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OFFICE OF INSPECTION AND ENFORCEMENT
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POTENTIAL EXPLOSIVE GAS MIXTURE ACCUMULATIONS ASSOCIATED WITH BWR OFFGAS SYSTEM OPERATIONS

Description of Circumstances:

On December 13, 1977, two hydrogen explosions occurred at the Millstone Nuclear Power Station Unit No. 1, a boiling water reactor (BWR).

The first explosion occurred at 9:30 a.m. and was mostly confined to the offgas system. Damage was relatively minor, including the breaking of glass faces on offgas system flow differential pressure gages, the blowout of a rupture disk and the evacuation of loop seals between the offgas system drain lines and stack base sump.

The second explosion occurred at 1:00 p.m. outside the offgas system in the two-level room at the base of the plant stack. This explosion blew the stack base space door into a warehouse about 200 feet away, breached the reinforced concrete ceiling between the stack chimney and the stack base space, extensively damaged the ceiling beams, dislodged the 2-ton concrete plugs in the floor above the offgas system particulate filters, damaged the stack radiation monitor isokinetic probe supports, and produced cracks in the stack. These cracks were vertical, with a maximum separation at the surface of 1/16 inch; however, the overall structural capability of the stack was not impaired.

One man was injured by the blast, receiving a concussion, skin abrasions, and contamination. He was hospitalized because of the concussion and was released four days after the event.

The licensee's review of the event concluded that the action taken to restore offgas system drain line loop seals in the stack base space had not been successful. Without these seals, gases from the offgas system accumulated in the space, resulting in an explosive mixture which was probably ignited by a spark from the level switch in the stack base sump. Inadequate ventilation of the stack base space and the lack of equipment installed to monitor explosive gas concentrations within the enclosed area were concluded to be contributing factors.

By way of background, it is recognized that accumulation of explosive hydrogen mixtures was considered in the design of the BWR offgas system. As a result, the design has prevented major releases of airborne radioactivity in the approximately 25 known hydrogen gas explosions that have occurred within the offgas systems of operating BWRs. Extensive mechanical damage to equipment and structures, however, in addition to uncontrolled release of radioactive material, have resulted from five explosions, including the Millstone event, where hydrogen gas accumulated outside of the offgas system.

Action to be Taken by Licensees:

For all BWR power reactor facilities with an operating license:

1. Review the operations and maintenance procedures related to the offgas system to assure proper operation in accordance with all design parameters. Include in this review measures you have taken or will take to prevent inadvertent actions (such as arc strikes) which might cause ignition of the mixture of gases contained in the offgas piping.

2. Review the adequacy of the ventilation of spaces and areas through which offgas system piping containing explosive mixtures of gases pass. The review should consider ventilation losses and off-normal offgas system operation, such as lack of dilution steam, lost loop seals, blown rupture disks, bypassing recombiners, and leakage of offgas into isolated portions of systems.

3. For those spaces and areas identified, describe what action you have taken or plan to take to assure that explosive mixtures cannot accumulate, that monitoring equipment will warn of such an accumulation, and that disposal of such mixtures will be controlled without resulting in a damaging explosion.

4. Loop seals are potential offgas leakage paths following a pressure transient in the offgas system piping. Describe your design features to minimize and detect the loss of liquid from loop seals and describe operating procedures which assure prompt detection and re-seal of the blown loop seals.

5. Review operating and emergency procedures to assure that your operating staff has adequate guidance to respond properly to offgas system explosions.

6. Within 45 calendar days of the date of issue of this bulletin, report in writing to the Director of the appropriate NRC Regional Office, the results of your review and your plan of action with regard to Items 1 through 5. A copy of your report should be sent to the United States Nuclear Regulatory Commission, Office of Inspection and Enforcement, Division of Reactor Operations Inspection, Washington, D. C. 20555.

For all BWR power reactor facilities with a construction permit, this Bulletin is for information only and no written response is required.

Approved by GAO, B180225 (R0072); clearance expires 7/31/80. Approval was given under a blanket clearance specifically for identified generic problems.