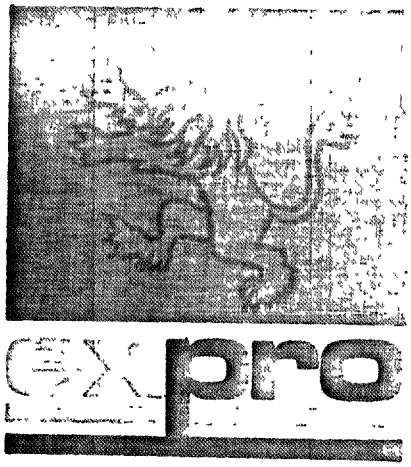


Customer	:	Statoil
Field	:	34/10-8
Expro Ref.	:	STAT/235/Amended
Date	:	28.10.80.

laboratory report

Exploration and Production Services (North Sea) Ltd

P.V.T LABORATORY 48 QUEENS ROAD READING RG1 4AU

TELEPHONE: READING (0734) 57433 TELEX: 849447

CONTENTS

Description of Experiments

1. The saturation pressure of the bottom hole sample in container 14068/45 was measured at ambient temperature (FIGURE 1)

2. A quantity of sample was flashed from the container and the resulting oil and gas analysed for reservoir fluid composition (TABLE 3)

3. Approximately 40cc of sample was charged to a Ruska visual cell. The validity of the sample was checked by doing a bubble point run @ ambient. The sample was then heated to reservoir temperature 73^{o}C, and a PV relationship carried out followed by a differential vapourisation. The resulting gases were then analysed by chromatograph (TABLE 4,5,6; FIGURES 2,3,4,5,6,7).

4. A Ruska rolling ball viscometer was charged with a portion of the sample and the viscosity determined at reservoir temperature, above and below the saturation pressure (TABLE 7; FIGURE 8).

TABLE 1

Sampling Details

Well	:	34/10-8
Reservoir Pressure	:	312 Abs. Bars.
Reservoir Temperature	:	$73^{o}C$

TABLE 2

Single Stage Flash at 18°C from 483 ABS.Bars to Atmospheric Pressure

Temperature	:	18°C
GOR. SCF/STB	:	656
Gas Gravity (Air = 1.0)	:	0.681
Oil Density @ 15°C, kg/m^3	:	884

TABLE 3

Reservoir Fluid Composition

Component	Residual Oil wt % in oil	Residual Oil wt % in reservoir fluid	Gas wt % in gas	Gas wt % in reservoir fluid	Reservoir Flui wt %	Reservoir Flui mol %
N_2	-	-	1.68	0.17	0.17	0.70
CO_2	-	-	3.71	0.37	0.37	0.96
C_1	-	-	69.77	6.92	6.92	49.56
C_2	-	-	10.39	1.03	1.03	3.93
C_3	-	-	3.08	0.31	0.31	0.81
iC_4	0.01	0.01	2.06	0.20	0.21	0.41
nC_4	0.05	0.04	2.83	0.28	0.32	0.63
iC_5	0.10	0.09	1.83	0.18	0.27	0.43
nC_5	0.18	0.16	0.59	0.06	0.22	0.35
C_6	0.48	0.43	1.35	0.13	0.56	0.75
C_7	2.48	2.23	1.83	0.18	2.41	2.76
C_8	3.98	3.58	0.70	0.07	3.65	3.67
C_9	4.94	4.45	0.01	0.01	4.47	4.00
C_{10+}	87.79	79.08	-	-	79.08	31.03

Av. Mol. Wt. C_{10+} : 292

TABLE 4

PV Relationship at 73°C

Pressure, Abs. Bars	Relative Volume VBP at 73°C = 1.00	Fluid Density kg/m^3
490	0.968	768
450	0.981	765
410	0.985	762
380	0.988	760
350	0.993	757
320	0.995	755
* 312	0.996	754
300	0.998	753
279 (Saturation Pressure)	1.000	751
270	1.006	747
240	1.031	729
210	1.067	704
180	1.120	671
150	1.203	624
120	1.341	560
90	1.594	471
60	2.146	350
30	3.926	191
20	5.760	130

* Reservoir pressure

Coefficient of Compressibility above saturation pressure (between 312 and 279 Abs.Bars = 1.12×10^{-4} m^3/m^3/bars

TABLE 5

Differential Vapourisation at 73°C

Pressure, Abs. Bars	Oil Volume Factor,[1] Bo	Cumulative Solution G.O.R.[2]	Gas Compressibility Factor, Z	Gas Gravity (Air = 1.0)	Fluid Density, Kg/m^3
490	1.277				768
450	1.281				765
410	1.286				762
380	1.291				760
350	1.295				757
320	1.299				755
* 312	1.301				754
300	1.303				753
** 279	1.305	641.7			751
236	1.268	545.7	0.931	0.656	761
197	1.235	456.2	0.900	0.626	771
158	1.203	369.8	0.890	0.625	783
119	1.170	283.0	0.907	0.619	794
79	1.139	197.3	0.938	0.624	806
40	1.107	109.2	0.974	0.640	817
1	1.055	-	1.000	0.883	836

