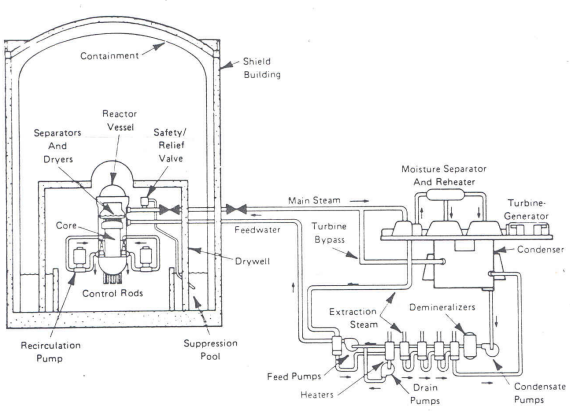
Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions
issue brief

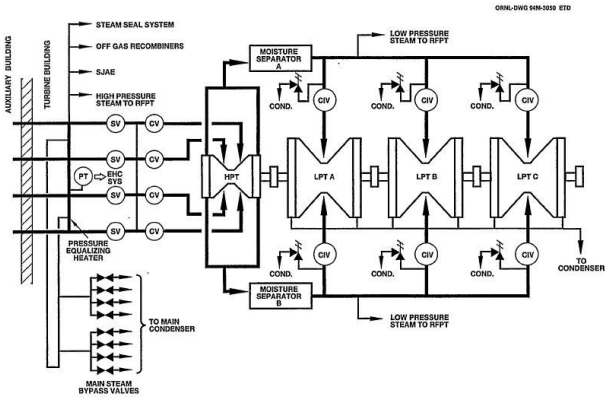
MONTICELLO'S TURBINE VALVE EVENT

On January 10, 2007, the Monticello nuclear plant in Minnesota automatically scrammed. This backgrounder summarizes what happened based on information provided by the Nuclear Regulatory Commission (NRC) in Event Notification 43088 and Preliminary Notification of Occurrence PNO-III-07-001. Why this event happened awaits results from ongoing investigations by worker and NRC inspectors.

Monticello was operating at about 90 percent power. Monticello is a boiling water reactor (BWR). In these types of nuclear power reactors, the heat produced by the reactor core boils water inside the reactor vessel. The steam flows through four steam pipes (represented by a single line in the schematic) to spin the turbine. The turbine is connected to a generator that makes electricity. The pressure at the inlet to the turbine is held constant. When the reactor's power level increases, more water is boiled and more steam flows down the pipes. The additional steam flow would increase the pressure, except that the turbine control system automatically opens the inlet valves to admit more steam, dropping the inlet pressure back to the specified setpoint. Conversely, when the reactor's power level drops, the reduced steam flow automatically causes the turbine inlet valves to close.



On January 10, 2007, workers tested the turbine inlet valves, called the turbine control valves (represented by the four circles with CV in them in the schematic; HPT is the high pressure turbine). One turbine control valve is located in each of the four steam pipes to the turbine. It is common to reduce the reactor's power level from 100 percent to 90 percent to provide margin for the pressure transient that can occur when one turbine control valve is manually closed during a test and the other three turbine control valves automatically open to compensate. The turbine control valves are normally partially open even when the reactor is at 100 percent power.

