

GENERAL ELECTRIC

SPACE DIVISION
PHILADELPHIA

ENCLOSURE 1

*CLASS. LTR.	OPER. NO.	PROGRAM	SEQUENCE NO.	REV. LTR.
U	1454		294	
PIR NO.				

PROGRAM INFORMATION REQUEST / RELEASE

*USE "C" FOR CLASSIFIED AND "U" FOR UNCLASSIFIED

FROM	L. Heverly, Specialist Analyzer Programs	TO	F.S. DiSanto, Manager Environmental Programs
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DATE SENT	DATE INFO. REQUIRED	PROJECT AND REQ. NO.	REFERENCE DIR. NO.
4/27/83			

SUBJECT	REPORT ON HYDROGEN SENSOR RESPONSE TO DYNAMIC HYDROGEN BUILDUP FOR SOUTHERN CALIFORNIA EDISON
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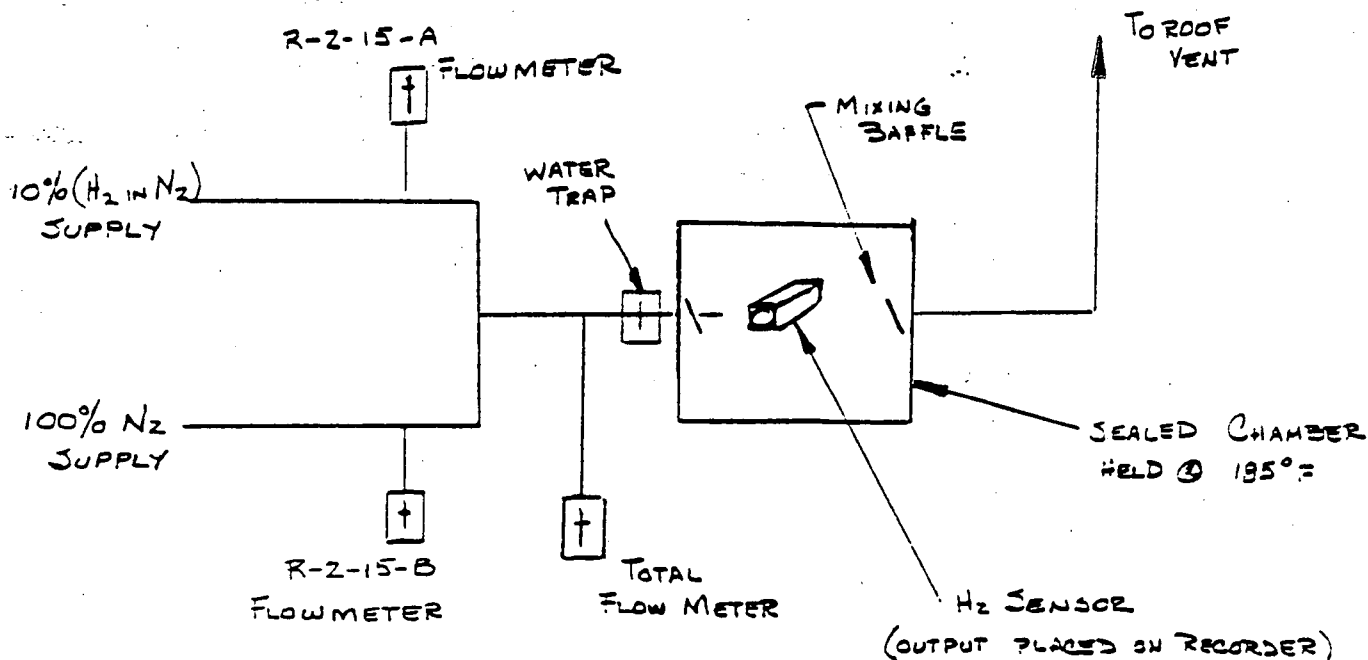
INFORMATION REQUESTED/RELEASED

This report outlines the testing conducted and the sensor response to a dynamic hydrogen environment (Figure C-10 attached). Testing was conducted on two separate hydrogen sensors GE Drawing 47E231417G4, Serial Nos. 815 and 812. Both runs with data is included.

Test environmental conditions:

Pressure = Ambient
Temp. = 185°F ± 5°F

Test set-up is shown below:



8307200205 830718
PDR ADOCK 05000361
P PDR

N. Cerone
L. Heverly

F. DiSanto
W. Bender

PAGE NO.

1 OF

RETENTION REQUIREMENTS

COPIES FOR	MASTERS FOR
<input type="checkbox"/> 1 MO.	<input type="checkbox"/> 3 MOS.
<input type="checkbox"/> 3 MOS.	<input type="checkbox"/> 6 MOS.
<input type="checkbox"/> 6 MOS.	<input type="checkbox"/> 12 MOS.
<input type="checkbox"/> MOS.	<input type="checkbox"/> MOS.
<input type="checkbox"/>	<input type="checkbox"/> DO NOT DESTROY

SENSOR CALIBRATION

Each sensor was calibrated with known hydrogen gases. These calibration runs are shown in data enclosed. Thru these data points a best fit straight line was drawn and used for reading sensor mv output vs. % hydrogen. Certified gases used for these runs were 100% Nitrogen (zero); 1.02% hydrogen in nitrogen; 2.10% Hydrogen in N₂; 4.00% hydrogen in N₂ and 10.2% hydrogen in N₂. It is to be noted that sensor calibration is more accurate within the 1.0 to 4.0% hydrogen range since network trimming on the sensor is carefully matched at that range. The 10 percent point is probably not as well compensated for.

