ENCLOSURE 1-NP to LD-83-068

INFORMATION ON
SYSTEM 80
BYPASS FLOW

AUGUST, 1983

LEGAL NOTICE

INFORMATION ON SYSTEM 80 BYPASS FLOWS

1. Introduction

The System 80 design contains five different types of guide tubes, each type having different flow resistance networks and, therefore, different bypass flow rates. The flow networks and flow resistances are presented in detail in this report.

Also presented in this report is a comparison of bypass flow rates between the System 80, 2570 MWth and 3410 MWth class designs.

2. Types of Guide Tubes

The System 80 reactor design contains five different kinds of guide tubes. They are:

1. center guide tubes containing in-core instrumentation
2. empty center guide tubes
3. corner guide tubes containing control rods (CEA's)
4. corner guide tubes in non-CEA locations
5. corner guide tubes in CEA locations but containing no control rods

At the present time the inventory of these five types of guide tubes in the reactor is as follows:

1.	instrumented center guide tubes:	61
2.	empty center guide tubes:	180
3.	rodded corner guide tubes:	740
4.	corner guide tubes in non-CEA locations:	160
5.	unrodded corner guide tubes in CEA locations:	64
	Total	1205

3. Driving Heads

The driving heads for the five categories of guide tubes are listed in the following Table. The subscripts coincide with the numbered guide tube stations shown in Figure 1.

TABLE OF DRIVING HEADS

Type of Guide Tube	$P_{in}-P_{out}$	Numerical Value (psi)
1. instrumented center GT	P_1-P_6	[
2. empty center GT	P_2-P_6	
3. rodded corner GT	P_4-P_8	
4. corner GT in non-CEA location	P_4-P_6	
5. unrodded corner GT in CEA location	P_4-P_8	]

4. Flow Networks

The overall geometry of the five categories of guide tubes is exhibited in Figure 2. The inlet and exit positions of the flow are indicated by wiggly arrows. Next to each flow network a sketch of the applicable guide tube geometry is added to help interpret the network components. For each branch of every flow network the pressure loss coefficient is shown in the form K/A^2, which can be interpreted as the pressure loss coefficient per unit square area. The K values are based on empirical information from published literature. For convenience, the pressure at the flow inlet is always designated as 0 psi.

4.1 Instrumented Center Guide Tube

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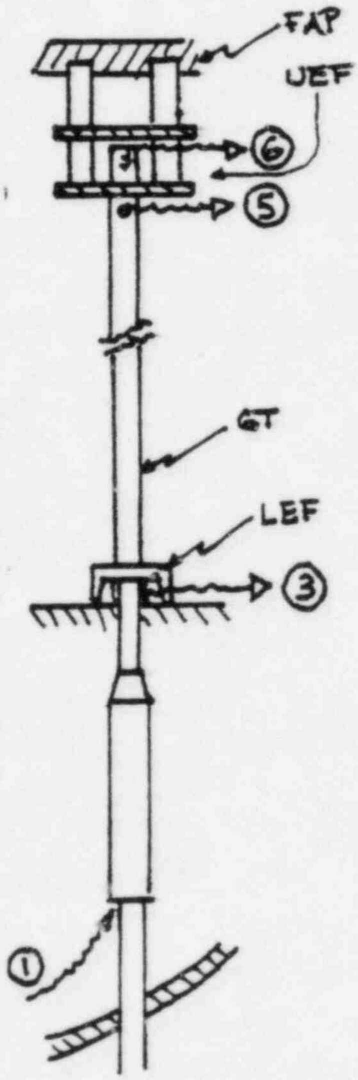

The GT bypass flow in the above flow network is represented by the term $(W_1 - W_2)$. The numerical solution of the network equations yields

$$(W_1 - W_2) = [\quad] \text{lbm/sec}$$

The total bypass flow for the 61 instrumented center GT's then becomes:

$$(W_1 - W_2)_{\substack{\text{center GT} \\ \text{W/ICI}}} = [\quad] \text{lbm/hr}$$

