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DR GAS LOOP TEST # 1 LIMITATIONS

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DR GAS LOOP TEST # 1 LIMITATIONS

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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DR GAS LOOP TEST # 1 LIMITATIONS**DECLASSIFIED**INTRODUCTION

In accordance with the agreement in a meeting with Aerojet-General Nucleonics representatives, certain information is presented for use in planning the first DR Gas Loop test run. Included are the following:

1. Estimates of test section power prediction uncertainty and variation during run.
2. Estimates of limiting test section design powers and ΔP 's, presented as variables versus maximum loop flow as a parameter. (Figure 1).
3. Spatial relation between in-pile tube and reactor surroundings. (Figures 2 and 3).
4. A representative relative flux traverse in the sample space. (Figure 4).

The user of this information is cautioned to study the discussion to fully understand the significance of what is presented.

POWER UNCERTAINTIES AND VARIATIONS

Two factors enter in the prediction of test section power in the loop. The first of these is the uncertainty inherent in predicting power for known pile conditions from Hanford Test Pile data. A conservative estimate of this uncertainty is ± 20 per cent. It is emphasized that this does not represent a variable. Whatever the ratio of predicted to actual power is for given conditions, said ratio is constant.

The second factor is the deviation of power at any time during the test from the power at the time of insertion into the pile, due to changes in local fluxes. The maximum range of possible variation from the test section power at insertion is estimated to be ± 20 per cent for the approximate period of time involved in this test.

Phenomena contributing to this variation are:

1. Seasonal variation in inlet water temperature.
2. Major revisions in control rod pattern leading to significant shifts in front-to-rear flux distribution.
3. Minor variations in local fluxes at equilibrium operation.
4. Flux perturbations due to changes in nuclear properties of changes in the vicinity of the specimens.
5. General changes in flux level due to changes in reactor operating limits.

Thus for a given predicted (or design) test section power " q ", at the time of insertion, the actual power may be anywhere from $0.8 q$ to $1.2 q$. In addition, the actual power at any time during the test may vary from the power at insertion by ± 20 per cent. Accordingly, during the test, the actual power may vary from $0.64 q$ to $0.96 q$ at the low extreme, or from $0.96 q$ to $1.44 q$ at the high extreme. These variations are not rapid in nature.

LIMITING TEST SECTION ΔP 's AND TOTAL POWERS

From the discussions in the September 8 and 9 meeting, it is understood that Aerojet wishes to irradiate an element of fixed geometry and dimensions, and that this element is such that at a total power of 45 KW and a flow rate of 1600#/hr, the ΔT across the gas film is 200 F. It is further understood that one firm criteria of test operation is that the peak fuel temperature be maintained constant at 1400 F.

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Maximum achievable flow rates have been estimated for various assumed nominal test section pressure drops. By nominal, the test section ΔP at 1600#/hr is meant. The results are plotted in Figure 1, Curve 2, in terms of nominal test section ΔP versus the maximum flow rate. It was assumed in this calculation that the test section ΔP is a function only of the weight rate of flow squared, for simplicity and speed in completing the analysis. The same assumption was made for loop ΔP 's assuming those values estimated at loop design conditions. In addition, the blower ΔP at 2000#/hr was assumed to be 12 psi (80 per cent of calculated) for conservatism, since only calculated values for loop and blower characteristics are available.

Maximum total design test section powers have also been estimated for various maximum flow rates. These are plotted in Figure 1, Curve 1, as maximum design power versus maximum flow rate.

The maximum total design test section power is that design power for which, at the maximum flow, the peak temperature of 1400 F can just be maintained if the estimated maximum values are achieved for both the variation factor and the uncertainty factor of power prediction.

Assumptions made in this analysis are:

1. The full predicted irradiation heating for the in-pile tube assembly will be achieved and this will vary in proportion to test section power variation.
2. There is no interchange of heat between graphite stack and in-pile tube.
3. The test section heat transfer coefficient will vary from that defined above only by the 0.8 power of the weight flow rate.

USE OF FIGURE 1

Case 1: Suppose a particular test section design power is desired. From Curve 2, the maximum flow rate required to maintain peak temperature at 1400 F for the maximum anticipated deviation from this power is obtained. Then, from this condition and Curve 1, the maximum nominal test section ΔP can be determined. The nominal ΔP for the proposed section (ΔP at 1600#/hr) must be equal to or less than this value.

Case 2: Suppose it is desired to maintain the flow rate constant at some value throughout the test. Then, from Curve 2, the maximum test section design power can be obtained, and again, the maximum nominal ΔP can be obtained from Curve 1.

Case 3: Suppose it is desired to irradiate a test section with a certain nominal ΔP . From Curve 1, the maximum flow rate can be obtained, and then from Curve 2, the maximum design power can be obtained.

The maximum design powers determined in Cases 1 and 3, apply only if the associated maximum flow rate is acceptable. Such flow rate would not necessarily be achieved in the test, of course, depending upon whether or not the maximum possible deviation from design power on the high side is achieved.

These predictions are necessarily rather conservative. As actual measurements of some of the quantities involved in the calculation are obtained, a lesser degree of conservatism can be incorporated. Probably, however, most such measurements will not be obtained until too late to be of value to this first test, excepting the blower characteristic curves which should be available in two to three weeks.

Also, some of the assumptions made in the calculation are not truly valid - as for instance - the assumption that loop and test section ΔP 's are functions only of the weight rate of flow squared.

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RELATION OF IN-PILE TUBE ASSEMBLY TO REACTOR COMPONENTS

Figures 2 and 3 show the dimensional relations between the in-pile tube and surrounding reactor components. Figure 4 shows a representative relative flux traverse across the sample space.

CONCLUSIONS AND RECOMMENDATIONS

While based on gross assumptions, the information in Figure 1 does outline approximately the area of limits. It is clear that compromises in the test run desires as outlined in the September 8-9 meeting are necessary.

Upon receipt of more specific test criteria from Aerojet based upon the above information, more rigorous calculations, leading to more exactly determined limiting powers and ΔP 's, will be performed.

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Irradiation Testing Operation

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FIGURE 2

NOTE: DIMENSIONS FROM
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FIGURE 3

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