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CONTAINMENT ISSUE

ISOLATION TRANSIENT

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1.0 INTRODUCTION.

Various Scenarios lead to conditions where suppression pool water may overflow/backflow over the weir, splashing onto, or partial immersion of, recirculation pumps and piping become possible. Thermal shock, and resulting fatigue, will add to the system imposed (Service Levels A and B) fatigue life for the recirculation piping system and may consume all remaining useful life. Occurrence of any other concurrent, or subsequent, loading could result in a recirculation break LOCA.

2.0 PURPOSE.

The purpose of this report is to show that if this incredible event, were to occur it would not damage the piping system to an extent whereby loading could cause a recirculation break LOCA.

3.0 CLASSIFICATION OF EVENT.

Drywell flooding is a rare event and it is postulated to occur only once or twice during a 40 year plant life. This event can be classified as Service Level C or Service Level D event (Reference 7.1) and no fatigue analysis is required.

4.0 DRYWELL FLOODING TRANSIENT STRESS EVALUATION.

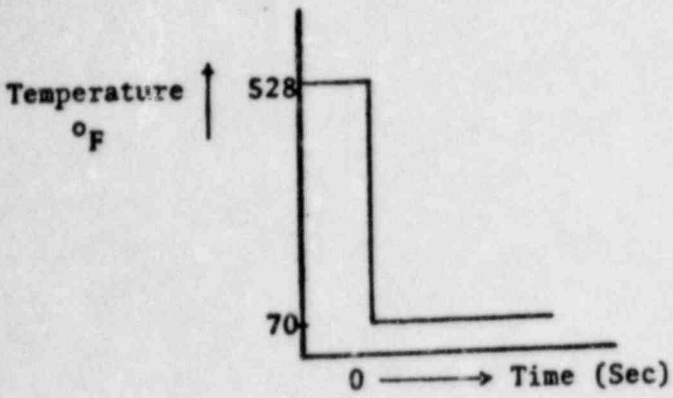
Although this event is classified as Service Levels C or D event, simplified fatigue analyses were made (Reference 7.2) for the pump casing and a typical BWR-6 recirculation piping system subjected to this postulated transient. The assumptions for this evaluation were as follows.

4.1 RECIRCULATION PUMP

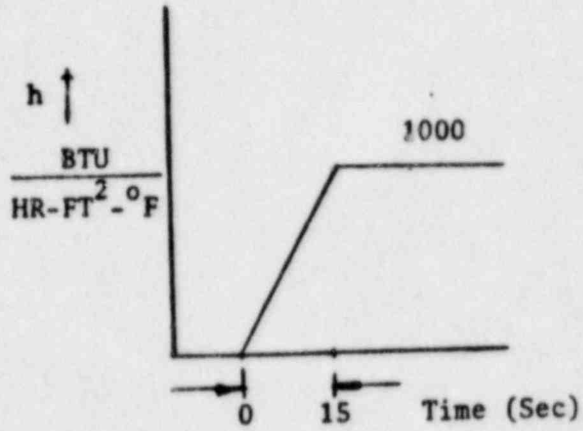
The present capability of the recirculation pumps as documented by the Byron Jackson stress report, states the pump casing can withstand a maximum temperature gradient of 350°F without any fatigue evaluation. However, a fatigue evaluation was made with a pump casing temperature gradient of 450°F.

4.2 RECIRCULATION PIPING

A fatigue evaluation was made for this event and the stresses were added to the piping stresses due to system loading and thermal transients. The thermal gradient was evaluated for this event using the LION401 computer program. The surface temperature of the pipe was assumed to be 70° immediately after water reaches the pipe surface. The boundary temperature and heat transfer coefficient were conservatively assumed as follows:



TEMPERATURE PROFILE



HEAT TRANSFER COEFFICIENT

The heat transfer to water increases rapidly in 15 seconds to 1000 BTU/hr°F Ft^2 and partially destroy the insulation. This causes high thermal gradient in the pipe.

5.0 RESULTS.

The results of the evaluation (Section 4.0) were:

5.1 RECIRCULATION PUMP

5.1.1 The calculated allowable cycles for this transient were 150 cycles which gives a fatigue usage factor of 0.007 (1/150).

5.1.2 Distortion

There is a chance the 450°F temperature difference would cause local yielding such that a dimensional check of the critical parts would be required. The recirculation pump motor cannot tolerate flooding without subsequent cleaning, oil change and drying its' winding. These operations and check have to be done after this event.

5.1.3 Fracture Toughness

The pump casing is cast austenitic stainless steel, so brittle fracture is not a concern.

The pump cover case bolts are ferritic steel. The mean temperature of the cover is: 1/2 (450) + 100 = 350°F. This temperature is above NDTT (Nil Ductility Transition Temperature) of ferritic steel.

5.2 RECIRCULATION PIPING

5.2.1 The calculated maximum temperature gradients for this transient described in Section 4.2 were:

ΔT_1 = 354°F

ΔT_2 = 88°F

T_{AB} = 46°F (Due to thick pump casing and thin pipe)

The stresses due to the above thermal gradients were added to the stresses due to the system loads and thermal gradients. The allowable cycles with these stresses were 900, which gives a fatigue usage factor of 0.001 (1/900).

5.2.2 Distortion

The temperature gradient may distort the pipe at the pipe to pump casing weld location which will not affect the function of the recirculation piping.

5.2.3 Fracture Toughness

For the austenitic stainless steel recirculation piping, fracture is not a concern for this event.

6.0 CONCLUSIONS AND RECOMMENDATIONS.

The above transient is similar to events of "Improper Start of a Cold Loop", except the temperature shock ΔT is 398°F instead of 450°F. So the transient is not totally new for the recirculation piping system design. This event is not a safety concern based on the fatigue evaluation and the following reasons.

1) The stresses produced by the event are in a category (secondary & peak) that do not require evaluation except for Service Levels A & B conditions. These peak stresses produced by the thermal shock are important only for fatigue and fatigue usage which, for a few rare events, is not required by the Code or by NRC rules.

2) If it were necessary to consider the fatigue usage due to this thermal shock, calculations show; based on worst case conditions, that significant fatigue usage would not result unless there were more than one hundred such cycles.

3) Under a worst case condition the potential damage to the piping could be slight distortion at the weld joints. The worst case condition is defined as the insulation being removed and a 450° temperature difference between the outside and inside of the recirculation pipe. In the event that suppression pool water immersed part of the recirculation piping, we would recommend the insulation of the piping be removed and the weld joints connecting the recirculation piping to the recirculation pump be visually examined for deformation at the next shutdown.

   Additionally, a dimensional and alignment check of the pump is recommended. The pump motor must be reconditioned by decontamination and drying the insulation, an electrical check, and an oil change. This assumes the motor was flooded.

7.0 REFERENCES.

7.1 ASME Boiler and Pressure Vessel Code, Section III Division I - 1980 Edition upto and including Winter 1982 Addenda.

7.2 Design Record File #124-98, Recirculation Flooding.

APPENDIX A

LION401 PROGRAM

LION401 is a digital computer program which is used to solve the steady state or transient temperature distribution in any three-dimensional configuration. The heat source may be externally conducted or internally generated.

In addition to the solving of heat conduction in structural elements, LION401 may also be used in such cases as forced convection, free convection, or radiation where the output will yield temperatures and heat fluxes for points representing the surface of the structure.

The program solves the transient heat conduction equations for a three-dimensional field using a first forward difference method.

Input to the program consists of structural geometry, physical properties, boundary conditions, internal heat generation rates and coolant flow properties and rates.