SSC-N-77

FNAL SSC CRYO 85-9

PRELIMINARY RESULTS OF FERMILAB TWO PHASE HELIUM TESTS

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CONCLUSIONS

1. Saturated liquid in a venturi does not obey the normal flow squared relationship of differential pressure versus mass flow rate, but follows a higher order one due to flashing in the throat. This in turn produces premature choking of the venturi.

2. Stratified flow occurs at much higher velocities than predicted by the Baker diagram (several orders of magnitude). We were not able on this run to produce high enough steady state flow to find any boundaries.

EXPERIMENTAL SETUP

Drawing 1650-MB-168394 shows the experimental layout; it is driven by one of our standard satellite refrigerators operating in stand alone mode. The liquid is cooled to about 4.4K by heat exchanging with boiling liquid in a 450 liter dewar. It is then heated to produce a 20 mixture which first passes through 25 ft. of .920 in ID pipe before entering the 80 ft. 1.77 in. ID test line; the entire length has a 5K shield.

At the end of the test line a knife blade separates the top and bottom halves of the flow and drains each into a phase separator. The collected liquid can be measured as a rate of change in liquid levels or by drain venturies. The gas flows are combined and pass through a pressure regulating valve.

The experimental setup will measure the liquid flow in each half of the pipe as a function of total flow, quality, and incline. The entire line can be inclined at ± 2%. The goal being to find the stable operating regions for an inclined SSC.

20 EXPERIMENT

For a horizontal line at 1.4, 1.6 and 1.8 ATM we set up a constant 10 *g/sec* subcooled liquid flow and increased the heater wattage until we broke into the 20 region. The flow appears to be "stratified flow". All the liquid drained into the lower pot, we were never able to get any into the upper pot. Figure 1 shows a possible explanation of the data.

An alternate explanation is that gravitation effects caused the liquid to be sucked in by the vertical phase separator piping. The drain venturies choked at above 10 *g/sec*. This prevented us from increasing the flow further.

PHASE SEPARATION TEST

As an independent cross check, we inclined the line upward by 2%. We put a 20 mixture into the line filled with saturated gas and measured the time delay for liquid to reach the other end. With froth flow we would have a very fast response (Table I, Column 4). Column 5 is the time for perfect phase separation, i.e. volume divided by the liquid flow. Column 6 is the experimental measurement. Column 7 is the ratio of Column 6 divided by Column 5 and is the fraction of the test system filled with liquid.

To cross check the data we then put in a second pulse with a few percent gas to fill the line; this time is given in Column 8. Figure 2 shows the points plotted on the Baker diagram as well as the horizontal 20 runs.

				TIME DELAY				
	1	2	3	4	5	6	7	8
	PRESS	FLOW	QUALITY	FROTH	LIQUID	MEASURED	RATIO	TOP OFF TIME
#	(ATM)	(*g/sec*)	(% GAS)	(MIN)	(MIN)	(MIN)	(COL. 6/5)	(MIN)
1	1.6	10.5	60	2.7	18.5	16.0	.865	2.2
2	1.8	10.6	45	3.6	12.6	10.5	.832	~2.5
3	1.8	20.8	49	1.8	6.9	5.0	.721	1.5
4	1.8	30.2	51	1.2	5.0	3.0	.600	~1.3
5	1.8	44.	43	0.9	3.0	1.8	.600	1.2
6	1.8	44.	88	0.6	13.9	1.8	.129	1.9

TABLE I

The two 44. *g/sec* data points both appear to be near phase boundaries. The high liquid data point(#5) showed liquid hitting the upper pot 0.4 min. after hitting the lower pot; this is the only point that liquid reached the upper pot. The high gas point(#6) showed an effect that may have been a decreasing frequency wave action hitting the knife.

FUTURE PROGRAM

1. We will replace the load (drain) venturies with much larger ones to reduce flashing and choking.

2. We will redesign the load phase separators to eliminate all vertical legs with their possibility to set up gravitational induced pressure drops and flows.

