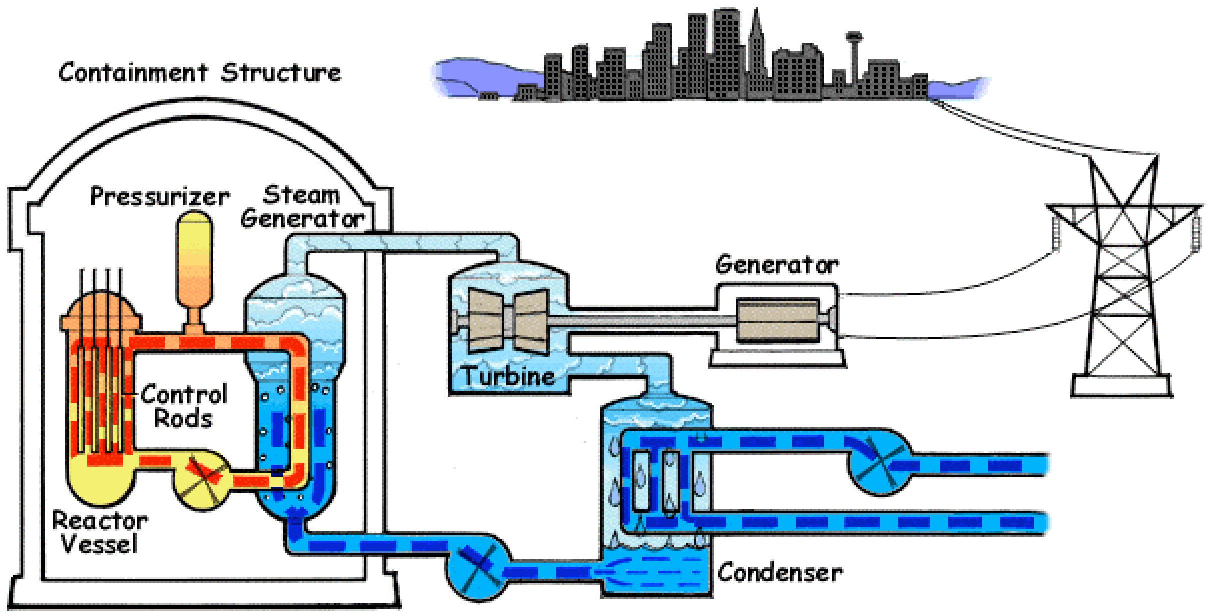
Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

issue brief

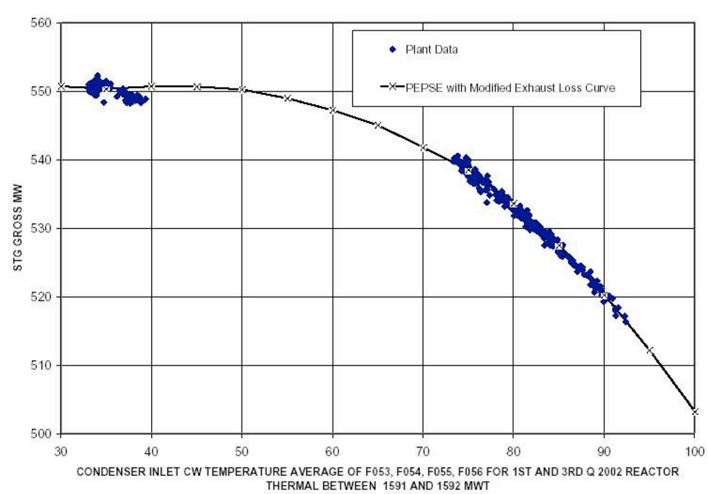
NUCLEAR HEAT

Summer heat waves increase the demand for electricity and reduce the ability of nuclear power plants to meet that need. This issue brief explains how rising summer temperatures challenge nuclear plant output during normal operation and nuclear plant safety under accident conditions.



All US nuclear power plants use the energy produced from splitting atoms to boil water. That steam spins a turbine connected to a generator that makes the power fed to the electrical grid. After the steam exits the turbine, water from a nearby lake, river, or ocean cools it down and converts it back into water so it can be recycled to make steam again. Nuclear power plants are only about 33 percent efficient, meaning that for every three units of energy produced by the reactor core, two units of waste heat are rejected to the environment.