TEST EQUIPMENT

- Sealed Test Chamber
- Regulating Flow Meter (Rotameter R-2-15A) (H₂ in N₂)
- Regulating Flow Meter (Rotameter R-2-15B) (N₂ Supply)
- Total Flow Meter (Kept at Constant Flow)
- Temperature Controller
- Chart Recorder
- Gas Supply 10% (H₂ in N₂)
- Gas Supply 100% N₂

TEST CONDITION

Two test runs were conducted with two different sensors (Serial Nos. 812 and 815) after sensor calibration. Sensors were installed in the chamber and chamber sealed. Per the test set-up shown, a total flow through the chamber was maintained at two (2) liters/minute at all times. The chamber was stabilized at 185°F. The regulating flow meters were then adjusted every five minutes to vary the hydrogen content of the flow to track Figure C-10. Flow meter calibration data is attached and settings for the flow meter is shown in figure titled Flow Meter setting for hydrogen content. Note: Total flow thru the chamber was kept fixed at 2 liters/minute. By adjusting the input flow meters every five minutes an approximation of the Figure C-10 was made.

Example: 100% flow of N₂ = ZERO hydrogen content

22.5% total flow of N₂ mixed with 77.5% total flow of
(10% H₂ in N₂) = 7.75% hydrogen content

As hydrogen content rose, sensor output versus time was recorded and plotted (see attached plot)

By picking off a millivolt output vs. time from this plot, a correlation to Hydrogen can be made from the calibration plot for each sensor. The percent hydrogen reading of the sensor output was then plotted against the Figure C-10. See attached plots.

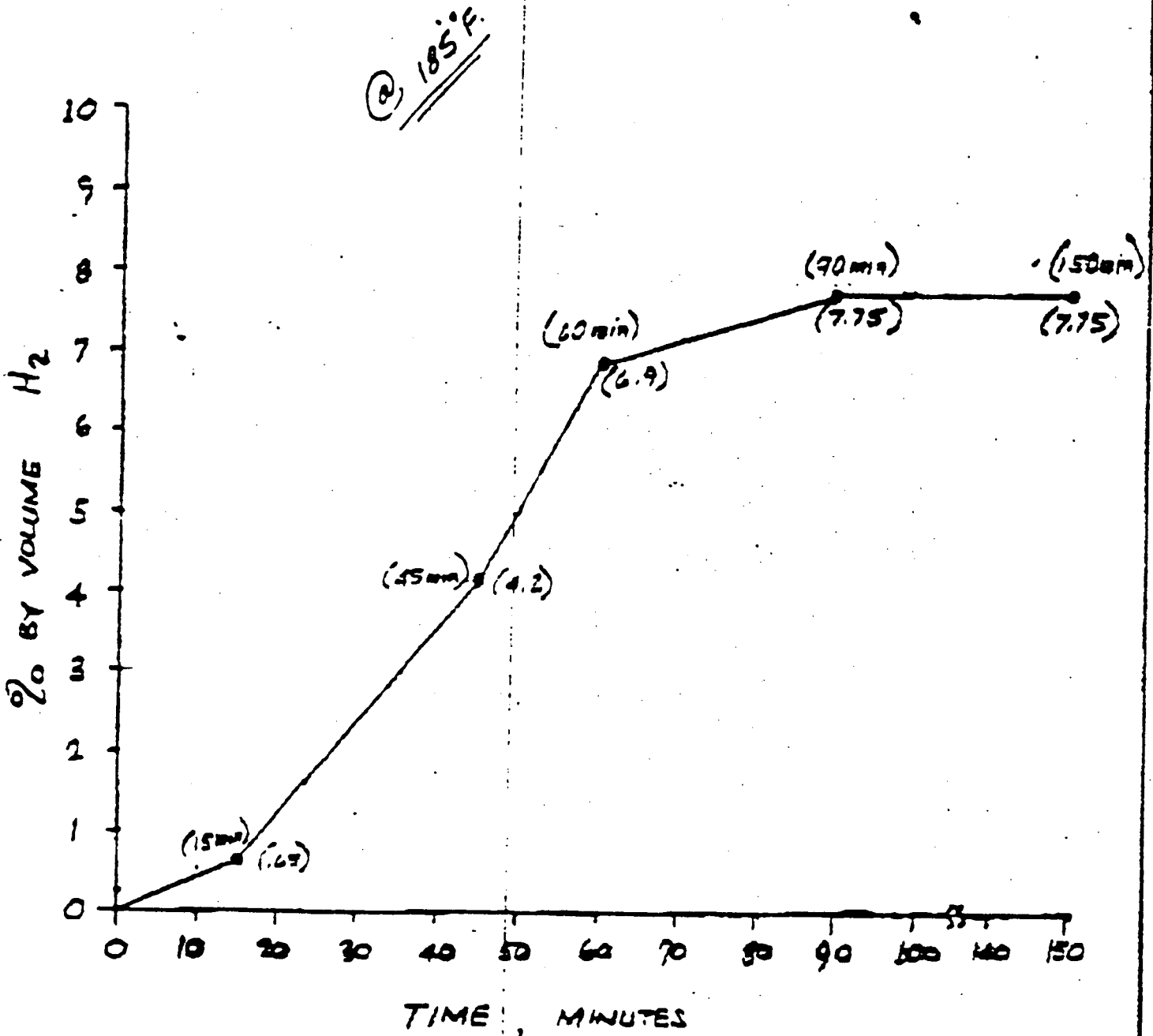
SUMMARY AND CONCLUSIONS

As can be seen from Run #1 and #8, the sensor tracks the hydrogen buildup as would be expected. The ramps in Figure C-10 are very fast buildups up to the 7.75 percent point. The sensor responds but does not have time to achieve a steady state reading. In the one hour period at the 7.75 percent hydrogen dwell, the sensor output does achieve a steady state output and does close on the Figure C-10 ideal curve. See figures titled H₂ Sensor Trace vs. Dynamic Buildup (H₂ in N₂).