3. We will run at flows $\geq$ 50 *g/sec* to find the Baker Diagram Froth and Stratified Boundaries.

jp

REV	DESCRIPTION	DRAWN / DATE APPD / DATE
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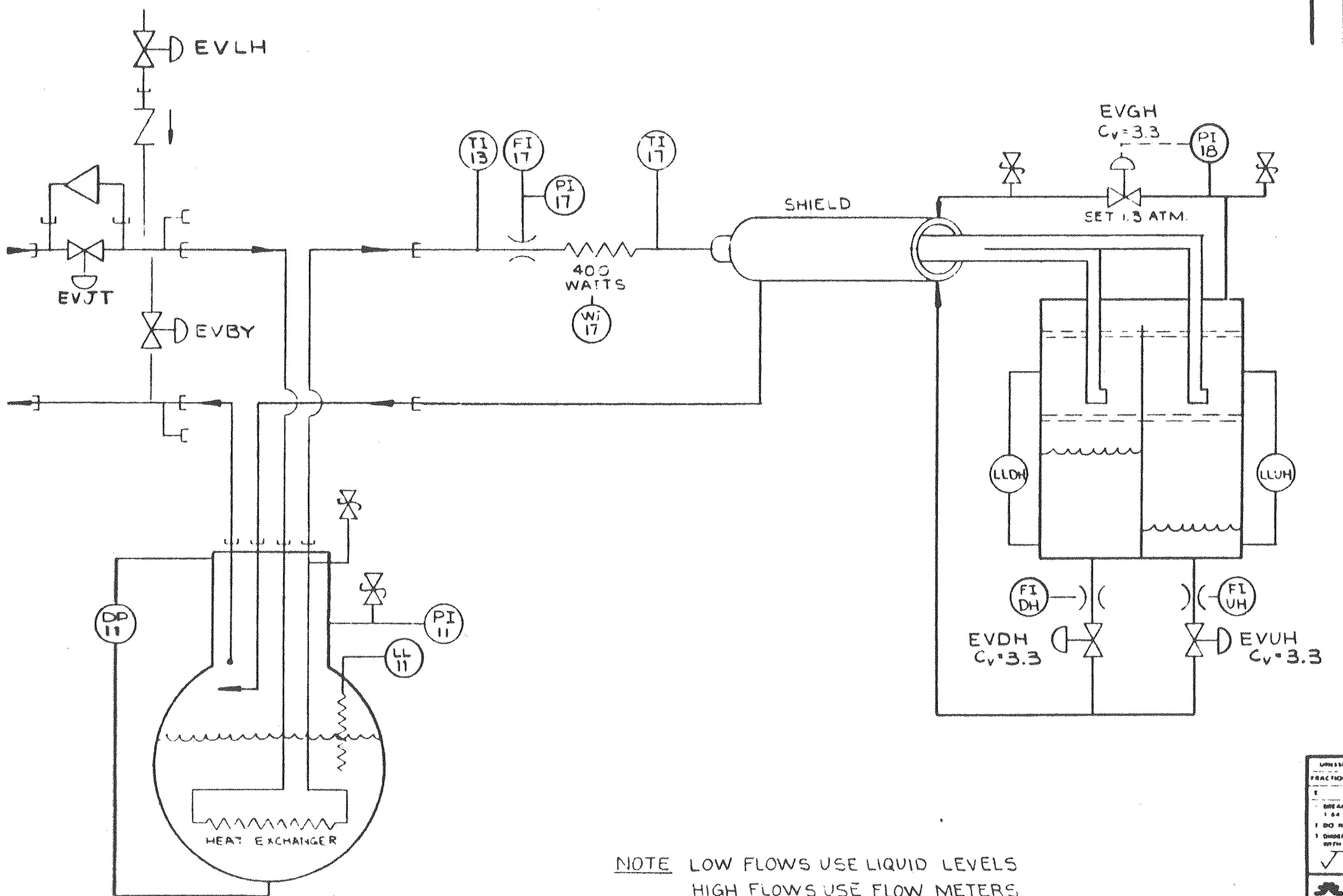


NOTE LOW FLOWS USE LIQUID LEVELS
HIGH FLOWS USE FLOW METERS

ORIGINATOR	J. THIELACHER	1-85
DRAWN	R.M. KMAK	1-8-85
CHECKED		
APPROVED		

UNLESS OTHERWISE SPECIFIED
1. BREAK ALL SHARP EDGES 1/64 MAX
2. DO NOT SCALE DWG
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5 STD.

