TASK CLOSE OUT DOCUMENT

Task Scope NATURAL CIRCULATION - DEGRADED CORE GEOMETRY - CALCULATION OF TEMPERATURES

To: M. Levenson
S. Levy
E. Zebroski

Task No. 29 Date Complete 4/21

Reason felt task is complete:

Preliminary temperature calculated

Members of Committee

Performed at EPRI under W. Loewenstein

W. Loewenstein for S. Levy
Signed
Committee Leader

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1.

To: M. Levenson

From: W. Loewenstein

NATURAL CIRCULATION/DEGRADED CORE EXPERIMENT

OBJECTIVE: To ascertain the efficiency of cooling by free convection within degraded core.

ASSUMPTION: (1) Fuel has collected in layers over central core region at grid spacer elevations. (15 inches apart)

(2) Heat generation rate of 1.5×10^{-3} of nominal full power (2732 MW).

(3) Total blockage of central core region (annular bypass of scaled dimensions)

a) 3/4 blockage

b) 7/8 blockage

SOLUTION: (1) Use Volume Scaling (i.e. KW/ft^3 water)

(2) Q_{core} = 4.1 MW
Q_{layer} = 450 KW (9 layers)
$\frac{Q_{Layer}}{V_{Layer}}$ = 6.3 $\frac{KW}{ft^3}$

} Target TMI

Test Vessel I.D.	= 9 inches	Test Model
Test Pressure	= Atmospheric	
Plate to Wall Gap	= 0.300 in. (3/4 Blocked)	
Plate to Wall Gap	= 0.150 in. (7/8 blocked)	
Target Test Model Q	= 0.23 KW/layer	
Spacing between layers	= 1.25 inches	

Q_{layer} = 0.21 KW/layer
Q_{layer} = 0.40 KW/layer
Q_{layer} = 0.67 KW/layer

} Achieved

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RESULTS: (1) Boiling not observed anywhere during free convection.

(2) Threshold of local boiling (top layer) only observed when inlet flow reduced by use of valve.

(3) See Figure attached for actual results.