CALCULATION SHEET

LWS 8814 8-71

SIGNATURE B. DUNCIL DATE 4-6-83 CHECKED _____ DATE _____
 PROJECT SONGS 2+3 JOB NO. 10079
 SUBJECT NUREG 2540 FIGURE C-10 SHEET 1 OF _____ SHEETS



FLOW METER SETTING FOR HYDROGEN CONTENT

TIME	%H ₂	N ₂ 215B		215A	
		51.3 = 2 LIT/MIN		84.7 = 2 LIT/MIN	
		SCALE	% Sample	SCALE	% Sample
0	0				
5	.3	49.7	(.97)	6.6	(.03)
10	.5	48.65	.95	9.8	.05
15	.65	47.825	.935	12.15	.065
20	1.1	45.45	.89	17.1	.11
25	1.5	43.45	.85	20.3	.15
30	2.2	40	.78	25.8	.22
35	3.0	36.1	.7	31.9	.3
40	3.5	33.6	.65	35.3	.35
45	4.2	30.2	.58	39.5	.42
50	5.2	25.4	.48	47.2	.52
55	6.2	20.5	.38	54.1	.62
60	6.9	17.15	.31	59.0	.69
65	7.2	15.7	.28	61.3	.72
70	7.35	15.025	.265	62.5	.735
75	7.5	14.3	.25	63.7	.75
80	7.6	13.8	.24	64.5	.76
85	7.7	13.35	.23	65.3	.77
90	7.75	13.125	.225	65.75	.775



ROAMETER CALIBRATION DATA



BROOKS INSTRUMENT DIVISION
EMERSON ELECTRIC CO.
MATFIELD, PENNSYLVANIA 18440

CUSTOMER		CUSTOMER ORDER NUMBER	BROOKS SERIAL NUMBER

MAX. FLOW	MIN. FLOW	UNITS	METERED FLUID	DATE
1.72	.01	STD. LIT./MIN.	NITROGEN	20 OCT 1972

MODEL NUMBER		METERING TEMPERATURE	70.00	DEG.F
TUBE NUMBER	R-2-15-A	METERING PRESS., ABS.	14.70	PSI
FLOAT NUMBER	SPHERICAL	METERING DENSITY	.001160	GMS/CC
FLOAT MATERIAL	SIL.ST.316	FLOAT DENSITY	8.040	GMS/CC
STD. CONDITIONS	1 ATMOS. & 70°F	DENSITY AT STD. COND.	.001160	GMS/CC
PERF. CURVE NO.	0040	METERING VISCOSITY	.0175c	CP.

DESCRIPTION

STD. LIT./MIN.									
FLOAT ELEVATION	FLOW	FLOAT ELEVATION	FLOW	FLOAT ELEVATION	FLOW	FLOAT ELEVATION	FLOW	FLOAT ELEVATION	FLOW
149.7--		112.5--		77.7--		47.2--		17.9--	
148.7--		111.6--		76.9--		46.5--		17.1--	
147.8--	1.70	110.7--	1.30	76.0--	.90	45.8--	.50	16.3--	.10
146.9--		109.8--		75.1--		45.1--		15.5--	
145.9--		108.9--		74.3--		44.4--		14.5--	
145.0--		108.0--		73.5--		43.7--		12.9--	
144.1--		107.1--		72.7--		43.0--		11.4--	
143.1--	1.55	106.2--	1.25	71.9--	.85	42.3--	.45	9.8--	.05
142.2--		105.3--		71.0--		41.6--		8.2--	
141.3--		104.4--		70.2--		40.9--		6.6--	
140.3--		103.5--		69.4--		40.2--		5.1--	
139.4--		102.7--		68.6--		39.5--		3.5--	
138.5--	1.50	101.8--	1.20	67.8--	.50	38.8--	.40		
137.5--		101.0--		67.0--		38.1--			
136.6--		100.1--		66.2--		37.4--			
135.7--		99.3--		65.3--		36.7--			
134.7--		98.4--		64.5--		36.0--			
133.8--	1.55	97.6--	1.15	63.7--	.75	35.3--	.35		
132.8--		96.7--		62.9--		34.6--			
131.9--		95.9--		62.1--		33.9--			
131.0--		95.0--		61.3--		33.2--			
130.0--		94.2--		60.5--		32.5--			
129.1--	1.50	93.3--	1.10	59.7--	.70	31.8--	.30		
128.2--		92.5--		59.0--		31.1--			
127.2--		91.6--		58.3--		30.4--			
126.3--		90.8--		57.6--		29.7--			
125.3--		89.9--		56.9--		28.9--			
124.4--	1.45	89.1--	1.05	56.2--	.65	28.1--	.25		
123.5--		88.2--		55.5--		27.3--			
122.5--		87.3--		54.8--		26.5--			
121.6--		86.4--		54.1--		25.8--			
120.7--		85.6--		53.4--		25.0--			
119.7--	1.40	84.7--	1.00	52.7--	.60	24.2--	.20		
118.8--		83.8--		52.0--		23.4--			
117.9--		83.0--		51.3--		22.6--			
117.0--		82.1--		50.6--		21.8--			
116.1--		81.2--		49.9--		21.0--			
115.2--	1.35	80.4--	.95	49.3--	.55	20.3--	.15		
114.3--		79.5--		48.6--		19.5--			
113.4--		78.7--		47.9--		18.7--			

