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GENERAL ELECTRIC COMPANY

ATOMIC POWER EQUIPMENT DEPARTMENT

SAN JOSE, CALIF.

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SUMMARY OF MONTICELLO BIOLOGICAL SHIELD WALL STRENGTH

by

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In order to assure the AEC Regulatory Staff that the biological shield surrounding the Monticello reactor vessel can withstand the pressure that could be developed by failure of a nozzle safe-end, General Electric investigated the strength characteristics of the shield wall. This investigation is now complete. The following is a description of the investigation which has shown the shield wall strength to be more than adequate and that even if the penetration plugs should become missiles, they would not have sufficient energy to penetrate the primary containment.

The biological shield wall is a right circular cylinder of approximately 24 feet outside diameter which is anchored to the Reactor Pressure Vessel (RPV) support pedestal at its base and the ring truss at the top. As shown in the attached figure, an annulus is formed between the RPV and the biological shield wall. The shield wall is approximately 26 inches thick and consists of 27 inch WF columns tied together by horizontal WF beams and 1/4 inch steel plates. These plates are welded to the column flanges, both inside and outside, thereby forming a double walled shell. The shell is filled with concrete for shielding purposes. Pipes leaving the vessel at elevations below the top of the shield wall penetrate the wall. A number of the penetrations utilize removable shield plugs fitting around the penetration to allow access to the pipe welds for in-service inspection. In order to reduce the possible energy of any one shield plug piece, the space is filled as much as practical by small concrete bricks. The circle-to-square conversion is made by the use of pre-cast concrete pieces, segmented at the 90° positions. All bricks and shield pieces are retained by a 3/16" steel plate bolted to the penetration flange.

The investigation aimed at resolving the ACRS concern for the biological shield integrity involved defining the break area and location and calculating the resulting peak pressure in the annular space between the biological shield and the reactor pressure vessel. Particular attention was given to the pressure at the shield wall penetration shield plugs.

To calculate the peak pressure inside the biological shield, a leak in the recirculation nozzle, equivalent in area to a 28" recirculation line break was assumed. The break location was assumed such that the leak would be between the reactor vessel and the biological shield although, if a leak must be postulated, the nozzle to safe-end weld is believed to be more susceptible to failure. At Monticello, the nozzle to safe-end weld is located about 12 inches inside the shield wall and therefore an assumed break of this weld would result in a lower pressure inside the shield than under the above assumption.

It was further assumed that the vessel insulation in the annulus is either crushed or blown off; that saturated water is being discharged into the annulus at a rate corresponding to critical flow; that steam and water are well mixed so that vent flow stagnation enthalpy is equal to reactor water enthalpy; that steady blowdown and venting flows are appropriate due to the rapid pressure buildup in the annulus; that the friction loss of the vent area is equivalent to a pipe whose FL/D is approximately 0.25 and in which critical mixture flow occurs at the exit.