4.2 Empty Center Guide Tubes

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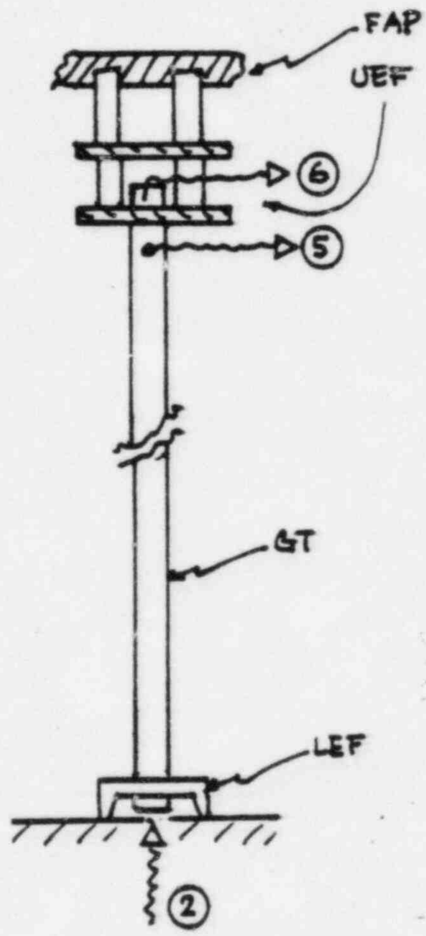

The GT bypass flow in the above flow network is represented by the term W_1. The numerical solution of the network equations yields

$$W_1 = [\quad] \text{lbm/sec}$$

The total bypass flow for the 180 empty center GT's then becomes:

$$W_{\substack{\text{center GT} \\ \text{W/o ICI}}} = [\quad] \text{lbm/hr}$$

4.3 Rodded Corner Guide Tubes

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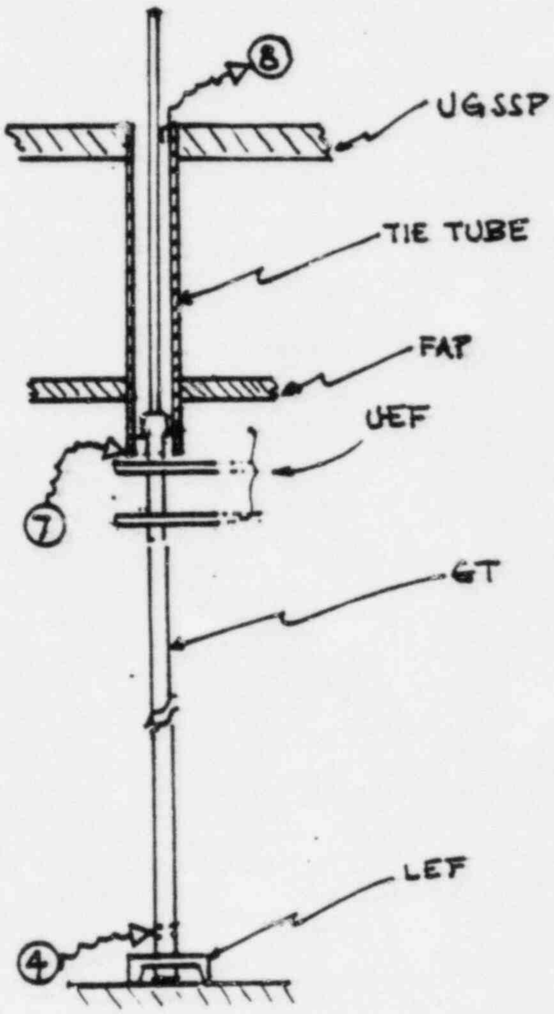

The GT bypass flow in the above flow network is represented by the term W_1. The numerical solution of the network equations yields

$$W_1 = [\quad] \text{ lbm/sec}$$

The total bypass flow for the 740 rodded corner GT's then becomes:

$$W_{\substack{corner\\rodded}} \text{ GT} = [\qquad] \text{ lbm/hr}$$

4.4 Empty Corner Guide Tubes in Non-CEA Positions

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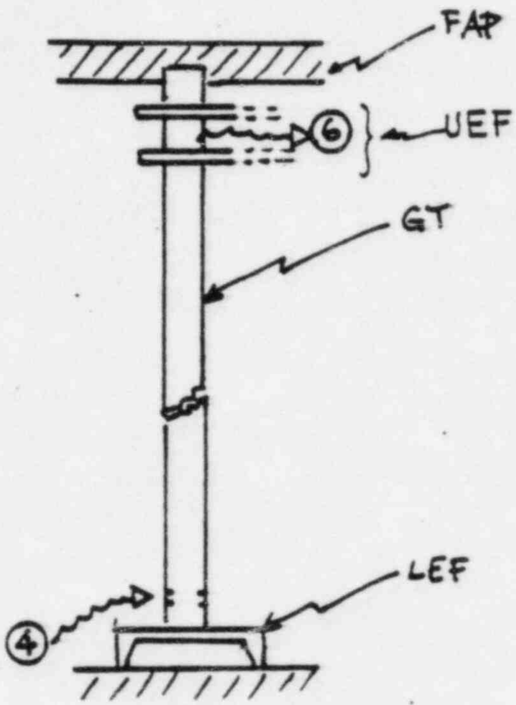

The GT bypass flow in the above flow network is represented by the term W. The numerical solution of the network equations yields:

$W = [\quad]$ lbm/sec

The total bypass flow for the 160 empty corner GT's then becomes:

$W_{\substack{corner\ GT \\ empty}} = [\qquad]$ lbm/hr .