ROTAMETER CALIBRATION DATA



BROOKS INSTRUMENT DIVISION
EMERSON ELECTRIC CO.
MATFIELD, PENNSYLVANIA 19440

CUSTOMER			CUSTOMER ORDER NUMBER	BROOKS SERIAL NUMBER

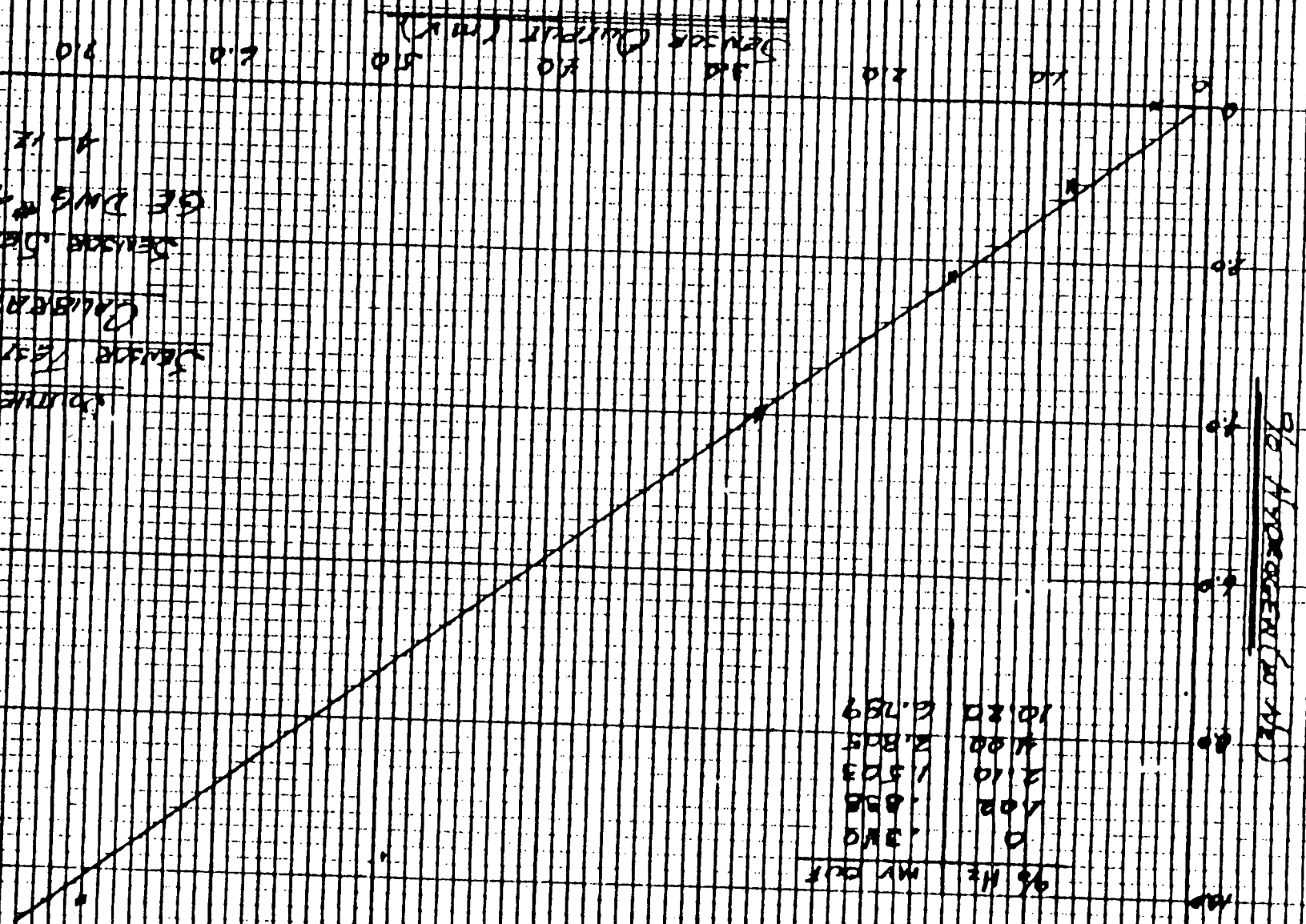
MAX FLOW	MIN FLOW	UNITS	METERED FLUID	DATE
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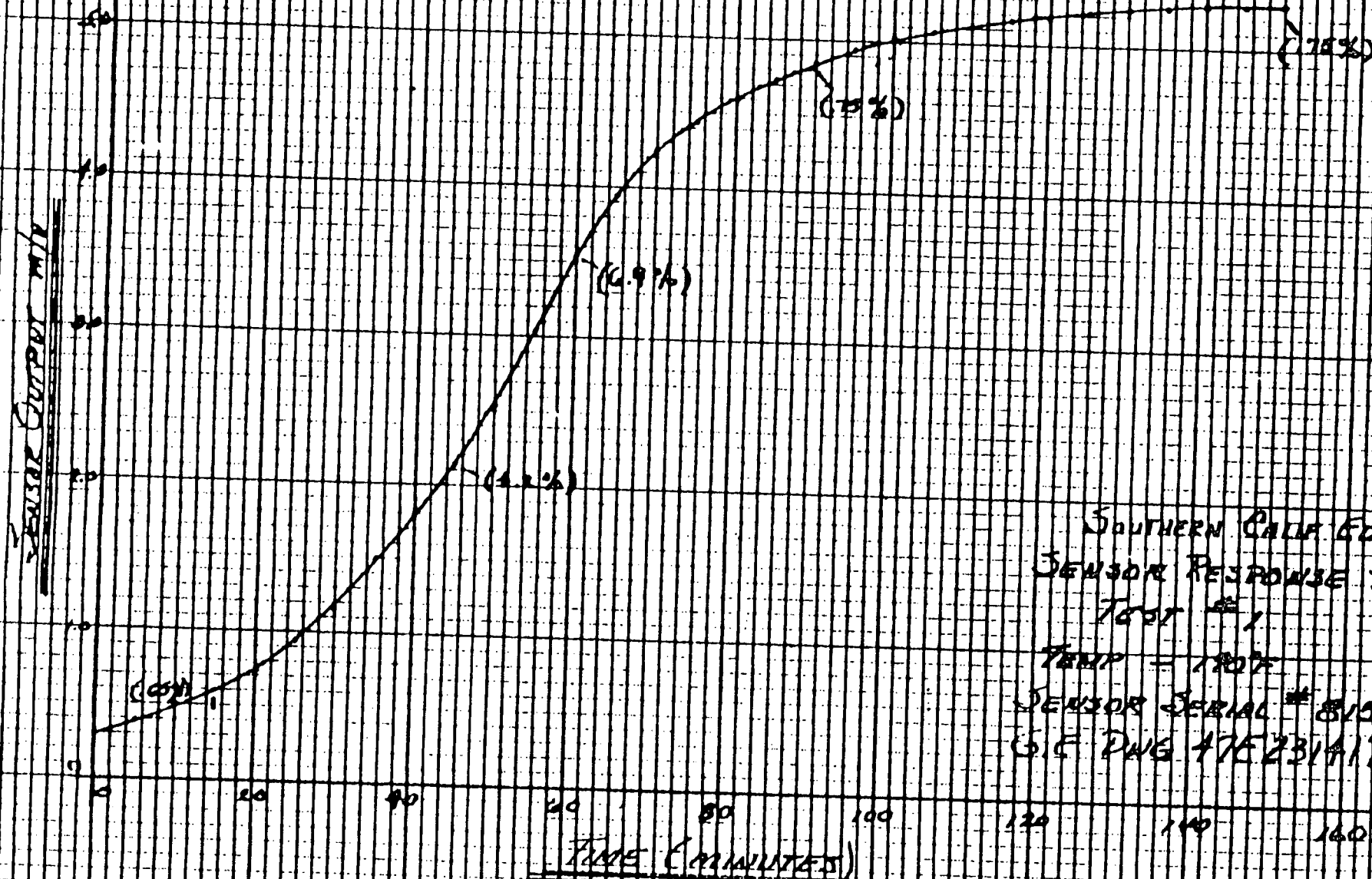
MODEL NUMBER		METERING TEMPERATURE	70.00	DEG.F
TUBE NUMBER	R-2-15-B	METERING PRESS., ABS.	14.70	PSI
FLOAT NUMBER	SPHERICAL	METERING DENSITY	.001160	GMS/CC
FLOAT MATERIAL	GLASS	FLOAT DENSITY	2.540	GMS/CC
STD. CONDITIONS	1 ATMOS. & 70°F	DENSITY AT STD. COND.	.001160	GMS/CC
PERF. CURVE NO.	0050	METERING VISCOSITY	.01752	CP.