As summer heat waves increase the water temperature of the nearby lake, river, or ocean, the effectiveness of the condenser in converting steam back into water decreases. As a result, steam is not “pulled” through the turbine as swiftly and less electricity is “cranked” out. How big of an effect is rising temperature? The chart to the right from an actual nuclear plant – typical of the others – shows that the lake, river, or ocean water temperature rising from 70ºF to 90ºF reduces the electrical output of the plant nearly five percent. As demand for electricity rises with the temperature, ability to supply drops.



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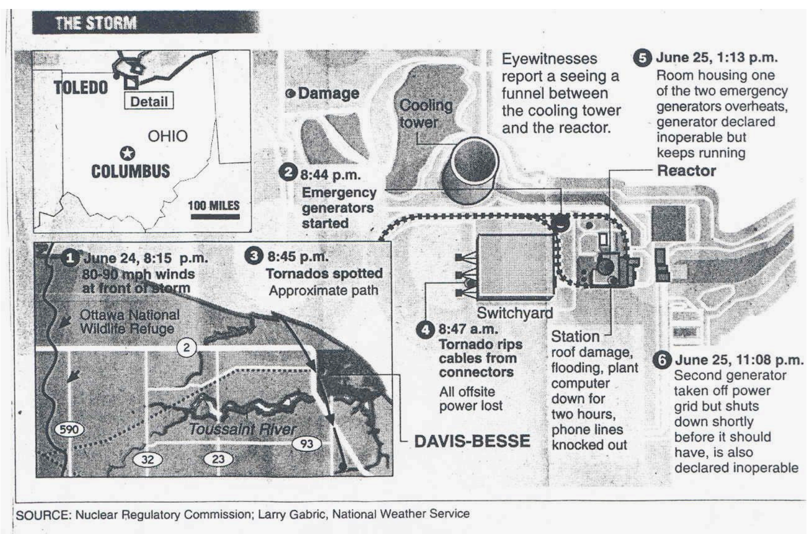
Rising summer temperatures also reduce margins available for a nuclear power plant to cope with an accident. Just as the increasing lake, river, or ocean temperature impairs heat removal capability from the condenser, the rising water – and ambient air – temperatures impair heat removal capabilities from safety equipment. Federal regulations require detailed calculations of the heat released into the containment structure during postulated accidents along with the ability of cooling systems to remove that heat. These calculations rely on assumptions about the air temperature inside containment when the accident starts, the ambient air temperature, and the cooling water temperature. These parameters are routinely monitored during plant operation and if any one of them moves non-conservatively past a value assumed in a safety study, federal regulations require that the plant be shut down because its underlying safety studies have been invalidated. The Unit 1 reactor at the Donald C. Cook nuclear plant in Michigan was forced to shut down in July 2006 for such a reason.

Events have demonstrated that the calculated safety margins are sometimes non-existent. On June 24, 1999, a tornado visited the Davis-Besse nuclear plant in Ohio. It was just passing through, but stayed long enough to topple transmission lines and disconnect the plant from its electrical grid. The nuclear reactor automatically shut down within seconds and emergency diesel generators automatically started to provide electrical power to the safety equipment needed to continue cooling the reactor core. The emergency diesel generators provided enough electricity to power equipment needed to cool the nuclear fuel in the reactor core. But the equipment needed to cool the nuclear fuel in the spent fuel pool was disabled when the plant's connection to the grid was lost. One of the emergency diesel generators failed about 16 ½ hours after the tornado because of inadequate ventilation for the room housing it. The surviving emergency diesel generator provided sufficient electricity for equipment cooling the reactor, but the spent fuel pool temperature continued to rise unchecked. Fortunately, the plant was reconnected to the electrical grid about 25 ½ hours after the tornado, restoring cooling for the spent fuel pool and stopping its temperature rise at 140ºF. The grid reconnection was especially timely – the second emergency diesel generator failed one hour later. On paper, the ventilation system for the emergency diesel generator rooms worked just fine for 30 days after an event. When actually confronted with 90-plus degree temperatures during this June event, the ventilation system was unable to protect the emergency diesel generators from failing in less than 30 hours.



Mercury rising means nuclear power electrical output and safety margins falling.

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