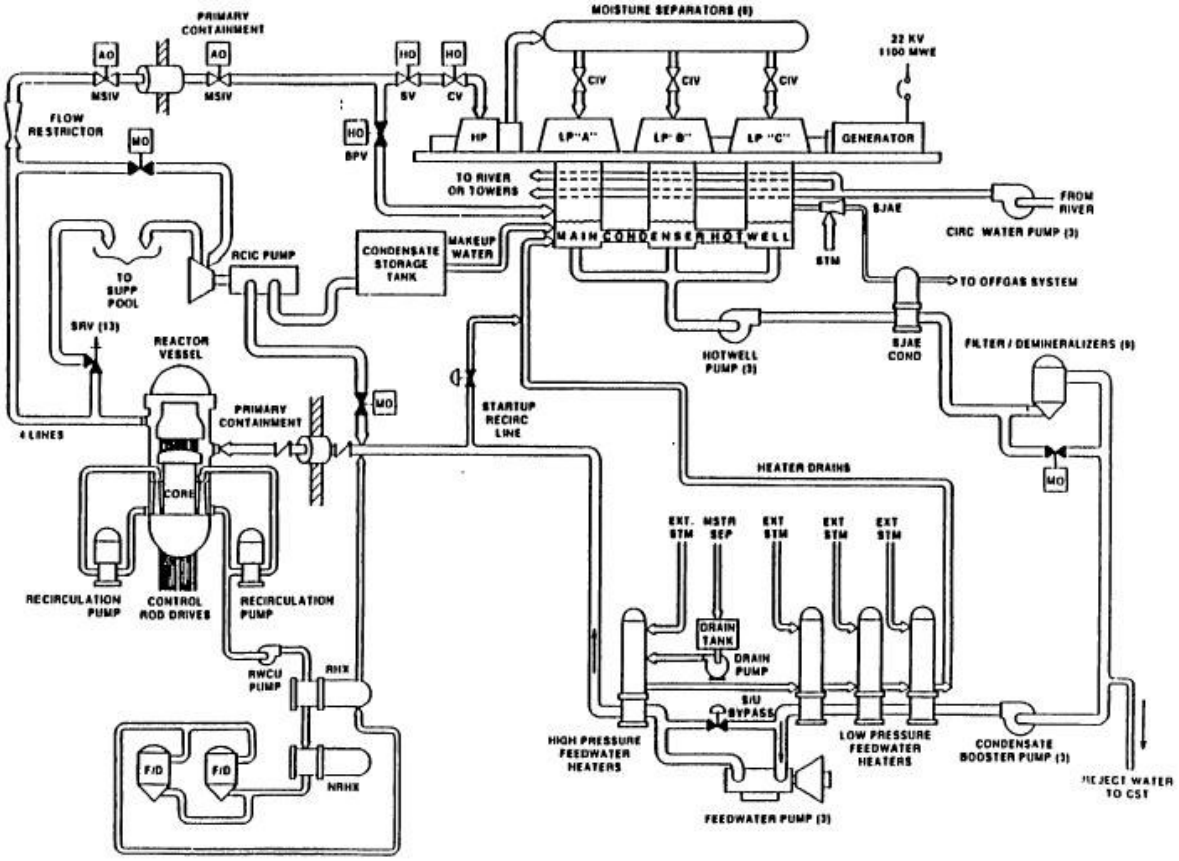


Typical BWR main steam system

For some reason, all four turbine control valves fully opened at Monticello. This caused the pressure in the steam pipes and the reactor vessel to drop. The pressure inside the reactor vessel is normally around 1,020 pounds per square inch. When the reactor vessel pressure dropped below approximately 815 pounds per square inch, automatic protection circuits closed the isolation valves in the main steam lines (represented by the two black "bow-ties" in the first schematic). The main steam isolation valves' closure in turn caused an automatic shut down of the reactor.

Washington Office: 1707 H Street NW Suite 600 • Washington DC 20006-3919 • 202-223-6133 • FAX: 202-223-6162
Cambridge Headquarters: Two Brattle Square • Cambridge MA 02238-9105 • 617-547-5552 • FAX: 617-864-9405
California Office: 2397 Shattuck Avenue Suite 203 • Berkeley CA 94704-1567 • 510-843-1872 • FAX: 510-843-3785

The closure of the main steam isolation valves meant that the normal means of providing cooling water to the reactor vessel was lost. The feedwater pumps normally provide that makeup flow, but they are steam-driven pumps supplied with steam downstream of the now-closed main steam isolation valves. Operators at Monticello used the reactor core isolation cooling (RCIC) system (shown above and to the right of the reactor vessel in the schematic) and the high pressure coolant injection (HPCI) system (not shown in the schematic but essentially a larger version of the RCIC system) to maintain water level inside the reactor vessel. The operators used the safety relief valves (labeled SRV in the schematic) to control pressure inside the reactor vessel, periodically cycling a safety relief valve open and then closed to discharge steam to the suppression pool, a large body of water inside the containment building that functions as a heat sink. As the pressure inside the reactor vessel dropped below about 400 pounds per square inch, the operators used another system, called the residual heat removal system, to cool the water circulating through the reactor core.



Simplified BWR Primary and Auxiliary Systems

Workers investigating the cause of the problem found that a large metal box around the turbine control valves had broken loose and fallen about a foot. It's not known at this time whether the box's movement caused the turbine control valves to fully open or just happened to be found now due to the inquiry into the recent event.

Prepared by: David Lochbaum
Director, Nuclear Safety Project