STD. LIT./MIN.

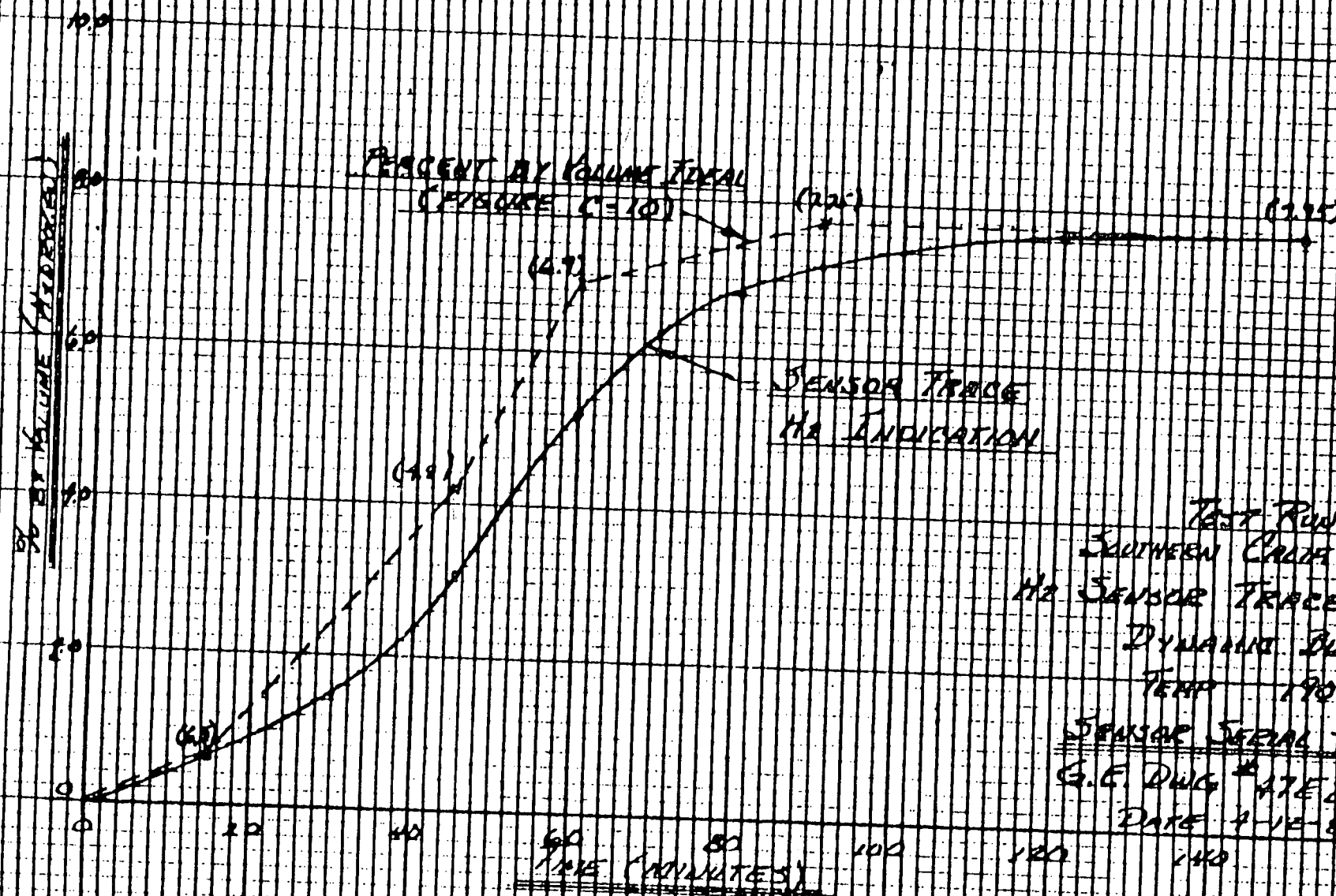
FLOAT ELEVATION	FLOW	FLOAT ELEVATION	FLOW	FLOAT ELEVATION	FLOW	FLOAT ELEVATION	FLOW
148.9----	2.4	87.9----	1.6	41.0----	.8		
147.0--		86.6--		40.0--			
145.2--		85.3--		39.0--			
143.3--		83.9--		38.0--			
141.5--		82.6--		37.1--			
139.6----	2.3	81.2----	1.5	36.1----	.7		
137.8--		79.9--		35.1--			
135.9--		78.6--		34.1--			
134.2--		77.2--		33.1--			
132.7--		75.9--		32.1--			
131.1----	2.2	74.6----	1.4	31.2----	.6		
129.6--		73.3--		30.2--			
128.0--		72.1--		29.2--			
126.5--		70.9--		28.2--			
124.9--		69.7--		27.3--			
123.4----	2.1	68.4----	1.3	26.3----	.5		
121.6--		67.2--		25.4--			
120.3--		66.0--		24.4--			
118.7--		64.7--		23.4--			
117.1--		63.5--		22.5--			
115.6----	2.0	62.3----	1.2	21.5----	.4		
114.0--		61.0--		20.5--			
112.5--		59.8--		19.6--			
110.9--		58.8--		18.6--			
109.4--		57.7--		17.6--			
107.6----	1.9	56.6----	1.1	16.7----	.3		
106.2--		55.6--		15.7--			
104.7--		54.5--		14.8--			
103.5--		53.4--		13.8--			
102.2--		52.4--		12.9--			
100.9----	1.8	51.3----	1.0	12.0----	.2		
99.6--		50.2--		11.1--			
98.3--		49.2--		10.2--			
97.0--		48.1--		9.3--			
95.7--		47.0--		8.4--			
94.5----	1.7	46.0----	.9	7.4----	.1		
93.2--		44.9--		6.5--			
91.9--		43.9--		5.6--			
90.8--		43.0--		4.7--			
89.6--		42.0--		3.8--			

