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SED-OSA-0082

August 13, 1982

Dr. Novak Zuber
U. S. Nuclear Regulatory Commission
Mail Stop 113055
Bethesda, Maryland 20555

Dear Dr. Zuber:

The information you requested after our meeting on 8/11/82 has been attached. An explanation of the Fracture Mechanics calculational procedure used to determine the wall heat flux as a function of time can be found on pages 41-46 of WCAP 10019.

If you have any questions regarding this data, please contact me.

Rick Ofstun
Rick Ofstun
Operational Safeguards Analysis

bmf

CC: T. Speis
B. Sharon
H. Julian

ENERGY BALANCE

$$M \frac{dh}{dt} = \dot{m}_{SI} \ (h_{IN} - h) + \dot{Q}''A$$

Solution

$$h = (h_o - h_{IN} - \frac{\dot{Q}''A)}{\dot{m}_{SI}} \ e^{-\dot{m}_{SI} t/M} + h_o + \frac{\dot{Q}''A}{\dot{m}_{SI}}$$

M = Mixing Mass

$\dot{m}_{SI}$ = SI Mass Flow

h_o = Initital Fluid Enthalpy

h_{IN} = SI Enthalpy

A = Heat Transfer Area

$\dot{Q}''$ = Wall Heat Flux from Fracture Mechanics

Westinghouse Model

M = 68043 lbm

$\dot{m}_{SI}$ = 146.5 lbm/S

h_o = 536.8 BTU/lbm

h_{IN} = 28.06 BTU/lbm

A = 2381 ft^2

$\dot{Q}''$ = Appended

t (Sec)	$\dot{Q}''$ BTU/HR-FT^2
0.0	0.0
100.	11.93 x 10^3
200.	17.51 "
300.	20.48 "
400.	22.09 "
500.	22.86 "
600.	23.25 "
1000.	21.45 "
1500.	18.12 "
2000.	14.87 "
2500.	12.20 "
3000.	10.06 "

Note: The above wall heat flux was determined assuming a free convection film heat transfer coefficient calculated by the correlation presented in WCAP 10019 with an assumed fluid temperature response given by:

$$T = 60 + 480\ e^{-1.667 \times 10^{-3} t} \quad \text{(t in sec)}$$

I recommend using Simpson's rule to integrate $\dot{Q}''$ over each time interval.

Cold Leg Data:

Metal Mass = 14641 lbm per Cold Leg

Length = 20.1 ft

Diameter = 2.29 ft

Material = Stainless Clad Carbon Steel

Thermal Shield Data:

I.D. = 158.5 in

Δt = 2.79 in

Length = 134.25 in

Material = Stainless Steel

Vessel Data:

Metal Mass above Bottom of Cold Leg Nozzles = 167518.1bm

Nozzle Metal Mass = 35674.1bm per Nozzle

Metal Mass below Bottom of Cold Leg Nozzles to Bottom of Barrel = 439791.1bm

Length above Bottom of Cold Leg Nozzles = 7.062 ft

Length below Bottom of Cold Leg Nozzles to Bottom of Barrel = 19.9797 ft

Lower Plenum Volume = 943.25 ft^3

Lower Plenum Metal = 161755 lbm

Material = Stainless Clad Carbon Steel

ATTACHMENT 5

COMMENTS ON NRC CONCERN THAT PTS OPERATING EXPERIENCE IS NOT CONSISTENT WITH WESTINGHOUSE PROBABILISTIC TREATMENT OF TRANSIENTS WHICH CHALLENGE VESSEL INTEGRITY

INTRODUCTION

The NRC, in a public meeting on August 11, 1982, expressed a concern that operating experience on W plants showed a higher frequency of occurrence of low final temperature events than was predicted by the W PRA study of PTS events (WOG May 28 and July 15 Reports). W has reviewed this NRC concern and concludes that the two sources compare favorably when consistent bases for comparison are utilized.

The NRC treatment of PTS operating experience is inconsistent with the W PRA in the following respects:

(Comment A): NRC event final temperatures are in certain cases selected long after operator initiated cooldown of the plant within Appendix G limits had commenced.

(Comment B): NRC plotting of historical data is inconsistent with their plotting of W PRA Data.