4.5 Empty Corner Guide Tubes in CEA Locations

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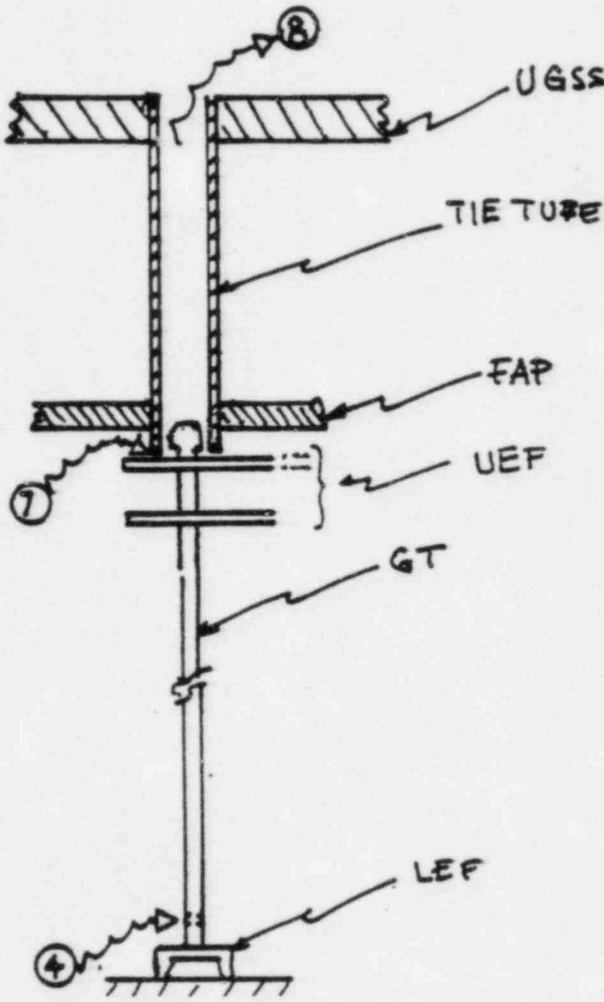

The GT bypass flow in the above flow network is represented by W_1. The numerical solution of the network equations yields:

$$W_1 = [\quad]\ \text{lbm/sec}$$

The total bypass flow for the 64 empty corner GT's then becomes:

$$W_{\substack{\text{corner GT}\\ \text{empty}}} = [\quad]\ \text{lbm/hr}$$

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*For simplicity, the same values as for the rodded case was used. The difference between rodded and unrodded case is negligible.

5. Operating Condition (Nominal Design Flow Rate)

Vessel mass flow rate: 164×10^6 lbm/hr

6. Summary of Results of Guide Tube Bypass Flow Rates

No. of GT's	Category of GT	Driving p (psi)	Q/Q_D (lbm/hr)	%
61	Center GT w/ICI			
180	Center GT w/o ICI			
740	Corner GT, rodded			
160	Corner GT, unrodded non-CEA pos.			
64	Corner GT, unrodded CEA pos.			
1205	TOTAL			

COMPARISON OF BYPASS FLOW RATES IN PERCENT OF DESIGN FLOW RATE

Bypass Flow Path	2570 MWth	3410 MWth	SYSTEM 80 3817 MWth
Outlet Nozzles	0.4	0.6	1.0*
Core Shroud	0.7	0.6	0.3**
(a) seams in shroud	0.4	0.3	0.0**
(b) cylinder holes	0.3	0.3	0.3
Alignment Keys	0.4***	0.1	0.4
Guide Tubes	1.7+	0.8+	0.7+#
(a) center guide tubes	0.2	0.2	0.3<
(b) corner guide tubes	1.5	0.6	0.4>
TOTAL	3.2	2.1	2.4

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* 2570 MWth and 3410 MWth design bypass flows are based on as-built nozzle gaps. System 80 outlet nozzle bypass flows are larger because of larger outlet nozzle diameter inherent in the design and calculations are based on maximum drawing allowed nozzle gap dimensions.

** Welded construction in System 80 has eliminated bypass flow through seams in core shroud.

*** The bypass flow through alignment keys reported in 2570 MWth class reactor FSAR was calculated for a flow area associated with an early design for the keyways. This area is larger (9.6 in^2) than for 3410 MWth (2.4 in^2) and System 80 (6.8 in^2) designs.

