** for a nuclear power plant to release radioactivity into our air, water and soil. All it takes is the plant's everyday routine operation, and federal regulations permit these radioactive releases.

2. Radioactivity is measured in "curies." A large medical center, with as many as 1000 laboratories in which radioactive materials are used, may have a combined inventory of only about two curies. In contrast, an average operating nuclear power reactor will have approximately 16 billion curies in its reactor core. This is the equivalent long-lived radioactivity of at least 1,000 Hiroshima bombs.

3. A reactor's fuel rods, pipes, tanks and valves can leak. Mechanical failure and human error can also cause leaks. As a nuclear plant ages, so does its equipment – and leaks generally increase.

4. Some contaminated water is intentionally removed from the reactor vessel to reduce the amount of the radioactive and corrosive chemicals that damage valves and pipes. This water is filtered and then either recycled back into the cooling system or released into the environment.

5. A typical 1000-megawatt pressurized-water reactor (with a cooling tower) takes in 20,000 gallons of river, lake or ocean water per minute for cooling, circulates it through a 50-mile maze of pipes, returns 5,000 gallons per minute to the same body of water, and releases the remainder to the atmosphere as vapor. A 1000-megawatt reactor without a cooling tower takes in even more water – as much as one-half million gallons per minute. The discharge water is contaminated with radioactive elements in amounts that are not precisely tracked, but are potentially biologically damaging.

6. Some radioactive fission gases, stripped from the reactor cooling water, are contained in decay tanks for days before being released into the atmosphere through filtered rooftop vents. Some gases leak into the power plant buildings' interiors and are released during periodic "purges" or "ventings." These airborne gases contaminate not only the air, but also soil and water.

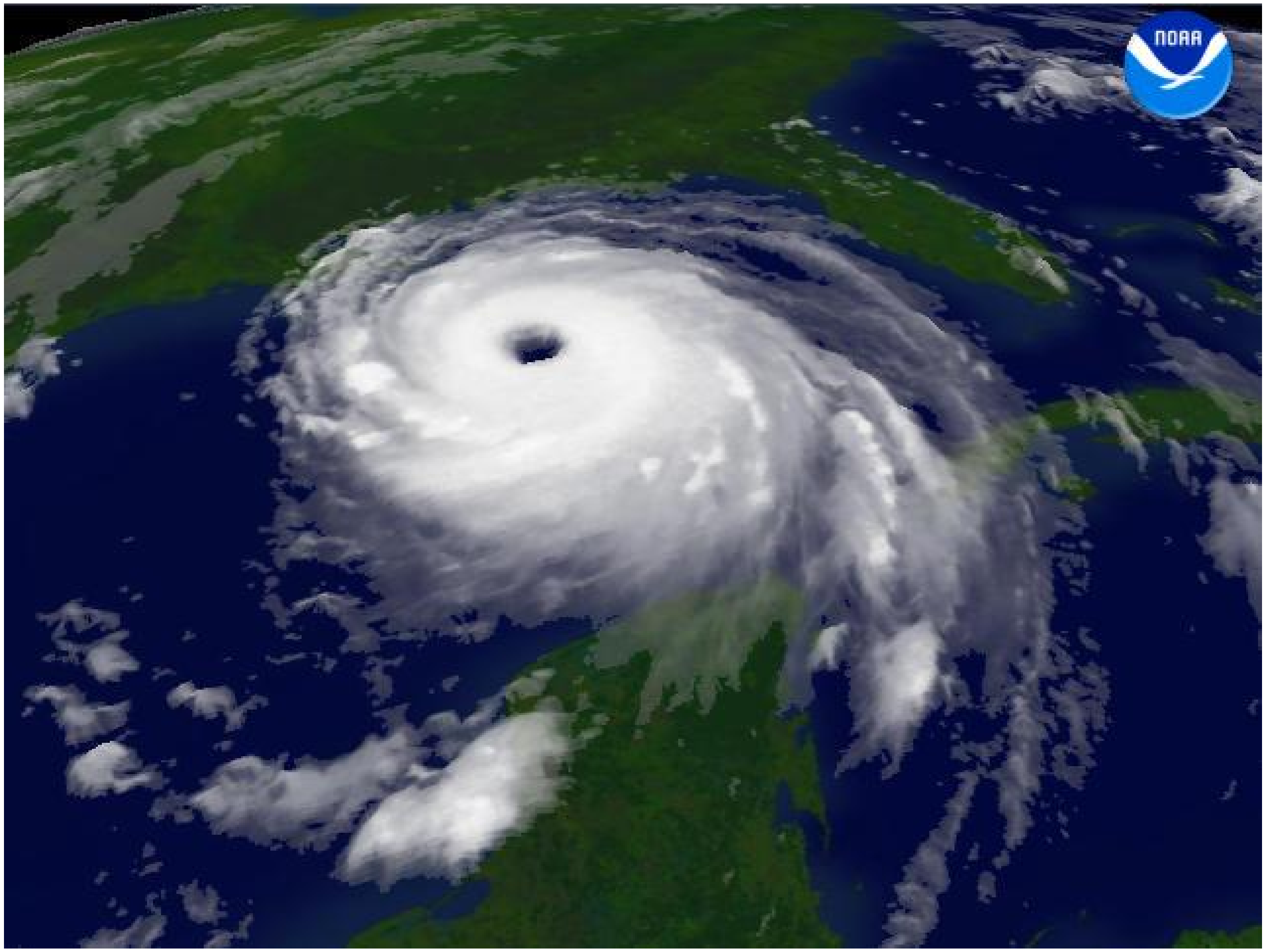
7. Radioactive releases from a nuclear power reactor's routine operation often are not fully detected or reported. Accidental releases may not be completely verified or documented.