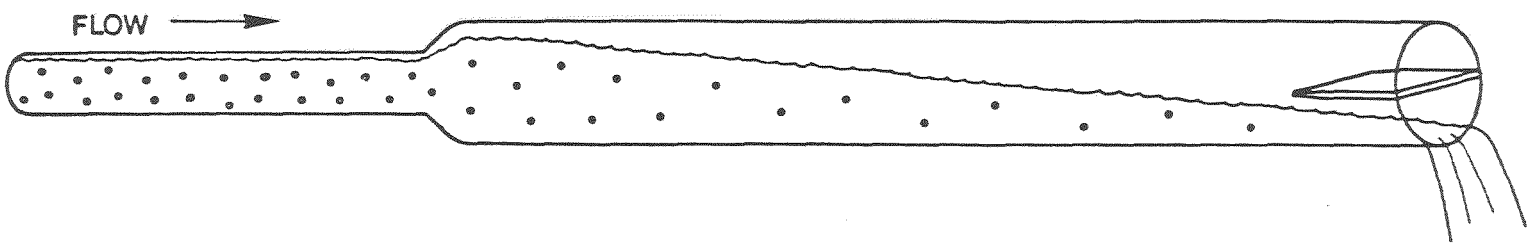
USED ON

MATERIAL

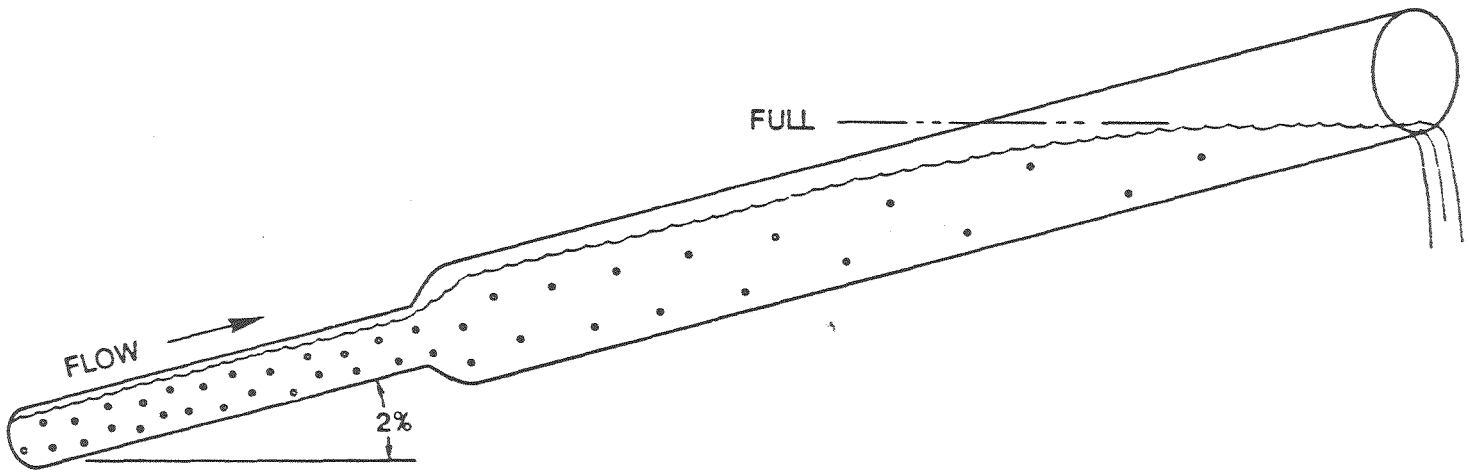
FERMI NATIONAL ACCELERATOR LABORATORY
U.S. DEPARTMENT OF ENERGY

SAVER CRYOGENIC SYSTEMS GROUP
