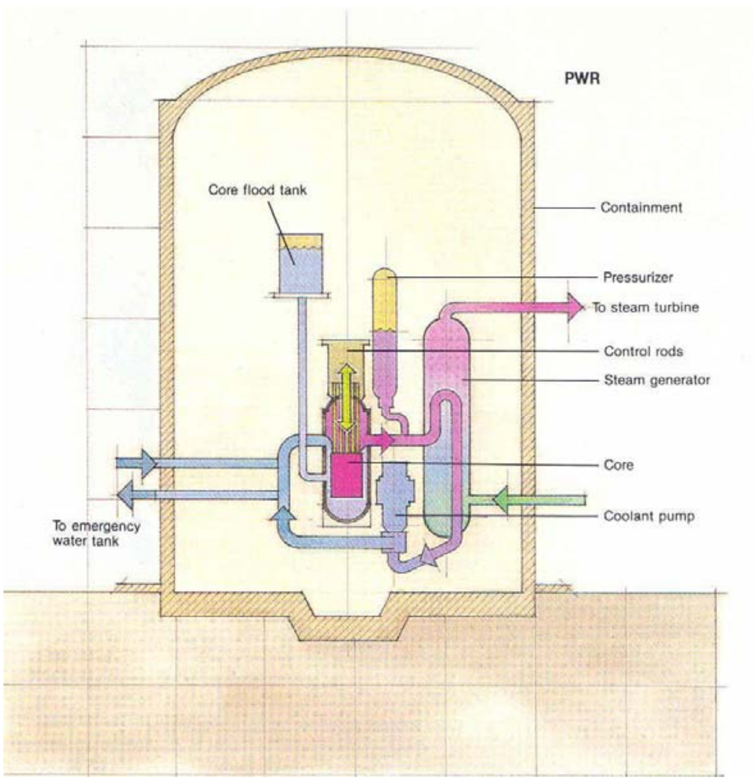
Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions
issue brief

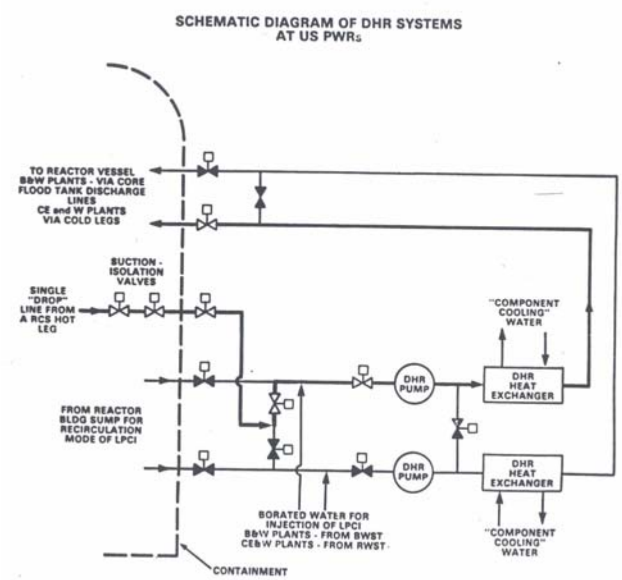
DAVIS-BESSE'S LEAKING DECAY HEAT REMOVAL LINE

The Nuclear Regulatory Commission's daily event report No. 43880 dated January 4, 2008, covered the notification to the agency by FirstEnergy that workers at the Davis-Besse nuclear plant in Ohio had discovered reactor cooling water leaking from a weld in the common piping section of the decay heat removal system. Davis-Besse was shut down late last month for a refueling outage. When Davis-Besse is operating, the heat produced by the reactor core is removed by circulating hot, pressurized water through two steam generators. The steam is used in a turbine/generator to make electricity.



