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DESIGN MANUAL AND HAZARDS ANALYSIS

FOR EXPERIMENT NO. 40/W004, CONTROL

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DRUM BEARINGS

AT PLUM BROOK REACTOR FACILITY

(RFI, 63-05)

INFORMATION CATEGORY	
<i>Unclassified</i>	
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1. INTRODUCTION

Experiment No. 40/W004 is the irradiation testing of two control drum bearings and a retainer ring under the environmental conditions in the W-2 Loop of the HT-1 in the Plum Brook Reactor Facility. The cooling, control, and instrumentation system described in WANL-TNR-119, "Design Manual and Hazards Analysis for Exp. No. 63-05"* remains the same.

2. EXPERIMENT DESCRIPTION

This experiment is designed to static test two control drum bearings and an extra retainer ring in the nuclear and temperature environment existing in HT-1 in the vicinity of the core centerline. The test jig is shown in Figure 1. The test specimens are placed in a machined aluminum container which isolates them from direct contact with the loop cooling water. The aluminum container is fitted with four thermocouples which monitor approximate sample temperatures. No He gas system or other experiment actuation system exists in this experiment. The gas actuation descriptions and analysis described in WANL-TNR-119 for Experiment No. 63-05 are therefore superfluous for this experiment. The size and weight comparison to the experiment described in WANL-TNR-119 is as follows:

* WANL-TNR-119, "Experiment Design Manual and Hazards Analysis, Plum Brook Reactor Facility, Exp. No. 63-05", Radiation Effects Program, Westinghouse Astronuclear Laboratory, Large, Pennsylvania.

<u>Experiment Parameter</u>	<u>Envelope Experiment</u>	<u>Exp. No. 40/W004</u>
AL Weight	7 lb	5.1 lb
S.S. Weight	2 lb	1.1 lb
Total Weight	9 lb	6.2 lb
O.D.	6.12 in.	3.00 in.
Length	6.5 in.	4.35 in.

The W-2 Loop Instrument Set Points, System Operation and Post-Irradiation Handling remain the same as described in WANL-TNR-119. The experiment is static and required no actuation by gas systems.

3. CALCULATIONS

3.1 Heat Transfer

The gamma heating rate and distribution will be the same as shown in WANL-TNR-119; therefore, all loop heat loads will be the same, except for the sample section which will be less.

Heat load of envelope sample:

$$9.1 \text{ lb} \times 6470 \text{ BTU/lb.} = 58,200 \text{ BTU/lb.}$$

Heat load of Exp. 40/W004:

$$6.2 \text{ lb.} \times 6470 = 40,000 \text{ BTU/lb.}$$

Since the heat load and bulk water temperature rise will be less for this experiment, the maximum capsule wall temperature will be lower.

3.2 Nuclear

An activation analysis utilizing the most recent flux data for HT-1

has been performed using the ACT II Computer Code.* The fluxes used for the calculations are shown in Table 1. The code, as used for this calculation, assumed no perturbation of the fluxes presented in Table 1 due to the presence of the sample. For a 2.2 hr irradiation at 60 megawatts and zero decay time, the activation levels for Exp. No. 40/W004, which contains 5.1 pounds of 6061 Al and 1.1 pounds of 440C stainless steel are shown in Table 2.

TABLE 1

Neutron Fluxes in HT-1

<u>Energy Range</u>	<u>Flux</u> (n/cm ² sec)
0 - 0.625 ev	1.20 x 10 ¹⁴
0.625 ev - 5 Kev	2.66 x 10 ¹³
5 Kev - 821 Kev	2.28 x 10 ¹³
0.821 Mev - 10 Mev	1.90 x 10 ¹³

* WANL-TNR-063, Addendum 1, "Activation Source Strength Program, Act II," P. C. Heiser and L. O. Ricks, Westinghouse Astronuclear Laboratory, Large, Pennsylvania.

TABLE 2

Activation Levels for Experiment No. 40/W004

<u>Nuclide</u>	<u>Half Life</u>	<u>Energy</u> (Mev)	<u>Curies</u>
Al-28	2.27 min	1.78	3.25×10^4
Cr-51	27.8 days	0.325	0.475
Cu-64	12.8 hr	1.34	0.34
Cu-66	5.1 min	0.834, 1.04	0.86
Fe-59	45.1 days	1.10	0.074
Mg-27	9.45 min	0.84	5.84
Mn-54	291 days	0.84	1.64×10^{-3}
Mn-56	2.58 hr	0.85	1.13×10^3
V-52	3.76 min	1.44	16
Mo-99	66 hr	0.041	1.0

3.3 Reactivity

If required by PBRF the capsule and experiment complex or equivalent will be tested prior to irradiation to insure that the maximum reactivity of 1 per cent $\Delta K/K$ is not exceeded.

3.4 Stress

The same pressure containing members are used for this experiment as are used in Exp. No. 63-05 and described in WANL-TNR-119.

4. HAZARDS ANALYSIS

4.1 Maximum Credible Accident

The Maximum Credible Accident is considered to be the complete severance of the capsule piping below the level of the quadrant water. The analysis presented in WANL-TNR-119 indicates a more severe case than that for this experiment (No. 40/WO04), because the heat generation is less. This is shown in Section 3.1 of this report.

4.2 Loss of Coolant Pumps

The analysis presented in WANL-TNR-119 is conservative for Exp. No. 40/WO04 because experiment heat generation is less, as shown in Section 3.1 of this report.

4.3 System Rupture

The analysis presented in WANL-TNR-119 is conservative for Exp. No. 40/WO04 because experiment heat generation is less, as shown in Section 3.1 of this report.

4.4 Loss of Power

The analysis presented in WANL-TNR-119 applies to this experiment.

4.5 Reactor Excursion

The analysis presented in WANL-TNR-119 is conservative for Exp. No. 40/WO04 because experiment heat generation is less, as shown in

Section 3.1 of this report.

4.6 Boiling

The analysis presented in WANL-TNR-119 is conservative for Exp. No. 40/WOO4 because experiment heat generation is less, as shown in Section 3.1 of this report.

4.7 Handling Accident

The analysis presented in WANL-TNR-119 applies to Exp. No. 40/WOO4. All handling operations will be monitored to ensure against hazard to personnel.

4.8 Instrument Failure

The analysis presented in WANL-TNR-119 applies to Exp. No. 40/WOO4.

4.9 Chemical Reactions

The analysis presented in WANL-TNR-119 applies to Exp. No. 40/WOO4.

4.10 Sample Bellows Rupture

No sample bellows exist in this experiment since no gas is utilized.

4.11 Accidental Capsule Ejection

The analysis presented in WANL-TNR-119 will apply to Exp. No. 40/WOO4.

5. REFERENCES

1. WANL-TNR-119, "Experiment Design Manual and Hazards Analysis, Plum Brook Reactor Facility, Expr. No. 63-05", Radiation Effects Program, Westinghouse Astronuclear Laboratory, Large, Pennsylvania.
2. WANL-TNR-063, Addendum 1, "Activation Source Strength Program, Act II," P. C. Heiser and L. O. Ricks, Westinghouse Astronuclear Laboratory, Large Pennsylvania.