NUCLEAR POWER PLANTS OF THE SOUTHEASTERN U.S.

1. **North Anna 1 & 2** intake & discharge to Lake Anna, VA &, ultimately, to the Chesapeake Bay.
2. **Surry 1 & 2** to the James River in VA, then to the Chesapeake Bay.
3. **Shearon Harris** to Buckhorn Creek, & the Cape Fear River, NC.
4. **McGuire 1 & 2** to Lake Norman on the Catawba River, NC.
5. **Brunswick 1 & 2** to the Cape Fear River at Southport, NC.
6. **Catawba 1 & 2** to Lake Wylie on the Catawba River, SC.
7. **Oconee 1, 2 & 3** to Lake Keowee, near Seneca, SC.
8. **H. B. Robinson 2** to Lake Robinson, near Hartsville, SC.
9. **Summer** to Monticello Reservoir, near Jenkinsville, 26 mi. northwest of Columbia, SC.
10. **Vogtle 1 & 2** to the Savannah River, near Waynesboro, GA.
11. **Hatch 1 & 2** to the Altamaha River, near Baxley, GA.
12. **Crystal River 3** Crystal River in FL to the Gulf of Mexico.
13. **St. Lucie 1 & 2** to the Atlantic Ocean, 8 mi. south of Fort Pierce, FL.
14. **Turkey Point 3 & 4** to Biscayne Bay of the Atlantic Ocean, 10 mi. east of Florida City, FL.
15. **Farley 1 & 2** to the Chattahoochee River, east of Dothan, AL.
16. **Grand Gulf** to Mississippi River, near Port Gibson, MS.
17. **Browns Ferry 2 & 3** to the Tennessee River, near Athens, AL.
18. **Sequoyah 1 & 2** to Chickamauga Lake, near Soddy Daisy, TN
19. **Watts Bar** to Chickamauga Lake, near Spring City, TN

TOTAL REACTORS: 33

Hurricane Katrina, Aug. 29, 2005



Katrina & Grand Gulf:

- As Grand Gulf nuclear power plant attempted to shut down as Hurricane Katrina approached the Gulf Coast, the storm's leading edge knocked out the offsite power to the facility – Grand Gulf was forced to rely on its emergency diesel generators to maintain safety and cooling systems.
- As global warming induced severe weather becomes more frequent and intense, nuclear power plants will be forced to shut down for safety reasons.
- Katrina made abundantly clear that U.S. emergency preparations and evacuation procedures are currently disasters in and of themselves, begging the question – what would happen during a severe-weather-induced radiological emergency?

