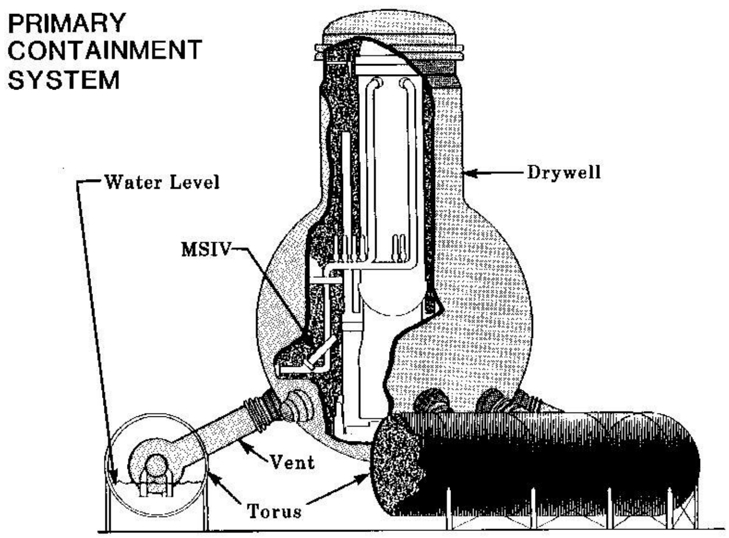
Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions
issue brief

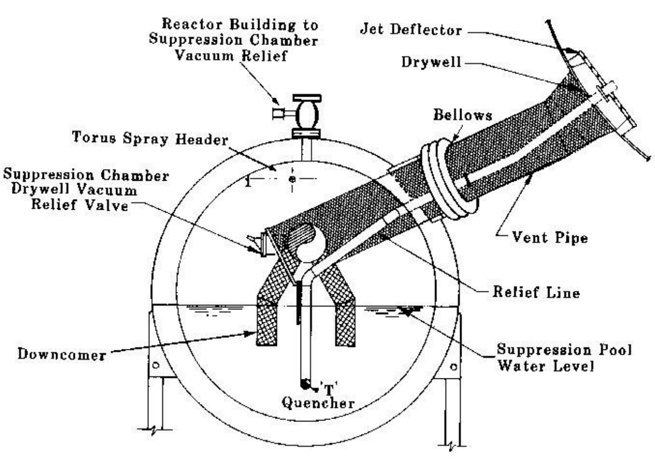
HOPE CREEK'S VACUUM BREAKER PROBLEM

Nuclear Regulatory Commission (NRC) Daily Event Report No. 41956 dated August 28, 2005, indicated that the Hope Creek Generating Station in New Jersey was being shut down because one of the drywell to suppression chamber vacuum breakers was not fully closed. According to the DER, "With the vacuum breaker open or partially open, the pressure suppression function of the suppression chamber could be compromised in event of a postulated loss of coolant accident and therefore this safety function is degraded." This issue brief seeks to explain vacuum breakers and their role in the plant's safety.

Hope Creek is a boiling water reactor (BWR) with a Mark I primary containment design. As shown in the figure, the cylindrical metal reactor vessel is housed within the drywell, which is a structure made of reinforced concrete and shaped like an inverted lightbulb. The torus is a large cylindrical ring that surrounds the lower region of the drywell. The torus is partially filled with water. Eight large vent pipes connect the drywell and the torus.



If a pipe connected to the reactor vessel breaks, steam jets into the drywell from the broken ends of the pipe. The rapidly rising pressure inside the drywell forces the steam to flow through the vent pipes and downcomers below the surface of the water in the torus. The water inside the torus condenses the steam.



The rush of steam down the vent pipes "sucks" the atmosphere out of the drywell with it. At Hope Creek, the drywell is filled with nitrogen gas during reactor operation. This nitrogen gas comes out of the downcomers and bubbles up through the water to the torus airspace. The drywell airspace may contain mostly steam. When that steam cools and condenses, the pressure inside the drywell could drop below the pressure outside the drywell. The drywell is designed to contain high pressure inside it. To protect it from being crushed or imploded by relatively high pressure outside it, there are vacuum breakers that open to allow flow from the torus airspace back up the vent pipes into the drywell. These vacuum breakers are closed then the drywell pressure is higher than the torus pressure and open when the torus pressure exceeds the drywell pressure.

At Hope Creek, one of the vacuum breakers could not be fully closed. If this vacuum breaker remained open when a pipe inside the drywell broke, the flow down the vent pipe might not go through the downcomers into the water but instead take a shortcut through the open vacuum breaker right into the torus airspace. The steam bypassing the water would not be condensed. It's energy would not be absorbed by the water. Consequently, the torus airspace could be pressurized beyond its ability to remain intact. Failure of the torus would breach the primary containment and allow more radioactivity to be released to the environment than assumed in the safety studies.

Although the chances of a pipe breaking to trigger this scenario are low, safety dictated that the Hope Creek reactor not continuing operating with this potential vulnerability. Its Technical Specifications, a part of the operating license issued by the NRC to the plant's owner, do not permit the reactor to operate for more than a handful of hours with one or more of the vacuum breakers not fully closed. The Hope Creek reactor was manually shut down to allow workers to enter the torus and repair the vacuum breaker.

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