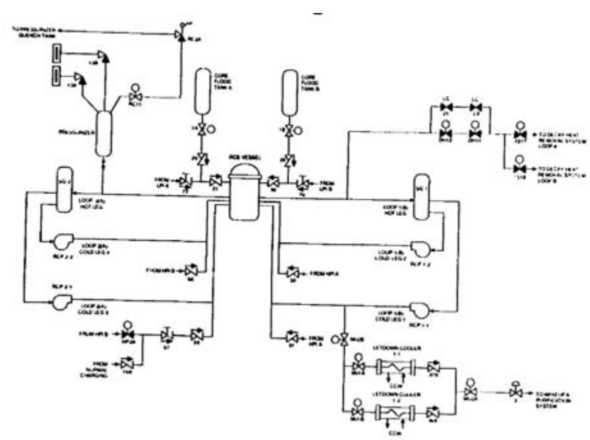
When the plant is shut down, the nuclear fuel in the reactor core continues to emit heat through the radioactive decay of fission byproducts. When the reactor is shut down, the rate of decay heat generation is initially about 7 percent of the thermal output of the reactor core at full power and then it decreases exponentially. The decay heat removal system is used to cool the water flowing through the reactor vessel in order to remove the decay heat being produced by the reactor core.

At the time of the discovery, the plant had been shut down about a week and the primary loop (i.e., the reactor vessel and the piping to and through the steam generator, the reactor coolant pump and back) had been partially drained until the water level was about two feet about the center of the hot leg piping (the pink-hued line in the diagram shown leaving the reactor vessel above and to the right of the reactor core).



At Davis-Besse and several other pressurized water reactors in the U.S., the decay heat removal system features a "single drop" configuration. In this design, a single pipe connects the decay heat removal system to the primary loop. Most of the decay heat removal system components (e.g., the decay heat removal pumps and heat exchangers) are located outside of the reactor containment structure, so this single pipe is routed through the containment's concrete wall. Outside containment, the single line splits to provide water to each of the two sets of decay heat removal system cooling units. The water cooled by the decay heat removal system is returned to the containment and the core flood tank so it can re-enter the reactor vessel.

Workers at Davis-Besse were applying an overlay to welds holding the pipe segments together in the decay heat removal system's single line inside containment. An emerging problem in the nuclear industry involves degradation of welds holding pipes of differing materials together. The overlay process is intended to protect against that degradation. During that process, a welder noticed water leaking from a crack in the weld. It was a small leak, characterized as "seepage," but a leak nonetheless.



Whether this known weld crack is the only significant one at Davis-Besse is uncertain at this time. If so, its repair is relatively simple and the risk implications of past operation with the crack are minimal. If not, the repairs and risk implications grow larger. In October 1999, FirstEnergy released a report on a probabilistic risk assessment it had conducted for Davis-Besse. Among the outcomes from this effort was a ranking of the risk consequences from key safety equipment being out of service. While this probabilistic safety assessment analyzed the risk impacts from safety equipment being out of service with the reactor operating at full power, it still provides useful insights into the relative importance of key safety systems during outage conditions. According to FirstEnergy's analysis, a single decay heat removal pump being out of service increased the risk of core damage by a factor of 5 to 10. That risk impact is greater than the loss of the pressurizer power-operated relief valve (PORV, made infamous for its role in the meltdown at Three Mile Island), the loss of the high pressure injection pump (one of the safety components fixed during Davis-Besse's prolonged 2002-2004 outage), or the loss of an emergency diesel generator.

Table E4. Effect on CDF with Significant Components Out of Service

Effect on Nominal CDF	Component Out of Service
> 100x	4160v bus D1 480v bus F1
50 to 100x	4160v bus C1
10 to 50x	Motor-driven feed pump Standby component cooling water pump Station battery 480v bus E1
5 to 10x	Auxiliary feedwater pump Decay heat removal pump
2 to 5x	Emergency instrument air compressor Pressurizer PORV Dilution pump (backup service water pump) Station blackout diesel-generator High pressure injection pump Emergency ventilation for a low-voltage switchgear room
< 2x	Emergency diesel-generator Makeup pump Spare component cooing water pump Spare service water pump

Source: FirstEnergy Probabilistic Safety Assessment Summary Report, October 1999

Because the cracked weld is on the common suction line to both decay heat removal pumps, it involves at least the potential for <u>both</u> decay heat removal pumps being lost. Consequently, FirstEnergy declared both sets of decay heat removal inoperable pending investigation of the extent of the problem and implementation of repairs.

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