Heat Waves/Droughts & Nukes:

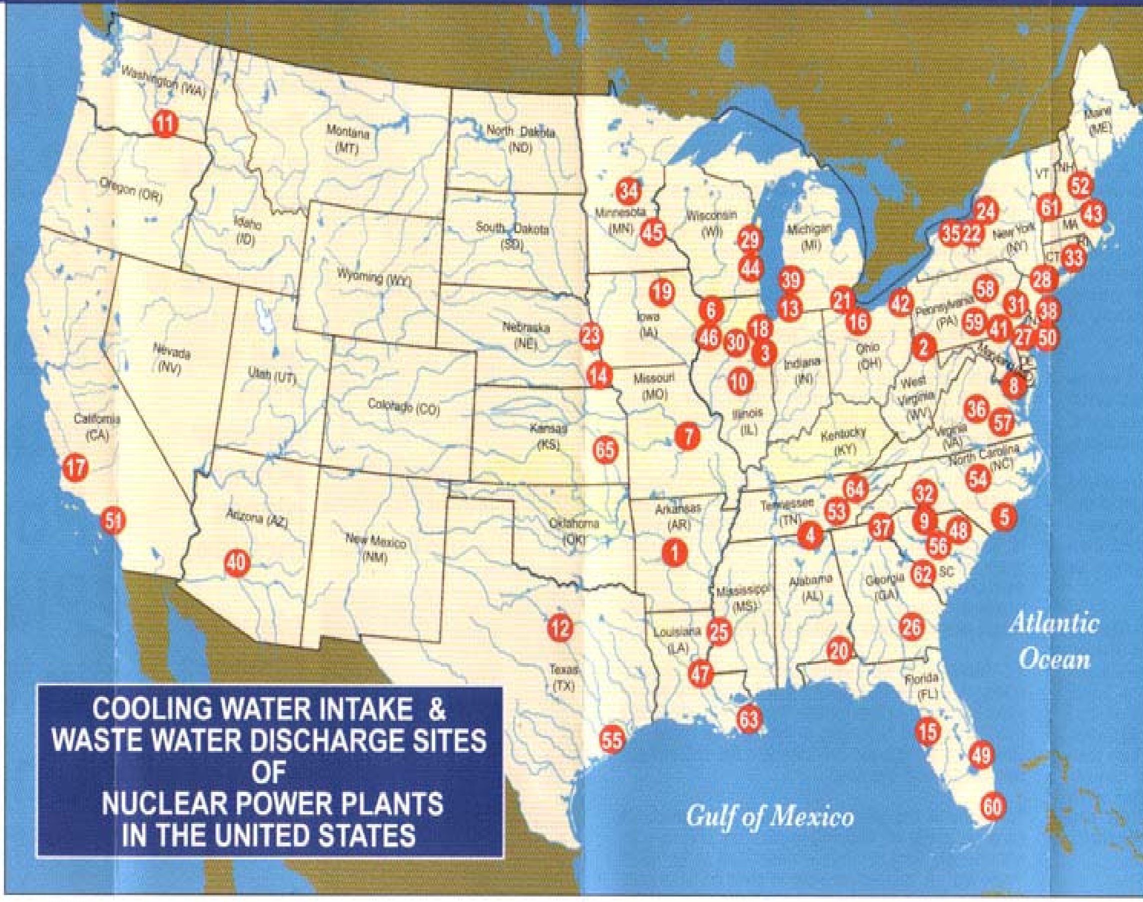
--European heat wave in summer 2003 killed tens of thousands

