MASTER

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RE&C INTERNAL REPORT RE-A-79-14

JULY 3, 1979

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THERMAL ANALYSIS OF MOUNTING PLATE AND
INSTRUMENT HOLDER IN UPPER CORE SUPPORT
STRUCTURE FOR LOFT CORE III

H. F. Rhodes

EG&G Idaho, Inc.

IDAHO NATIONAL ENGINEERING LABORATORY

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE UNDER CONTRACT DE-AC07-76IDO1570

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INTERNAL TECHNICAL REPORT

Title: THERMAL ANALYSIS OF MOUNTING PLATE AND INSTRUMENT HOLDER
IN UPPER CORE SUPPORT STRUCTURE FOR LOFT CORE III

Organization: THERMAL ANALYSIS BRANCH

Author: *H F Rhodes*

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IDAHO NATIONAL ENGINEERING LABORATORY
LOFT TECHNICAL REPORT
LOFT PROGRAM

TITLE		REPORT NO.
Thermal Analysis of Mounting Plate and Instrument Holder		LTR 1111-66
In Upper Core Support Structure For LOFT Core III		RE-A-79-14
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LOFT APPROVAL		
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FD&AB
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LEPD
Mgr.

DISPOSITION OF RECOMMENDATIONS

This analysis was used in the stress analysis of the mounting plate and instrument holder in the upper core support structure for LOFT Core III. The stress analysis is LTR 1111-62.

SUMMARY

The maximum temperature drop that could occur across the mounting plate or instrument holder is about 90F. This is based on conservative data and assumptions. Gamma heating was estimated from calculations for 55 MW operation; the value used was 0.015 Watts/gram of metal.

The mounting plate is the restriction orifice on top of the upper end box on the center fuel assembly. The instrument holder is bolted to the top of this plate.

Only steady state operation is considered.

RECOMMENDATIONS

Make stress analysis as required using this result.

THERMAL ANALYSIS OF MOUNTING PLATE AND INSTRUMENT HOLDER IN UPPER CORE SUPPORT STRUCTURE FOR LOFT CORE III

I. INTRODUCTION

The instrument holders for the linear variable displacement transducers and ultrasonic density detectors are about 1.5 in. thick. They are bolted to the top of the 1.5 in. thick orifice plate, which is mounted on the top of the upper end box of the center fuel assembly (Figure 1, attached).

This study was made to determine the temperature difference across these pieces for thermal stress evaluation, at steady state.

II. DISCUSSION

From References 1 and 2, the location and dimensions of the pieces most likely to develop significant temperature differences were determined. The 1.5 in. thick orifice plate on top of the upper end box is the support for the instrument holder.

The base of the instrument holder is 1.5 in. wide. It is mounted adjacent to (and partly "over-hanging") the edge of the orifice hole.

The coolant stream will flow past this "inside surface", as well as contacting the bottom of the orifice plate. Therefore, the worst imaginable condition is that the top of the orifice plate and the "back side" of the holder is insulated by "stagnant water". Therefore, all internally generated heat must be removed from the bottom and inside surfaces of the orifice plate and instrument holder.

Other portions of the instrumentation assemblies are much smaller in the assembled configuration, and are farther from the core. Therefore, gamma heating will be much less than for the orifice plate.

The gamma heating of the orifice plate at the bottom surface was estimated by R. A. Grimesey^[3] from References 4, 5, 6, and 7. The value at this location was never calculated, so extrapolation was made, obtaining an estimate of 0.015 Watts/gram at the bottom of the orifice plate. This is considered to be a "very conservative" value^[3]. The heating rate will decrease exponentially through the plate and instrument holder, but it is assumed here that attenuation does not occur.

The temperature difference was calculated using this equation, which is for a semi-infinite plate with a uniform internal heat generation rate and with its back side insulated:

$$\Delta T = q''' x^2 / 2 k;$$

where ΔT - temperature difference, $^{\circ}\text{F}$,
 q''' - internal heat generation rate, Btu/hr-ft^3 ,
 x - plate thickness, ft,
 k - metal thermal conductivity, $\text{Btu/hr-ft-}^{\circ}\text{F}$ (used as 10.5 at 600°F).

III. RESULTS

The calculated temperature difference is 8.63°F ($\sim 9^{\circ}\text{F}$) across both the orifice plate and the instrument holder at the 1.5 in. thickness. All other instrument paraphernalia will have even less temperature differences.

During a LOCE the temperature difference caused by gamma heating will be much less than calculated for steady state operation at power. Reactor scram occurs at about the start of LOCE, and before PC flow has decreased significantly. The temperature difference will decrease because the power, and gamma heating, decrease will be much faster than the cooling capability decrease as the LOCE proceeds.

In the accident cases, the greatest temperature difference would be only trivially more than the value calculated for the steady state case because scram occurs quickly. The worst anticipated event would be the case of uncontrolled rod withdrawal at power with scram at $\sim 4\%$ overpower at about 8 seconds. The maximum increase in temperature difference would be $4\%^{[8]}$ of the steady state value, if scram were delayed indefinitely at the maximum power, less than half a degree.

IV. CONCLUSIONS AND RECOMMENDATIONS

The maximum temperature difference that could occur is $\sim 9^{\circ}\text{F}$. Use this value for stress analysis as required.

V. REFERENCES

1. John Fredell, EG&G, private discussion in BFA, January 10, 1979.
2. EG&G Drawings 209520 Sheets 1 through 5, and sketch of installation arrangement of UDD and LVDT instruments and holders.
3. R. A. Grimesey, EG&G, Telephone conversation, January 10, 1979.
4. H. L. McMurry letter to M. N. Monson, "Radial Gamma Heat Production In The LOFT 5-1/2 Foot Core At 55 MW," HLM-35-70, September 24, 1970.
5. G. K. Wachs letter to M. N. Monson, "Gamma Heating Results For LOFT 5-1/2 Foot Core At 55 MW," Wac-13-70, October 7, 1970.
6. M. N. Monson, Gamma Heating In The Reactor Internals For LOFT Core I, LTR 111-7, October 8, 1970.
7. M. N. Monson, Axial Gamma Heating In LOFT Core I, LTR 1111-14, December 1970.
8. EG&G Idaho, Inc., "LOFT Final Safety Analysis Report (FSAR)," Figure 15-15 (1977).

FIGURE 1.-(WORKING SKETCH)

UDD & LVDT INSTRUMENT
HOLDER MOUNTING & ORIENTATION

WFR

(FOR LOFT CORE-III)

PLAN

{ UPPER CORE SUPPORT
"FRAME-WORK"

{ INSTRUMENT
HOLDER

{ P. COOL FLOW FROM
(CENTER FUEL ASSY.

{ 1 1/2" ORIFICE PL

{ UPPER END BOX

SECTION (ELEV)

INTEROFFICE CORRESPONDENCE

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date **JUL 17 1979**

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REMARKS: This analysis was used in the stress analysis of the mounting plate and instrument holder in the upper core support structure for LOFT Core III. The stress analysis is LTR 1111-62.

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