Specific gravity of residual oil at 15°C = 0.8829 = 28.68 °API

[1]Oil Volume Factor, Bo:- Volume of cell conditions per volume of Stock tank oil at STP

[2]Solution Gas Oil Ratio, Rs :- Gas volume in SCF per barrel of stock tank oil at STP

TABLE 6

Composition of Gases Evolved during Differential Vapourisation

Stage	1	2	3	4	5	6	
Pressure Abs.Bars	236	197	158	119	79	40	1
Component	Mol. %						
N_2	1.94	1.82	1.64	1.40	0.62	0.58	1.91
CO_2	1.45	1.42	1.43	1.58	1.70	2.00	2.79
C_1	91.03	91.66	91.79	91.82	91.63	89.05	67.27
C_2	3.71	3.62	3.80	4.02	4.72	6.49	16.63
C_3	0.51	0.45	0.45	0.47	0.53	0.79	4.01
iC_4	0.24	0.21	0.20	0.20	0.22	0.31	2.29
nC_4	0.20	0.16	0.15	0.16	0.16	0.24	1.96
iC_5	0.16	0.13	0.13	0.11	0.11	0.15	1.45
nC_5	0.06	0.04	0.04	0.04	0.04	0.05	0.45
C_6	0.11	0.10	0.08	0.09	0.06	0.09	0.48
C_7	0.27	0.20	0.13	0.12	0.12	0.14	0.56
C_8	0.21	0.11	0.13	0.07	0.07	0.08	0.17
C_9	0.11	0.08	0.03	0.02	0.02	0.03	0.03

TABLE 7

Viscosity Determined at Reservoir Temperature, 73°C

Abs.Bars.	Viscosity, cP
410	1.76
390	1.74
370	1.72
350	1.71
330	1.70
*312	1.69
290	1.68
260	1.68
230	1.70
200	1.75
170	1.83
140	1.95
110	2.09
80	2.26
50	2.54
20	3.07
11	3.60