(Comment C): One of the historical events which was used by the NRC (HBR-'70) is not considered to be an operational occurrence (although if it is arbitrarily included, the two sources of data still compare favorably).

When these inconsistencies are eliminated, W PRA Data matches historical data well. Refer to Table 1 and Figure 1.

Discussion

The objective of the W PRA was to establish an upper limit on the probability of reactor vessel flaw extension, not to predict the frequency of event final temperatures. The W selected event final temperatures were chosen so that they gave a fair representation of the transient when dovetailed with the NRC Probabilistic Fracture Mechanics Data. Thus, if it is desired to validate the W PRA against the limited amount of historical experience available, one must select the historical event final temperature in a manner consistent with that used in the PRA. The following comments provide the basis for this consistent method of treating the operational data:

(Comment A): 1. The W PRA utilizes event final temperatures which are dependent upon faults and operator action (including operator error) to stabilize the plant following fault initiation. The final temperatures are not influenced by subsequent controlled cooldown of the plant within Appendix G limits, based upon the assumption that the vessel integrity challenge can be principly associated with the initial transient and subsequent operator actions to stabilize the plant. This assumption is a logical one when simplified analysis based upon final temperatures rather than temperature time history is utilized, otherwise T_F is always final RCS temperature in cold shutdown (which yields excessively conservative results).

HBR '72 The plant was stabilized and a controlled cooldown was commenced at an RCS temperature of approximately 400°F.

HBR '75 The pump seal failure occurred during a plant cooldown. The operators continued to cool the plant when the event occurred such that the majority of the transient remained within Appendix G limits (cold leg temp apparently decreased 150°F in one hour at one point and operators immediately terminated the cooldown to reestablish a 100°F per hour cooldown rate). It is not possible by inspecting the transient temperature history to choose a final temperature which doesn't include operator controlled cooldown. If an energy balance is performed, it can be determined that the event quasi-equilibrium temperature four hours after the seal failure would conservatively have been 327°F if the operators had not been cooling down the plant per Appendix G.

Ginna In the W PRA, the final temperature was selected by drawing a smooth exponential through the goemetric center of any short downward thermal spikes. The justification for this method of temperature selection is that fracture mechanics results for the actual temperature history and the exponential are essentially identical.

Prairie Island Final temperature of 390°F would be selected using the geometric center technique described above.

2. The W frequency of final temperature increases sharply at about 320°F. This occurs because at these higher temperatures (where the probability of flaw extension is very low), bounding final temperatures were often used to describe a given scenario rather than specific analysis. The actual frequency of these higher final temperature events is not expected to be as large as the W PRA predicts.

(Comment B) 1. The W PRA curve was plotted by the NRC in a stairstep manner. Starting with the lowest temperature data point, the curve was plotted in the sequence "tread", "rise", "tread", etc. The NRC analysis of operating data was plotted in a reverse manner (i.e. "rise", "tread", "rise", etc.). The inconsistent means of plotting the data adds arbitrary margin between the historical and probabilistic data, and is not considered to be appropriate.

(Comment C) 1. HBR '70 initiated when safety valve piping failed during hot functional testing. The safety valve foundations were improperly designed due to faulty communication of reaction forces between W and the A/E. The safety valve testing program revealed, as it should have, that the foundation design was inadequate, and the foundations were redesigned and re-fabricated on all affected W plants (all were under testing or construction). HBR was not operational at the time of the event and no core was installed. It is considered inappropriate to treat this pre-operational test event as an operational event. The approach of excluding pre-op test data from operational data is consistent with virtually all PRA applications to date.