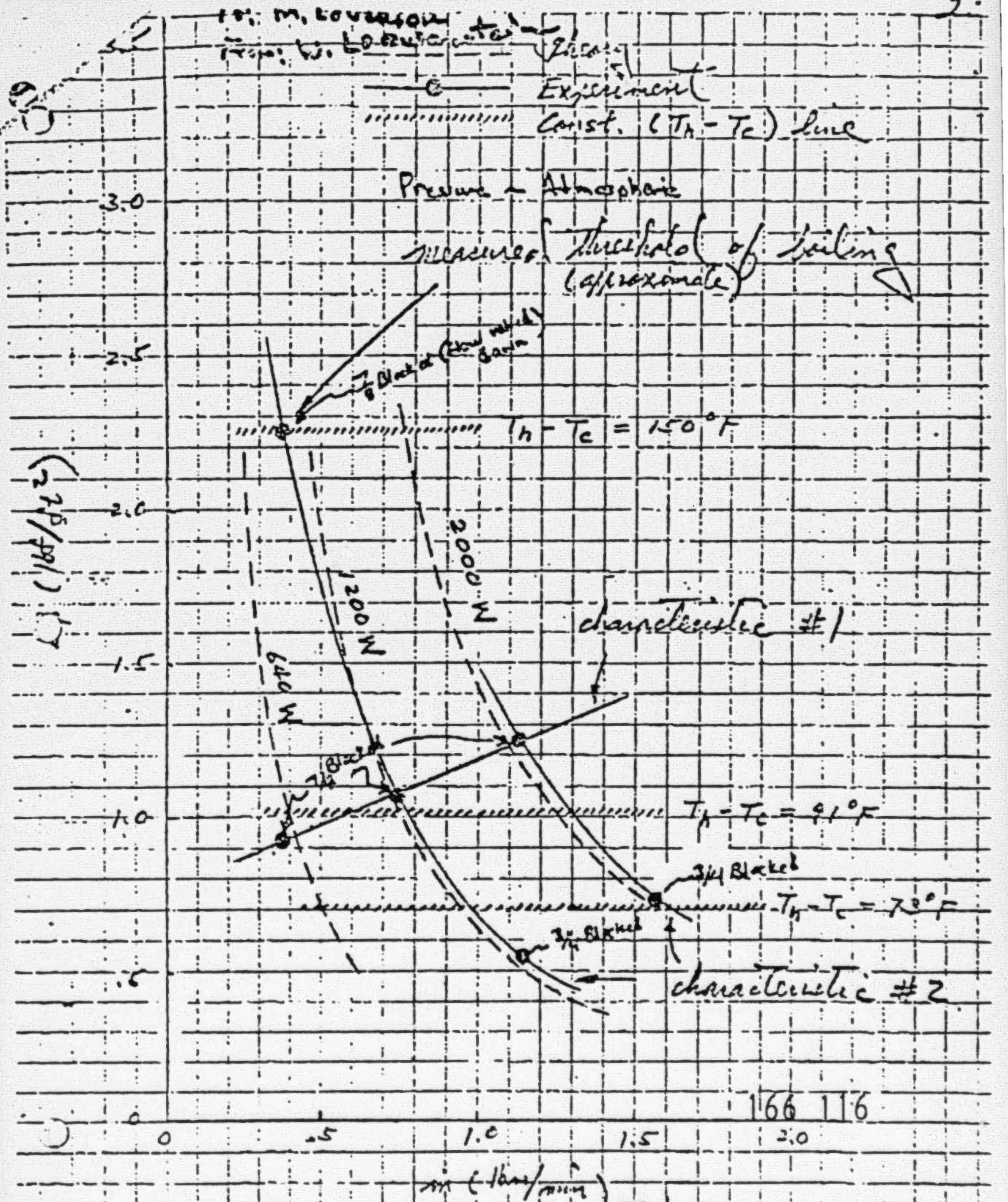

Fig. 2 System Characteristics

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To: M. Levenson
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Free Convection Heat Transfer Calculations
Through "Porous" Media

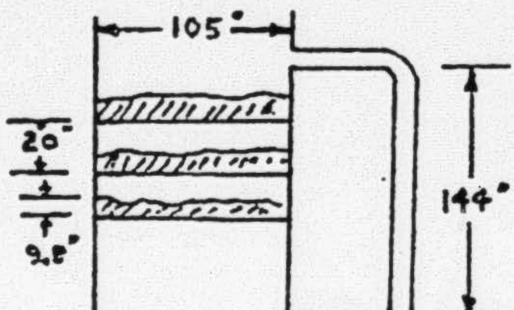
A. Calculate four cases:

1. System pressure = 900 psi
Inlet temperature = 280°F and 350°F

2. System pressure is atmospheric
Inlet temperature = 170°F and 200°F

Assumptions:

1. Power ~ 0.2% of 2500MW ~ 6MW
2. Core divided into 8 regions defined by spacers.
3. Region with porous medium has diameter of 105 in.
4. Porous medium is defined by cylinders of .4" diameter spaced with a pitch to diameter ratio of 1.065 in a staggered grid. This gives a porosity of 20%. For heat transfer area the ends of the cylinders are ignored.
5. Assume 3 "trays" of porous material, in following geometry.



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Results:

1. The heat transfer rate required in the porous medium is 306 BTU/hr ft^2 to carry away the heat generated. (If a temperature difference of 100°F is

Results (cont.):

assumed between the fluid and the surface, the heat transfer coefficient required is about 3 BTU/hr°F ft^2 which is typical of free convection in air.)

2. At a pressure of 900 psi, free convection provides more than enough flow at inlet temperatures of 280°F and 350°F to prevent the water from reaching saturation. The heat transfer coefficient is of order 250 BTU/hr ft^2 °F and the temperature rise approximately 1°F.

3. At atmospheric pressure with inlet temperature of 170°F or higher, free convection does not provide enough flow to allow water to remain subcooled. Hence local boiling will result.

4. Calculations using CHF correlations for beds consisting of 300 to 800 micron particles show that at atmospheric conditions CHF will probably be reached. However, due to the low power generation the temperature rise will not be significant.