"BR" TEST LINE SYSTEMS
SCHEMATIC

SCALE: NONE | DRAWING NUMBER: 1630-MB-168394 | REV: A



2Ø RUN



PHASE SEPARATION RUN

FIG. 1

9-17-85
CHR

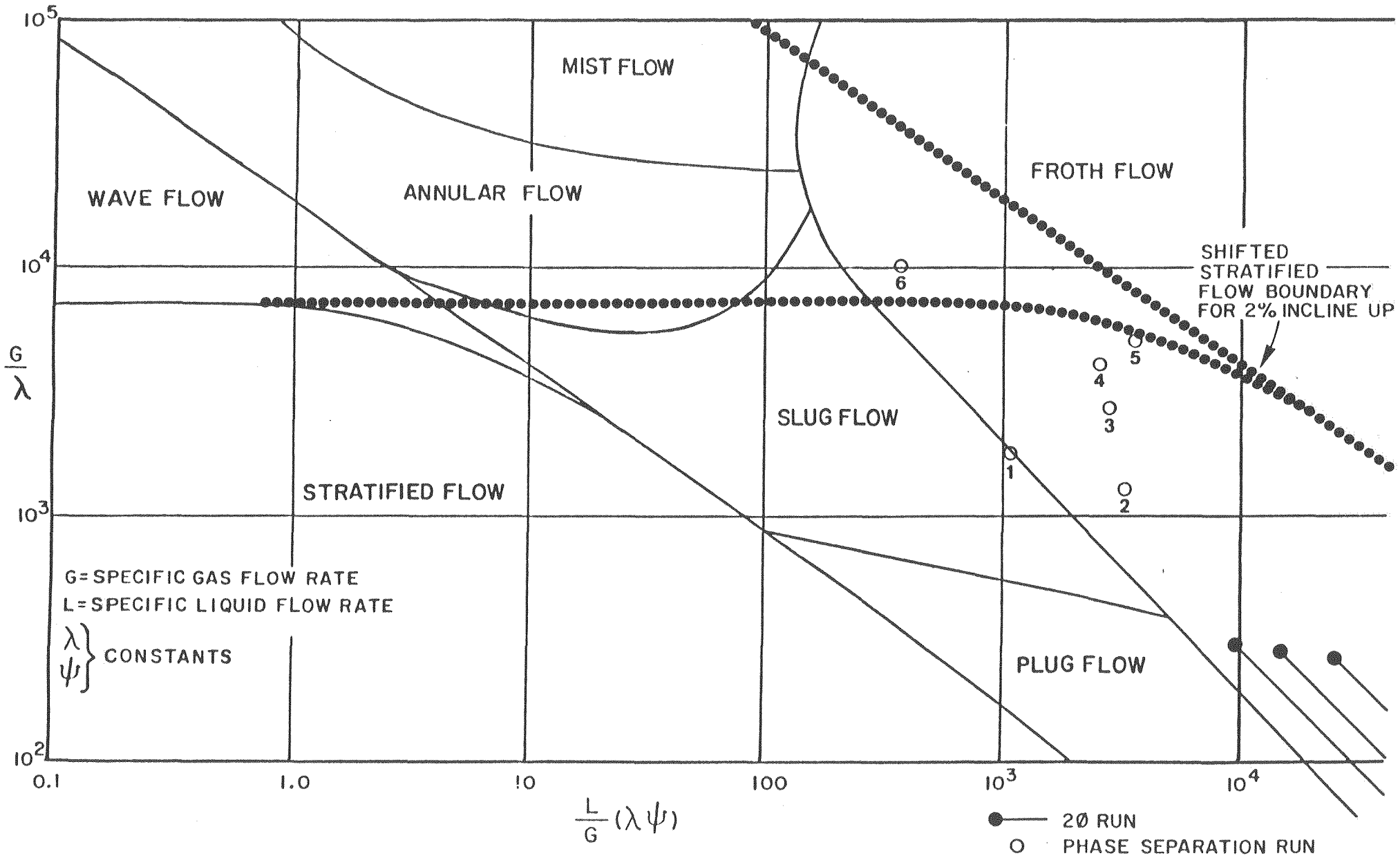


FIG. 2