\+ Guide tube bypass flows show a decreasing trend due to use of smaller guide tube flow holes for the later reactor designs.

\# The final best estimate guide tube flow rate has increased from 0.6% shown in CESSAR to the 0.7% shown here as a result of incorporating latest design changes. The design value for total bypass flow remains at 3.0% for System

< [ ]

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GUIDE TUBE STATIONS

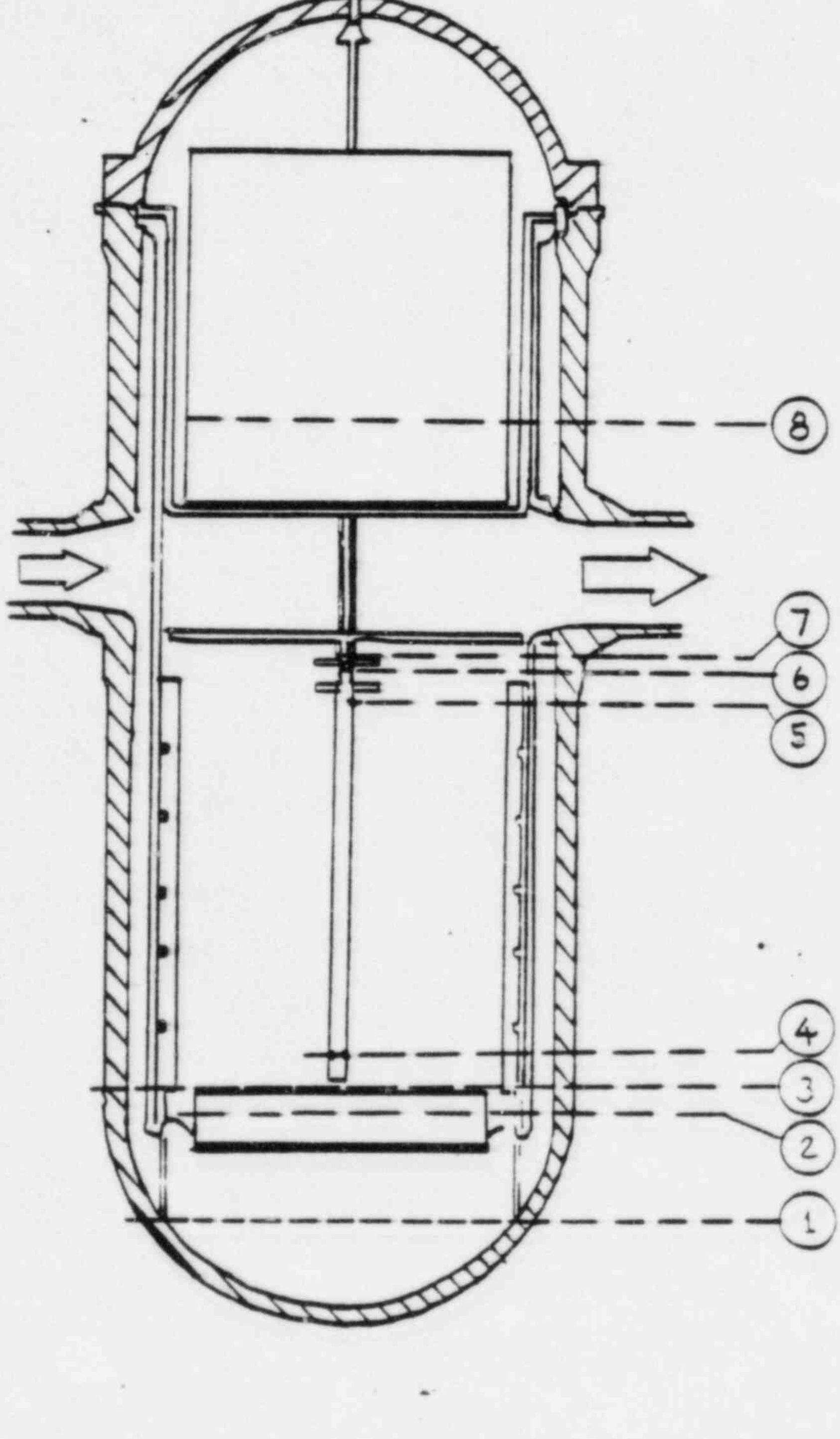

FIGURE 1

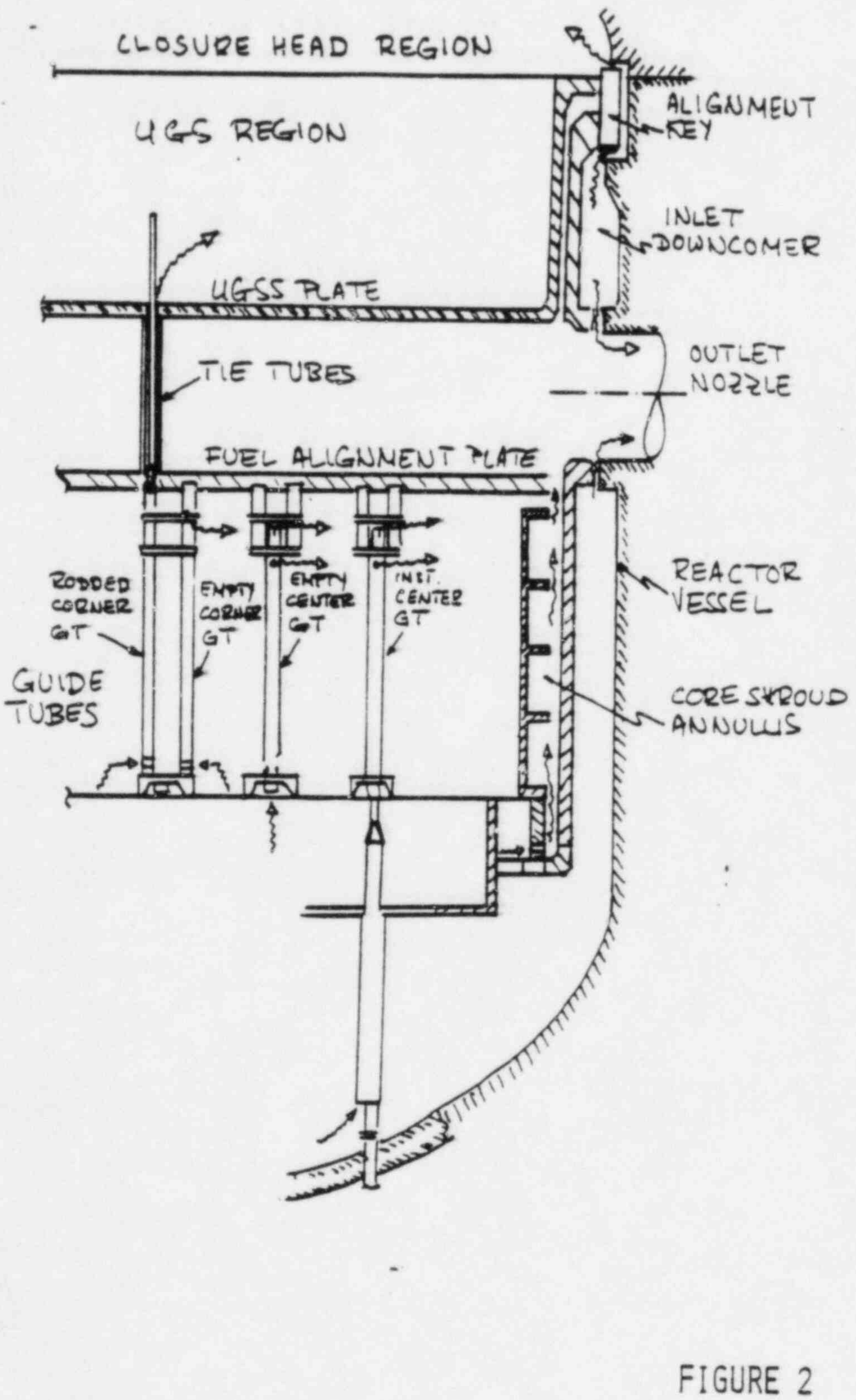
CLOSURE HEAD REGION
UGS REGION
ALIGNMENT KEY
INLET DOWNCOMER
UGSS PLATE
OUTLET NOZZLE
TIE TUBES
FUEL ALIGNMENT PLATE
RODDED CORNER GT
EMPTY CORNER GT
EMPTY CENTER GT
INST. CENTER GT
REACTOR VESSEL
GUIDE TUBES
CORE SHROUD ANNULUS

FIGURE 2

INITIAL DESIGN GUIDE TUBE FLOW HOLE DIMENSIONS *

GUIDE TUBE LOCATION	NUMBER OF HOLES	DIMENSION (INCHES)
Center Guide Tube	1	[
Corner Guide Tube	2	
	1	]

* These values were used in the initial calculation of best estimate core bypass flow which resulted in the 4.0% value quoted in Revision No. 4 of CESSAR-F.