UNITED STATES ATOMIC ENERGY COMMISSION

SAFETY EVALUATION BY THE DIRECTORATE OF LICENSING

DOCKET NO. 50-155

BIG ROCK POINT PLANT

ANALYSIS OF THE CONSEQUENCES OF HIGH ENERGY PIPING FAILURES OUTSIDE CONTAINMENT

INTRODUCTION

On December 18, 1972, and January 16, 1973, the Atomic Energy Commission's Regulatory staff sent letters to Consumers Power Company requesting a detailed design evaluation to substantiate that the design of the Big Rock Point Plant is adequate to withstand the effects of a postulated rupture in any high energy fluid piping system outside the primary containment, including the double-ended rupture of the largest line in the main steam and feedwater system. It was further requested that if the results of the evaluation indicated that changes in the design were necessary to assure safe plant shutdown, information on these design changes and plant modifications would be required. Criteria for conducting this evaluation were included in the letters. A meeting was held on January 24, 1973, to discuss the information already available on the Big Rock Point Plant design concerning postulated pipe ruptures, to discuss the criteria, and to assess those areas where additional information was required. In response to our letters, a report concerning postulated high energy pipe ruptures outside containment was filed by Consumers Power on June 29, 1973. A subsequent letter from Consumers Power dated February 7, 1974, answered additional questions in a letter from the staff dated January 23, 1974.

EVALUATION

Criteria

A summary of the criteria and requirements included in our letter of December 18, 1972, is set forth below:

a. Protection of equipment and structures necessary to shut down the reactor and maintain it in a safe shutdown condition, assuming a concurrent and unrelated single active failure of protected equipment, should be provided from all effects

resulting from ruptures in pipes carrying high energy fluid, where the temperature and pressure conditions of the fluid exceed 200°F and 275 psig, respectively, up to and including a double-ended rupture of such pipes. Breaks should be assumed to occur in those locations specified in the "pipe whip criteria". The rupture effects to be considered include pipe whip, structural (including the effects of jet impingement), and environmental.

b. In addition, protection of equipment and structures necessary to shut down the reactor and maintain it in a safe shutdown condition, assuming a concurrent and unrelated single active failure of protected equipment, should be provided from the environmental and structural effects (including the effects of jet impingement) resulting from a single open crack at the most adverse location in pipes carrying fluid routed in the vicinity of this equipment. The size of the cracks should be assumed to be 1/2 the pipe diameter in length and 1/2 the wall thickness in width.

High Energy Systems

Our evaluation included the following piping systems containing high energy fluids:

Main, Extraction, and Auxiliary Steam Systems

Feedwater System

Condensate System

Sample Lines (Environmental Effects Only)

Areas or Systems Affected by High Energy Pipe Breaks

An evaluation was conducted of the effects of high energy pipe breaks on the following systems, components, and structures which would be necessary (in various combinations, depending on the effects of the break) to safely shutdown, cooldown, and maintain cold shutdown conditions:

a. General

1. Control Room

2. Control and Instrument Cables and Tunnels

3. Electrical Distribution System

4. Emergency dc Power Supply (batteries)

5. Emergency ac Power Supply (diesels)

6. Heating and Ventilation Systems (needed for long-term occupancy to maintain the reactor in safe shutdown condition)

b. Reactor Control Systems and associated instrumentation

c. Cooling and Service Water Systems

d. ECCS components

Specific Areas of Concern

The applicant has provided the results of his examination of all postulated safety related high energy line break locations and evaluated the break consequences. We have reviewed all of this information, including the following specific areas of concern where the potential consequences might be severe or where specific corrective action would further assure safe cold shutdown of the plant.

a. Compartment Pressurization

Large pipe breaks, including the double-ended rupture of the largest pipes in a system, and small leakage cracks up to the design basis size have been considered for the main steam tunnel, the turbine building, and the electrical penetration room.

In the main steam tunnel, the effects of a combined main steam line break and a feedwater line rupture were considered as the worst case. The existing pipe tunnel and attached condenser area structure are able to resist loads due to pressurization of 2.4 psi with modifications. The resultant pressure from a piping failure inside the tunnel was calculated to increase to 20 psi. Modifications of the existing structures were considered to assure the integrity of the tunnel in the event of a postulated failure. To reduce the pressure below the 2.4 psi, approximately 140 square feet of additional vent area would be required. Since there is a ventilation connection

between the tunnel and adjacent electrical penetration room, a fast closure damper will be installed to mitigate environmental effects in the electrical penetration room.

b. Pipe Whip

The steam tunnel has been designed with thick reinforced concrete capable of withstanding large static and dynamic loads. The reinforced concrete steam tunnel in which the main steam and feedwater lines are routed from the primary containment to the turbine room is subjected to the loads of the piping and a live load from the floor on top of the tunnel roof. The possibility of a combined whip, jet thrust and pressure pulse acting upon the tunnel wall and on the containment was evaluated by the applicant. Break points of the lines were selected using the criteria in our December 1972 and January 1973 letters. A whipping line could crack the tunnel walls or overhead, but would only cause spalling and therefore would not generate any significant missiles which would damage safety related equipment. A whipping steam or feedwater line could cause the 4 and 6 inch core spray headers in the pipe tunnel to be severed. However, a redundant supply is available through a separate penetration approximately 180° around the containment from the pipe tunnel.

Other high energy lines such as the sample lines and reactor water cleanup line are located such that their rupture would not cause damage to the safety related equipment.

c. Control Room Habitability

The main control room is physically located away from and isolated from all high energy lines. Neither the control room equipment nor its ventilation system will be affected by environmental effects caused by a rupture of a high energy line.

d. Environmental Effects

Components and equipment were checked for possible adverse environmental effects which could be caused by the rupture of a high energy line. Adverse temperature, pressure, and humidity were the parameters which were used in the evaluation of safety related equipment.

We have reviewed the licensee assessment of the consequences of environmental effects on safety related equipment. We find that safety related equipment has been designed to limits in excess of postulated conditions which could arise from the rupture of a high energy line.

Modifications

Modifications to the existing facility will be required to assure that the design will have adequate safety margins in the event of a high energy line rupture outside the containment.

Modifications to existing structures are necessary to assure the integrity of the main steam tunnel and surrounding areas.

To reduce the pressure below 2.4 psi in the main steam tunnel, 130 to 140 square feet of additional vent area is required. Two acceptable alternatives were considered:

a. A vent hole in the west side of the pipe tunnel between the reactor and turbine buildings.

b. A vent hole in the concrete block shield wall on the west side of the condenser.

In addition to the vent opening, a ventilation duct between the pipe tunnel and the electrical penetration room will be modified to provide an automatic isolation in the event of tunnel pressurization.

CONCLUSIONS

On the basis of this review of the information submitted and our discussions with Consumers Power, we find that their assessment of the consequences of high energy line failures outside containment is acceptable. Some modifications are necessary. We have concluded that the potential consequences of the postulated high energy pipe failures, following the modifications, will not prevent the capability to achieve safe cold shutdown conditions consistent with the single failure and redundancy requirements as described in our letter of December 18, 1972.

The licensee has stated by telecon that modifications will not be complete until July 1975. In the interim we will require the licensee to undertake an increased surveillance program in the areas of concern.

Based on the decreased likelihood of a catastrophic high energy line break, owing to the increased surveillance and the limited time until the final modifications will be completed, we have concluded that there is reasonable assurance that the health and safety of the public will not be endangered by continued operation in the manner proposed.

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