10114723141762
 4-12-83
 DEWIDE TEST RAIL #1
 CALIBRATION @ 1001
 DEWIDE TEST RAIL #1
 DEWIDE TEST RAIL #1
 DEWIDE TEST RAIL #1

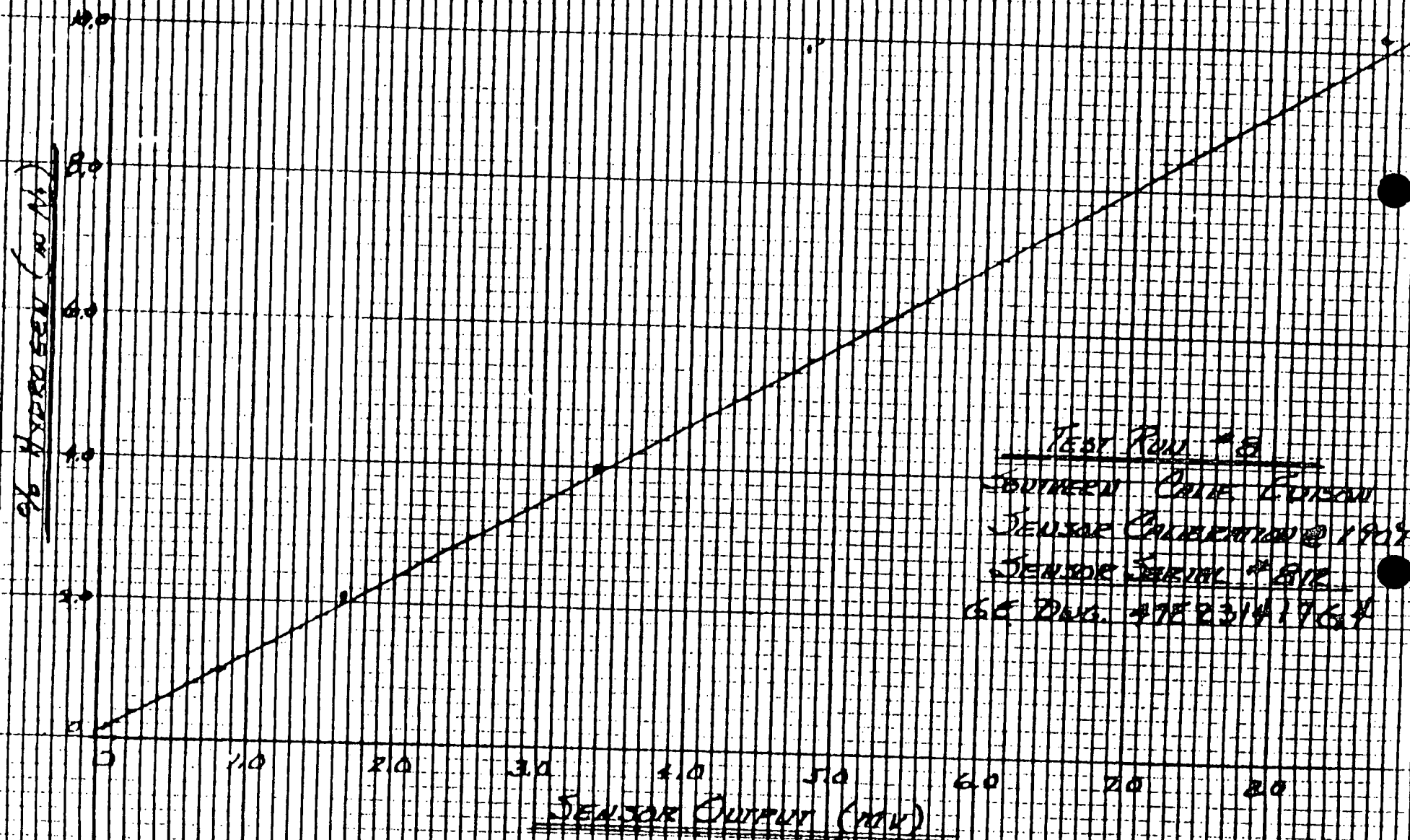




SOUTHERN CALIF EDISON
SENSOR RESPONSE TO N_2
TEST #1
TEMP = 180°F
SENSOR SERIAL # 815
S.E. DWG 47E231A17G4



TEST RUN #1
SOUTHERN CRUISE FIDSON
H₂ SENSOR TRACE 15.
DYNAMIC DUNDUP/H2 WIND
TEMP 190°F
SENSOR SERIAL #815
G.E. DWG #ATE23144764
DATE 4-15-83



SENSOR CALIBRATION RUN

PAGE:

DESCRIPTION: SPN ONOPR25

RUN # 7

REMARKS: CALIBRATION FOR T651 #8

185° (WET)

ENG.

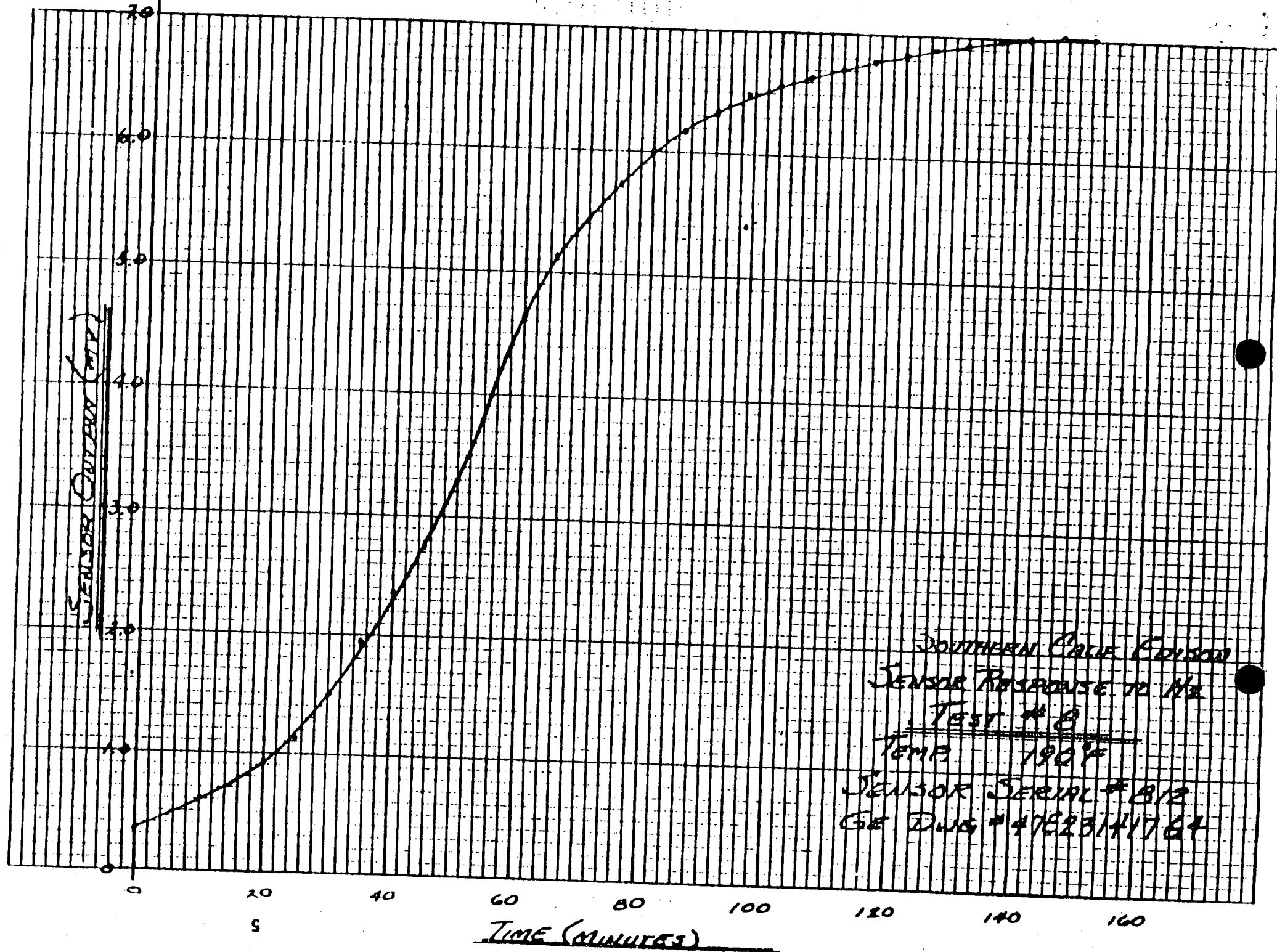
TECH.