--Safety margins and environmental regulations were overridden in France in bid to keep reactors running – exterior of reactor cores sprayed down with hoses, rivers "scalded" with hot water discharges

--Reactor in Romania forced to shut down when Danube River level dropped below cooling water intake pipe

Heat Waves/Droughts & US Nukes:

- Reactors on Great Lakes forced to shut down in late 1990s when lake water temperature rose too high, making steam condenser operation inefficient; similar shutdown at Cook plant on L. Michigan in summer, 2006.
- Not only are seven U.S. nuclear power plants located on the relatively shallow Lake Erie and Lake Ontario, but numerous U.S. reactors are located on rivers subject to dropping water levels and small lakes/reservoirs vulnerable to water temperature heat up.



1. **Arkansas One 1 & 2 (AR)**
Dardanelle Reservoir, Arkansas River
2. **Beaver Valley 1 & 2 (PA)**
Ohio River
3. **Braidwood 1 & 2 (IL)**
Braidwood Lake, Kankakee River
4. **Browns Ferry 2 & 3 (AL)**
Tennessee River
5. **Brunswick 1 & 2 (NC)**
Cape Fear River, Atlantic Ocean
6. **Byron 1 & 2 (IL)**
Rock River
7. **Callaway (MO)**
Missouri River
8. **Calvert Cliffs 1 & 2 (MD)**
Chesapeake Bay
9. **Catawba 1 & 2 (SC)**
Lake Wylie, Catawba River
10. **Clinton (IL)**
Clinton Lake, Salt Creek
11. **Columbia (WA)**
Columbia River
12. **Comanche Peak 1 & 2 (TX)**
Squaw Creek Reservoir, Brazos River
13. **Donald C. Cook 1 & 2 (MI)**
Lake Michigan
14. **Cooper (NE)**
Missouri River
15. **Crystal River 3 (FL)**
Gulf of Mexico
16. **Davis-Besse (OH)**
Lake Erie
17. **Diablo Canyon 1 & 2 (CA)**
Pacific Ocean
18. **Dresden 2 & 3 (IL)**
Kankakee River
19. **Duane Arnold (IA)**
Cedar River
20. **Joseph M. Farley 1 & 2 (AL)**
Chatahoochee River
21. **Fermi 2 (MI)**
Lake Erie
22. **James A. Fitzpatrick (NY)**
Lake Ontario
23. **Fort Calhoun (NE)**
Missouri River
24. **R. E. Ginna (NY)**
Lake Ontario
25. **Grand Gulf (MS)**
Mississippi River
26. **Edwin I. Hatch 1 & 2 (GA)**
Altamaha River
27. **Hope Creek (NJ)**
Delaware River
28. **Indian Point 2 & 3 (NY)**
Hudson River
29. **Kewaunee (WI)**
Lake Michigan
30. **LaSalle 1 & 2 (IL)**
LaSalle Lake, Illinois River
31. **Limerick 1 & 2 (PA)**
Schuylkill River
32. **McGuire 1 & 2 (NC)**
Lake Norman, Catawba River
33. **Millstone 2 & 3 (CT)**
Niantic Bay of Long Island Sound
34. **Monticello (MN)**
Mississippi River
35. **Nine Mile Point (NY) 1 & 2**
Lake Ontario
36. **North Anna 1 & 2 (VA)**
Lake Anna, North Anna River
37. **Oconee 1, 2 & 3 (SC)**
Lake Keowee, Savannah River
38. **Oyster Creek (NJ)**
Barnegat Bay of Atlantic Ocean
39. **Palisades (MI)**
Lake Michigan
40. **Palo Verde 1, 2 & 3 (AZ)**
Intake from groundwater and Phoenix City sewage treatment plants (35 miles away); waste water is evaporated, with saturated sludges shipped to a radioactive waste dump.
41. **Peach Bottom 2 & 3 (PA)**
Conowingo Pond, Susquehanna River
42. **Perry (OH)**
Lake Erie
43. **Pilgrim (MA)**
Cape Cod Bay of Atlantic Ocean
44. **Point Beach 1 & 2 (WI)**
Lake Michigan
45. **Prairie Island 1 & 2 (MN)**
Mississippi River
46. **Quad Cities 1 & 2 (IL)**
Mississippi River
47. **River Bend (LA)**
Mississippi River
48. **H. B. Robinson 2 (SC)**
Lake Robinson, Black Creek
49. **Saint Lucie 1 & 2 (FL)**
Atlantic Ocean
50. **Salem 1 & 2 (NJ)**
Delaware River
51. **San Onofre 2 & 3 (CA)**
Pacific Ocean
52. **Seabrook (NH)**
Atlantic Ocean
53. **Sequoyah 1 & 2 (TN)**
Chickamauga Lake, Tennessee River
54. **Shearon Harris (NC)**
Harris Lake, Buckhorn Creek, Cape Fear River
55. **South Texas Project 1 & 2 (TX)**
Colorado River, Gulf of Mexico
56. **V. C. Summer (SC)**
Monticello Reservoir, Broad River
57. **Surry 1 & 2 (VA)**
James River
58. **Susquehanna 1 & 2 (PA)**
Susquehanna River
59. **Three Mile Island (PA)**
Susquehanna River
60. **Turkey Point 3 & 4 (FL)**
Biscayne Bay of Atlantic Ocean
61. **Vermont Yankee (VT)**
Connecticut River
62. **Vogtle 1 & 2 (GA)**
Savannah River
63. **Waterford 3 (LA)**
Mississippi River
64. **Watts Bar (TN)**
Watts Bar Lake, Tennessee River
65. **Wolf Creek (KS)**
Coffey County Lake, Neosho River