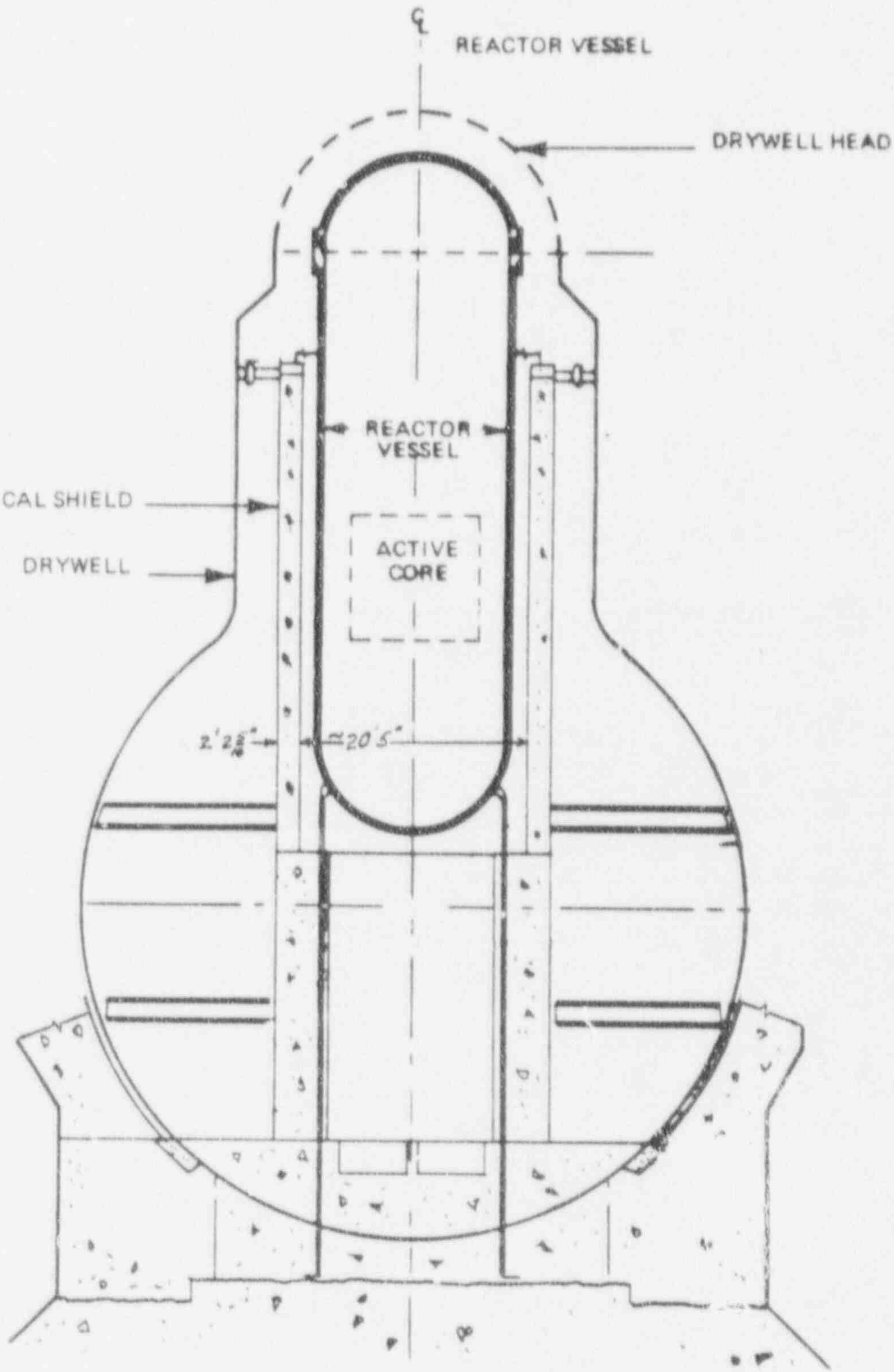
The leak described above is assumed to be equivalent in area to a 28" recirculation line, or 3.65 square feet. This release is vented through an area of 88.77 square feet comprised of the annular gap between the reactor pressure vessel and the biological shield plus the gaps between each line and its penetration through the biological shield. The peak pressure in the annulus based on the above assumptions, neglecting local stagnation and distribution effects was calculated to be 36.0 psi at the recirculation pipe penetrations through the biological shield.

Conclusions

The biological shield wall, based on an allowable stress of 150% of the 1969 AISC allowable stress, has the capability of withstanding a uniform internal pressure of 58 psi. This is sufficiently above the calculated uniform peak pressure of 36 psi such that the shield wall integrity is assured.

The calculated peak pressure could result in missiles since the 36 psi is sufficient to eject the largest shield plug with an energy of 16.2 ft. kips. In light of this missile potential, the containment's capability to withstand the impact of such a missile was investigated. The ejected shield plug was "Conservatively assumed to tumble during its flight to allow a pointed corner to impinge on the .635 inch (minimum) thick steel containment liner plate. An analysis based on U.S. Reactor Containment Technology, ORNL-NSIC-5 and assuming the 3/16 inch retainer plate did not restrict possible missiles, established that the containment could withstand a missile with an energy of 18.4 ft. kips.

The calculations reported herein demonstrate that the biological shield is adequate and that potential missiles would not penetrate the primary containment thereby demonstrating that loss of integrity of the nozzle would have "no intolerable consequences".



MONTICELLO REACTOR PRESSURE VESSEL AND SHIELD WALL

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