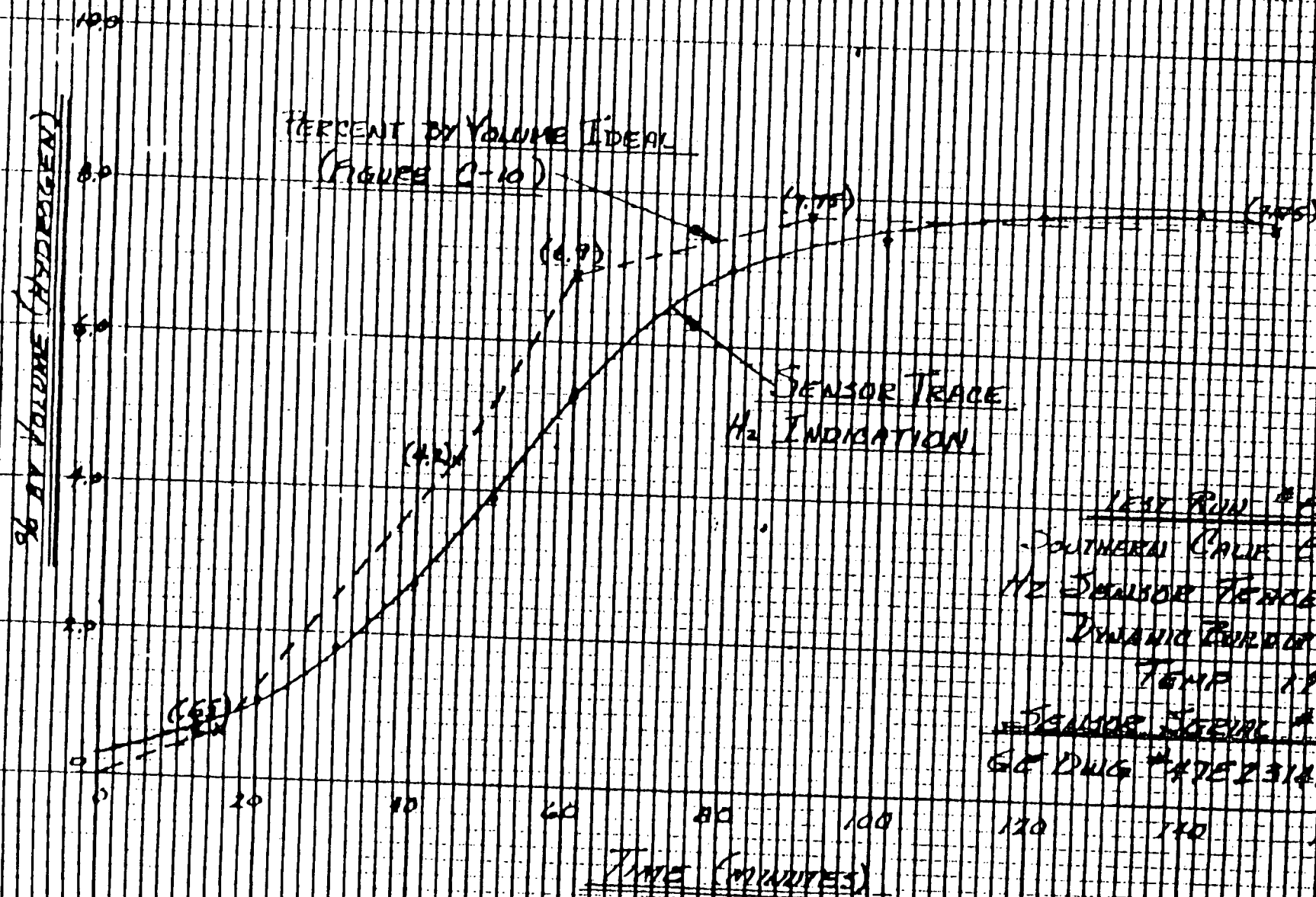
DATE: 4-20-83

TIME	GAS	#	812	PORT	m/z	GAS	#	812		
0	N ₂		265							
5	1.02%		490	225	2.0	2.10%		1.156	.941	
10			680	415	.002	2.10%		1.375	1.11	
15			757	1142	.412			1.481	1.216	
20		STAR	(504)	537	.528			1.544	1.279	
25			834	569	.558			1.589	1.324	
30			856	.591	.579		STAR	(624)	1.209	
35			876	6"	.549			1.652	1.317	
40			891	.626				1.678		
45			901					1.701		
50			912					1.720		
55			920					1.741		
60			927					1.759		
TIME	GAS	#	812			GAS	#	812		
5	4.4%		2.225			102%		4.870	5.55	8.944
10			2.670					6.406	2.57	8.972
15			2.917					7.094		8.998
20			3.006					7.406		8.998
25			3.100					7.701		8.998
30			3.174					7.875		8.998
35			3.239					8.026		8.998
40			3.284	3.019				8.153		8.998
45			3.327	3.002				8.277		8.998
50		STAR	(3.368)	3.003				8.404		8.998
55			3.401	3.006				8.526		8.998
60			3.427					8.592		8.998
65			3.453					8.671		8.998
70			3.475					8.721		8.998
75			3.498					8.777		8.998
80			3.521					8.829		8.998
85								8.870		8.998
90								8.910		8.998

CONT. FROM:

CONT. TO:





TEST RUN #3
SOUTHERN CALIF EDISON
H₂ SENSOR TRACE VS.
DYNAMIC BURST (H₂ INLET)
TEMP 190°F
SENSOR SERIAL #312
GE DUG #47523141764

4-22-83

Hydrogen % by Volume