TOTAL OPERATING REACTORS: 103

Sea Level Rise

- Current rates of sea-level rise are expected to increase as a result both of thermal expansion of the oceans and of partial melting of mountain glaciers and the Antarctic and Greenland ice caps. Consequences include loss of coastal wetlands and barrier islands, and a greater risk of flooding in coastal communities. Low-lying areas, such as the coastal region along the Gulf of Mexico and estuaries like the Chesapeake Bay, are especially vulnerable.

Warning signs today:

- The current pace of sea-level rise is three times the historical rate and appears to be accelerating.
- Global sea level has already risen by four to eight inches in the past century. Scientists' best estimate is that sea level will rise by an additional 19 inches by 2100, and perhaps by as much as 37 inches.

Taken from http://www.nrdc.org/globalWarming/fcons.asp

An Inconvenient Truth

"Global sea levels could rise by more than 20 feet with the loss of shelf ice in Greenland and Antarctica, devastating coastal areas worldwide."

--http://www.climatecrisis.net/thescience/

Threat to Reactors & Wastes

- Depending on their elevation above sea level, coastal reactors – and the high-level radioactive wastes stored on-site – could eventually be flooded by rising sea levels, or made more vulnerable to storm surges during hurricanes and tropical storms.

Proposed New Reactors

- To be located at places vulnerable to severe weather and rising sea levels, such as on sea coasts or rivers.

Grid Instability

- Because reactors must shut down as a safety measure in the face of severe weather, their large base load electricity supplies will be unavailable when most needed.
- Dozens of nuclear power plants in the Northeastern and Midwestern U.S. and Canada were forced to shut down as a safety measure during the August 2003 “Blackout,” spreading the power outage to 50 million people.

August 2003
Northeast Power Outage

Atomic Unreliability

- *NM Gov. Richardson: U.S. as "a superpower with a third-world electricity grid"*.
- Power outage started when FirstEnergy transmission lines failed in Ohio – could the company's loss of many hundreds of millions of dollars at Davis-Besse have anything to do with the un-maintained transmission lines?!
- Severe weather due to climate destabilization will put more pressure on the electricity grid, forcing safety shutdowns at atomic reactors, exacerbating the power outages.

Conclusion

- Severe weather and rising sea levels due to climate destabilization will make nuclear power unsafe, unreliable, and untenable.