UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

April 12, 2002

NRC INFORMATION NOTICE 2002-15: HYDROGEN COMBUSTION EVENTS IN FOREIGN BWR PIPING

Addressees

All holders of operating licenses for light water reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to inform addressees about two recent hydrogen combustion events in piping at foreign boiling water reactors (BWRs). These BWRs were not of domestic (U.S.) manufacture; however, the affected systems where the hydrogen combustions occurred are similar to those in some domestic BWRs. The events were publicly reported in the respective countries' news media. No injuries to personnel or radioactive releases to the environment were reported.

It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

The first foreign event occurred on November 7, 2001, while the BWR/4-type unit was operating at rated power. The utility was performing a periodic surveillance of the high pressure coolant injection (HPCI) system. Immediately after the test began, the HPCI system automatically isolated and the reactor building fire detectors actuated. The unit was then manually shut down. An examination of the residual heat removal (RHR) system revealed that a pipe elbow had ruptured near the high point in the RHR branch steam supply line leading to one of the two RHR heat exchangers (steam condensing mode line), in the reactor building as shown in Figure 1. Fragments from the piping rupture caused some damage to equipment in the general area, but no significant damage to any safety-related equipment. The subject line supplies steam to the RHR heat exchanger when the heat exchanger is operated in the steam condensing mode. The utility had modified the RHR piping by adding a water barrier upstream of the RHR steam supply isolation valve in order to reduce leakage through this valve.

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The utility initially reported the pipe rupture as a water hammer event; however, subsequent investigation has led the utility to re-characterize the rupture as a combustion event. This re-characterization was based in part on an analysis of gases in the sister BWR unit at the same RHR piping location. This analysis found the hydrogen levels to be 46 percent by volume (percent vol), 23 percent vol oxygen, and 31 percent vol steam. A metallurgical analysis of the resulting piping fragments indicated ductile fracture from excessive internal over-pressure.

The second foreign event occurred on December 14, 2001, while the unit was operating at 100-percent power. The utility interpreted a containment pressure increase, concurrent with an acoustic monitoring response, as a flange leak in the reactor head spray line. The utility uses the reactor head spray after shutdown to shorten outages (see Figure 2). The utility isolated the drain-and-keep-fill line valve for the reactor head spray, which appeared to stop the leak. The utility notified its regulatory authority, but did not shut down the unit until February 21, 2002, when the regulatory authority performed an inspection to determine the cause of the containment pressure increase. The inspection found that 2 to 3 meters (6.25 to 10 feet) in length of the 10-centimeter (about 4-inches) diameter head spray line had been destroyed; however, the effects of the ruptured piping were not reported to have caused any significant damage to any nearby safety-related equipment. Although the root cause of the pipe rupture has not yet been established, the utility is investigating the possibility of a hydrogen combustion event inside the pipe as a result of the buildup of hydrogen and oxygen gases created by radiolysis.

Discussion

Radiolysis occurs normally in the reactor core region when radiation decomposes some reactor coolant system (RCS) water into hydrogen and oxygen. Excess hydrogen and oxygen that does not recombine into water is normally removed by the off-gas system. Hydrogen is added in those BWRs utilizing hydrogen for reactor water chemistry control in order to scavenge excess oxygen from the RCS.

In these two foreign events, it appears that hydrogen and oxygen gases accumulated in system high points instead of being removed by the plants' off-gas system. Further, since the ignition energy for the above combustion events is predicted to be extremely small, the ignition source(s) may not be conclusively identified.

These events show the importance of preventing combustible gas mixtures from accumulating in piping. In both of the above described events, hydrogen and oxygen gases apparently accumulated to a combustible level which then catastrophically failed these piping systems. Proper venting or other considerations to prevent accumulation of combustible gases in piping high points might alleviate conditions leading to hydrogen combustion.

Related Generic Communications

The following NRC generic communications describe related reactor operating experience:

- Information Notice (IN) 88-23, "Potential for Gas Binding of High-Pressure Safety Injection Pumps," with five supplements, the latest dated April 23, 1999

- IN 90-64, "Potential for Common-Mode Failure of High-Pressure Safety Injection Pumps," October 4, 1990

- Generic Letter (GL) 93-06, Research Results on Generic Safety Issue 106, “Piping and the Use of Highly Combustible Gases in Vital Areas," October 25, 1993

- IE Bulletin No. 78-03, "Potential Explosive Gas Mixture Accumulations Associated With BWR Offgas System Operations," February 8, 1978

This information notice does not require any specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate project manager in the NRC’s Office of Nuclear Reactor Regulation (NRR).

