

Pressurized water reactors have several dozen penetrations through the curved dome called the reactor vessel head. These penetrations allow the control rods inside the reactor core to be connected to the motors outside the reactor vessel that regulate their movement. The penetrations are sleeved with stainless steel, typically a material called Alloy-600. The reactor vessel head itself is made of carbon steel.

Because the penetrations pass vertically through a curved surface, stresses (forces) develop when the metal expands as it heats up. Because the penetrations intersect the curved dome at sharp angles instead of perpendicularly, these stresses hit some parts harder than other parts. Over time, the hard-hit parts can develop cracks. Once cracks develop, impurities in the reactor water such as boron tend to collect in the cracks and can accelerate corrosion.

The PWR nozzle cracking discovered last year at Oconee, then Arkansas Nuclear One then Three Mile Island then Crystal River then Davis-Besse surprised the NRC. The nozzles were being routinely inspected. But those inspections focused exclusively on an area called the J-groove weld area. Basically, this area is located on the inside of the domed reactor vessel head where the nozzle begins passing through it. The thought was that this was the most vulnerable location for cracks - if they developed anywhere, they'd develop here first. But that assumption turned out to be wrong. The nozzles were cracking on the outside first and then cutting across to the inside. Because people were looking in the wrong place, they did not find the cracks until reactor water started leaking out through the nozzle cracks.

BWRs like Peach Bottom have only a few reactor vessel head penetrations. Most of the BWR penetrations are through the domed lower head.

Earlier this year, the Quad Cities BWR in Illinois reported a problem to the NRC. One of the jet pumps located inside the reactor vessel was found to be broken. The jet pumps are located in the space between the core shroud (the metal cylinder around the reactor core) and the reactor pressure vessel. The jet pumps are cone-shaped tubes about 12 feet long. They are anchored in place with several metal brackets.

At Quad Cities, the upper metal bracket broke. The brackets had been frequently inspected. But as in the PWR nozzle case, these inspections were not of the entire bracket but only of the portion of the bracket thought to be most vulnerable to cracking. Once again, that assumption proved wrong and the bracket cracked in an uninspected location.

This trend concerns us. License renewal is based on having adequate aging management programs. But if near-misses continue to be caused by people looking in the wrong places, clearly aging management programs are not meeting the necessary safety expectations.