NRC-84-186

WISCONSIN PUBLIC SERVICE CORPORATION
P.O. Box 1200, Green Bay, WI 54305

November 29, 1984

Mr. J. G. Keppler, Regional Administrator
Region III
U.S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Fllyn, IL 60137

Dear Mr. Kepp...

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
IE Bulletin No. 84-03: Refueling Cavity Water Seal

The subject bulletin requested that we perform an evaluation of the potential for and consequences of a refueling cavity water seal failure. The attachment to this letter provides a summary report of that evaluation.

Very truly yours,

D. C. Hintz
Manager - Nuclear Power

CAS/js

Attach.

cc - Mr. S. A. Varga, US NRC
Mr. Robert Nelson, US NRC
Director, Office of I&E, US NRC

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ATTACHMENT

POTENTIAL FOR AND CONSEQUENCES OF A REFUELING CAVITY WATER SEAL FAILURE

BACKGROUND:

On August 21, 1984, the Haddam Neck plant, with the refueling cavity flooded in preparation for refueling operations, experienced a failure of the refueling cavity water seal. The refueling cavity level (23 feet) decreased to the level of the reactor vessel flange within 20 minutes and flooded the containment with approximately 200,000 gallons of water.

The Haddam Neck seal consisted of a) a steel seal ring supported by nine equally spaced strongbacks bridging a two foot annular gap and b) inflatable seals (manufactured by Presray) placed in the approximately 2 inch space between the reactor vessel flange and the seal ring and between the seal ring and the bearing plate attached to the cavity floor. The inflatable seals were constructed of elastomeric having a durometer hardness of 40 and were inflated to an internal air pressure of 40 psig. The failure occurred when the outermost seal was pushed through the gap over a 90° arc.

Kewaunee employs a single inflatable seal to bridge an approximate 2 inch annular opening between the reactor vessel (RV) flange and the refueling cavity floor (623'7" El.). The seal was manufactured by Presray and is of the same general design and shape as those used at Haddam Neck, however with a durometer hardness of 60 and inflated to an internal air pressure of 20 psig. Plant Technical Specifications require that a minimum of 23 feet of water be maintained above the RV flange during refueling operations.

EVALUATION:

As shown in Figure 1, the cavity seal used at Kewaunee is of a T-shape with a tapered wedge and an inflatable bulb. The bar of the T measures 4 inches, and the wedge is approximately 2 1/2 inches at its widest part. Pre-operational measurements verified the annular opening to be less than 2 inches wide around the circumference of the reactor vessel. Since the seal rests on the reactor vessel and refueling cavity floor which are fixed, seal support geometry is constant.

The seal is constructed of Ethylene Propylene Di Manomer (EPDM) rubber having a durometer hardness of 60. Rubber materials having a durometer hardness of 60-80 are classified as "stiff" live rubber (durometer readings from 30-50 are typical for "soft" live rubber). This higher durometer hardness provides increased resistance to seal deformation.

A primary performance requirement of the cavity seal purchase specification is:

> The seal (with or without inflation) shall be safe against being forced through the opening under all hydrostatic loads the seal can be subjected to under service conditions and while inflated or deflated.

This capability was demonstrated during preoperational testing of a comparable seal at the Prarie Island Nuclear Plant. The seal was inflated to 35 psig, and the refueling pool was filled with water to its full capacity and no visible leakage was detected. The seal was then deflated and then reinflated with no visible leakage detected.

As noted, normal seal inflation pressure is 20 psig. At this lower than design pressure, the inflatable bulb provides less encouragement to seal blow through.

The loss of seal air pressure is not considered likely since 1) the seal ring is pressure tested prior to installation and 2) station instrument air is hard piped to the seal inlet nozzle with a nitrogen gas bottle piped in parallel to serve as an emergency backup.

Based on these factors:

1) fixed seal support geometry to ensure the design basis opening is not exceeded,

2) seal construction of stiff rubber to resist deformation,

3) successful testing of the seal in the inflated and deflated condition,

4) lower inflation pressure and redundant gas supplies, and

5) more than ten years of experience without a recorded seal failure,

sufficient assurance is provided that the seal will continue to function safely.

POSTULATED SEAL FAILURE:

Although failure of the cavity seal is considered extremely unlikely, one has been postulated to address additional issues identified in the bulletin. If we assume complete removal of one-eighth of the cavity seal, conservative calculations indicate that cavity draindown to the RV flange will occur in approximately 25 minutes (approximately 50 minutes with the transfer tube gate valve open to the spent fuel pool).

Fuel assemblies in the reactor vessel, the rod cluster control change (RCC) fixture, the fuel transfer upender, and the spent fuel racks will remain water covered above the active fuel. Assemblies in the RCC change fixture or in the upender in the vertical position would have the smallest amount of water coverage of only several inches.

An assembly suspended from the manipulator crane or the spent fuel handling tool would become uncovered unless operator action is taken. During the postulated seal failure, if the operator is to exit the area when the radiation levels reach 10-50 R/hr, action to move and begin lowering the assembly to an acceptable location would be required in less than five minutes (ten minutes with the transfer tube gate valve open).

If a spent fuel assembly was removed from the reactor after 100 hours of subcriticality (Technical Specification requirement) and completely exposed to air, very conservative calculations indicate that clad damage could occur in less than ten minutes. However because of the uneven distribution of decay heat generation in the fuel assembly, uncovery of only the upper part (approximately 6 inches) of the active fuel would not be expected to lead to clad failure for several hours.