/RA/

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Attachments:
1. Figures 1 and 2
2. List of Recently Issued NRC Information Notices

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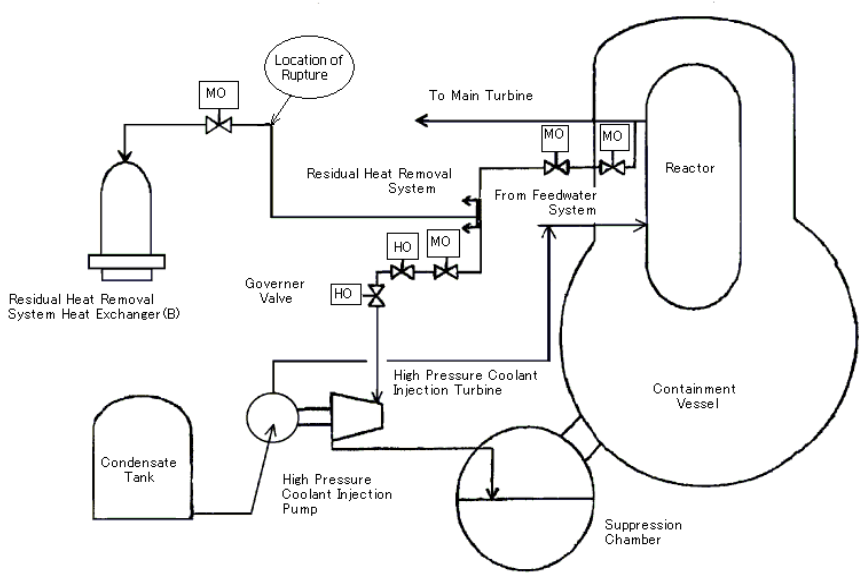

Figure 1. High Pressure Coolant Injection System and Residual Heat Removal System Branch Line

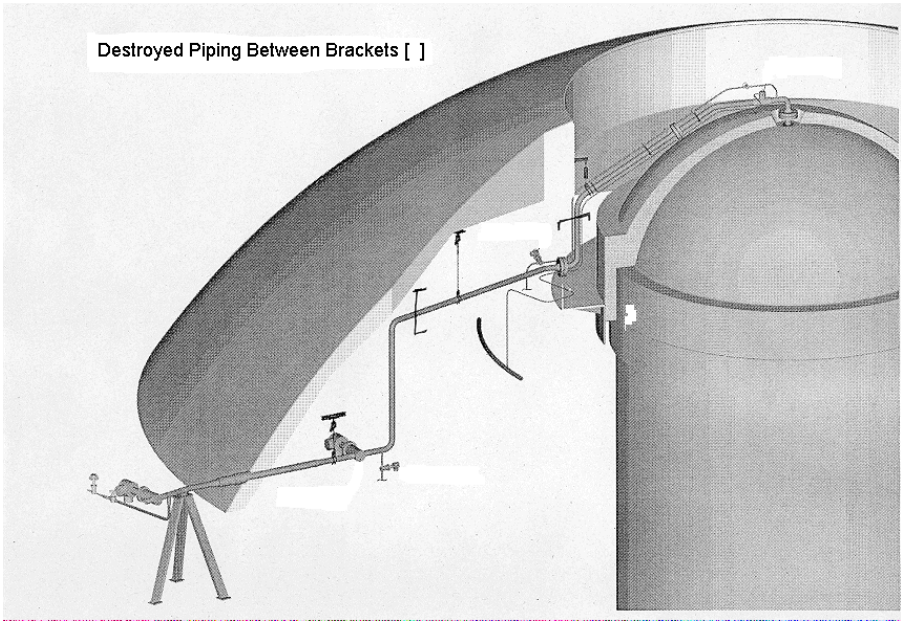

Figure 2. Head Spray System

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
2002-14	Ensuring a Capability to Evacuate Individuals, Including Members of the Public, From the Owner-Controlled Area	04/08/2002	All holders of operating licenses for nuclear power reactors, including those who have ceased operations but have fuel on site.
2002-13	Possible Indicators of Ongoing Reactor Pressure Vessel Head Degradation	04/04/2002	All holders of operating licenses for pressurized water nuclear power reactors, except those who have permanently ceased operations and certified that fuel has been permanently removed from the reactor.
99-28, Supp 1	Recall of Star Brand Fire Protection Sprinkler Heads	03/22/2002	All holders of licenses for nuclear power, research, and test reactors and fuel cycle facilities.
2002-12	Submerged Safety-Related Electrical Cables	03/21/2002	All holders of operating licenses or construction permits for nuclear power reactors
2002-11	Recent Experience with Degradation of Reactor Pressure Vessel Head	03/12/2002	All holders of operating licenses for pressurized-water reactors (PWRs), except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.
2002-10	Nonconservative Water Level Setpoints on Steam Generators	03/07/2002	All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.
2002-09	Potential for Top Nozzle Separation and Dropping of Certain Type of Westinghouse Fuel Assembly	02/13/2002	All holders of operating licenses for nuclear power reactors, and non-power reactors and holders of licenses for permanently shutdown facilities with fuel onsite.

OL = Operating License
CP = Construction Permit