Table 1 -- Operating Experience

Event[1]	NRC Selected Final Temp(°F)	W Selected Final Temp(°F) [3]
HBR '75	250	327
Ginna	325	300
(HBR '70	295	295)[2]
HBR '72	340	400
Prairie Island	350	390

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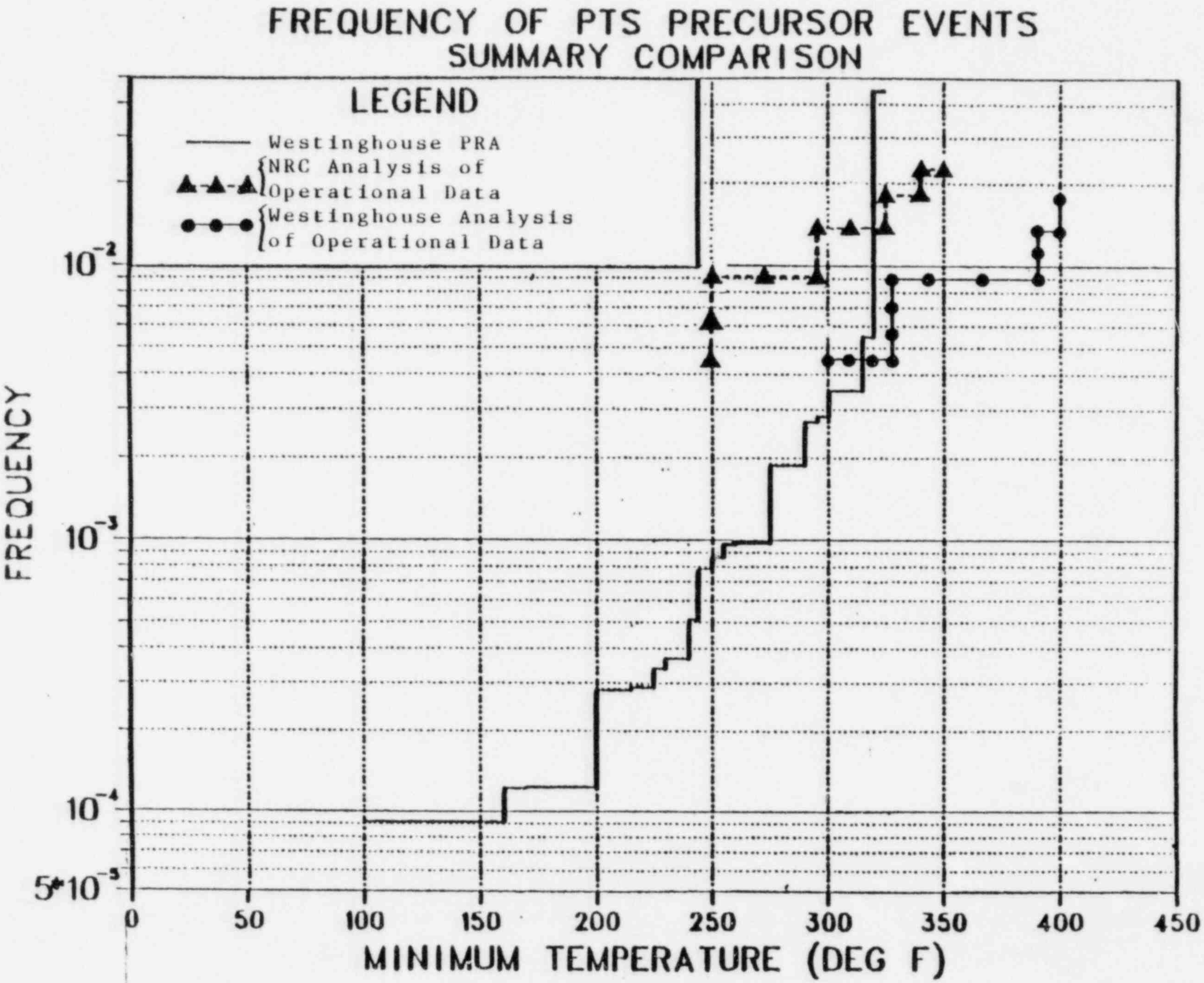
1. W Plant experience identified in NRC presentation of 8/11/82.
2. This event is not considered to be an operational occurrence for reasons which are explained within the text.
3. Eliminates consideration of operator controlled cooldown within Appendix G limits.

FIGURE 1



FREQUENCY OF PTS PRECURSOR EVENTS
SUMMARY COMPARISON
LEGEND
Westinghouse PRA
NRC Analysis of Operational Data
Westinghouse Analysis of Operational Data
FREQUENCY
10^-2
10^-3
10^-4
5*10^-5
0
50
100
150
200
250
300
350
400
450
MINIMUM TEMPERATURE (DEG F)