The average volumetric flow rate during the postulated draindown is estimated to be 9200 gpm. The potential sources of makeup would include:

Charging with reactor makeup feed

one pump operation	60 gpm max.
two pump operation	120 gpm max.

Taking suction on Sump B with the RHR pumps

one pump operation	2000 gpm max.
two pump operation	4000 gpm max.

Spent fuel pool makeup

Normal	100 gpm
Emergency	2500 gpm

The emergency spent fuel pool makeup could be used to provide water to the cavity pool through the transfer tube for cooling or to fill the spent fuel pool once the gate valve has been closed.

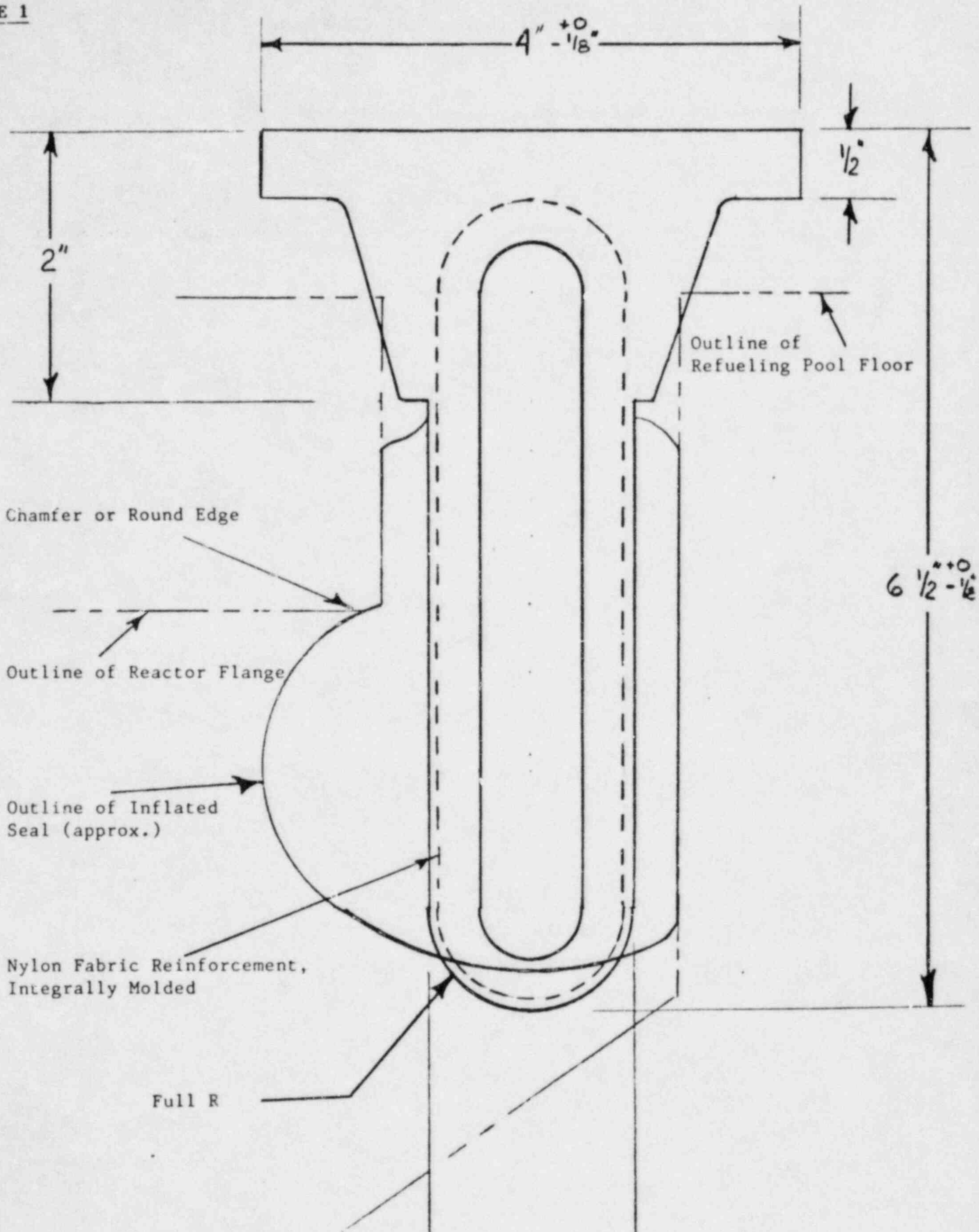
As outlined the consequences of a cavity water seal failure during refueling operations can be severe. To provide additional assurance that failure will not occur and proper operator actions will be taken, in the event of a failure, the following actions are being implemented:

1) A design change has been initiated to install a relief valve on the seal pressurization system to prevent exceeding recommended pressure.

2) A radiation monitor with local readout and alarm capability will be placed on the manipulator crane to alert the operator of abnormal pool radiation levels.

3) The current refueling procedure section "Fuel Handling Accident Emergency Instructions" is being revised to address a loss of water in the cavity and spent fuel pool due to a failure of the cavity seal.

FIGURE 1



PNEUMA SEAL FOR REFUELING CAVITY