* Reservoir Pressure

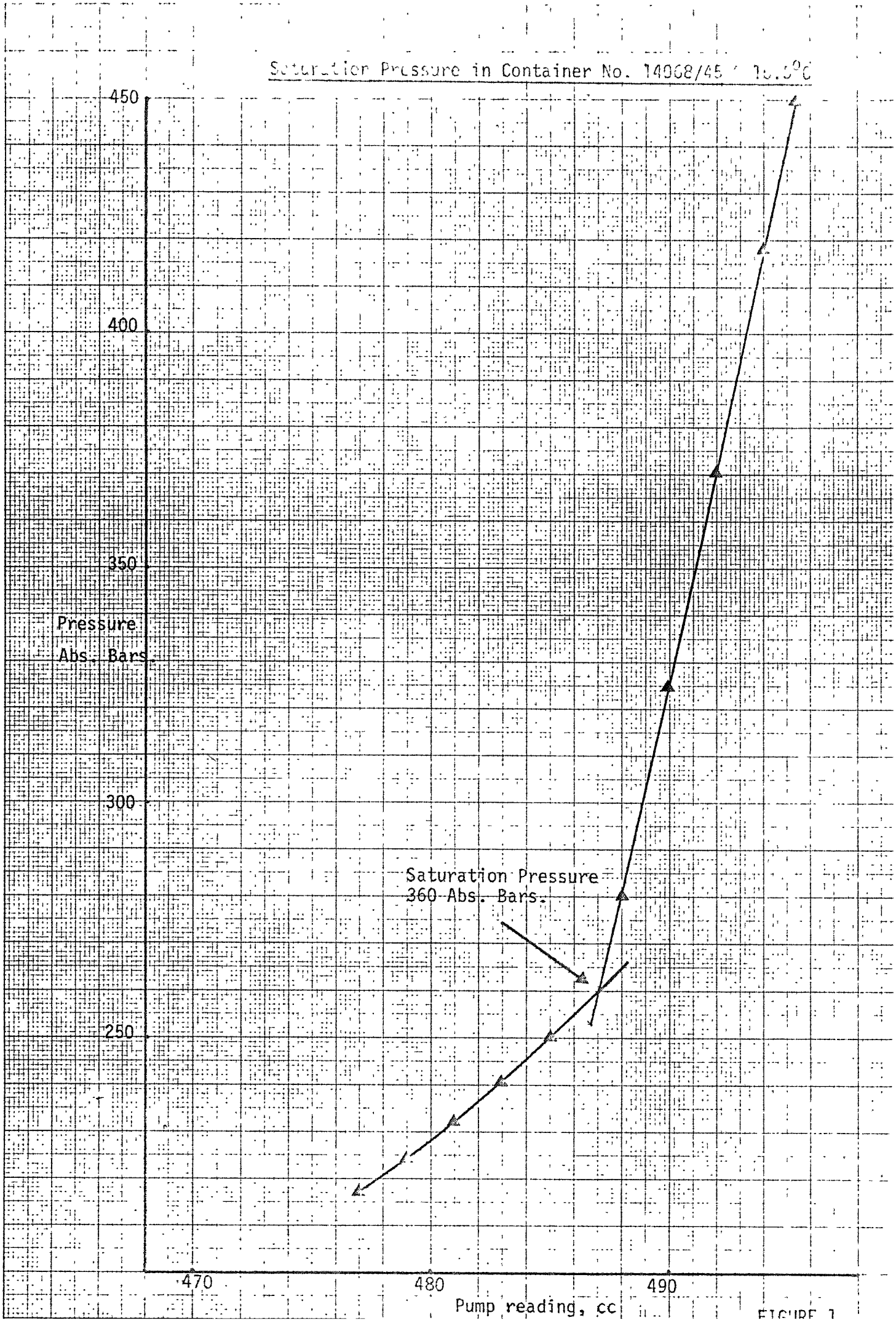

Saturation Pressure in Container No. 14068/45 ' 10.0°C
450
400
350
300
250
Pressure
Abs. Bars
Saturation Pressure
360 Abs. Bars.
470
480
490
Pump reading, cc

FIGURE 1

PV Relationship at 73°C

Fluid Density v Pressure above the Saturation Pressure

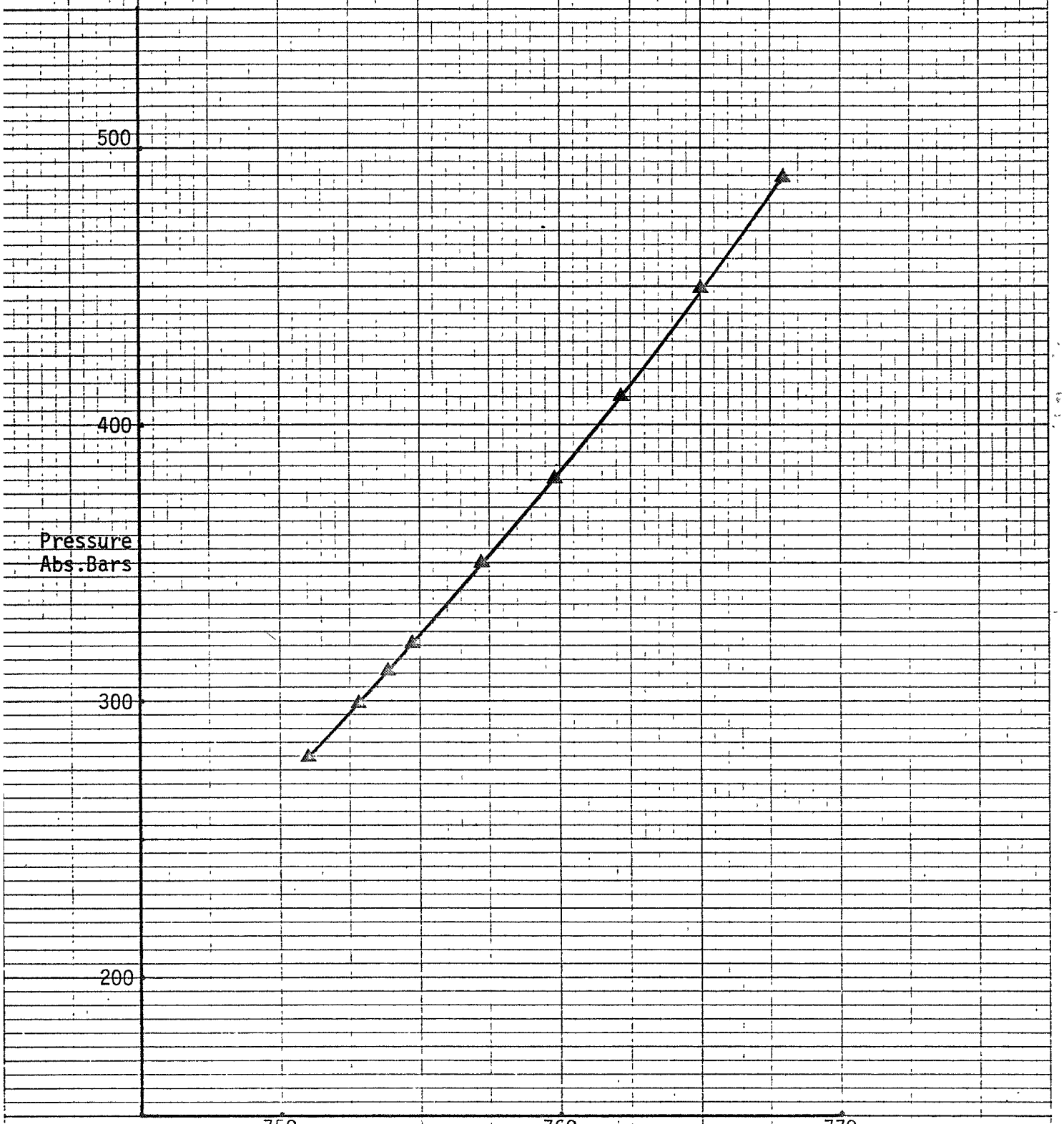


FIGURE 2

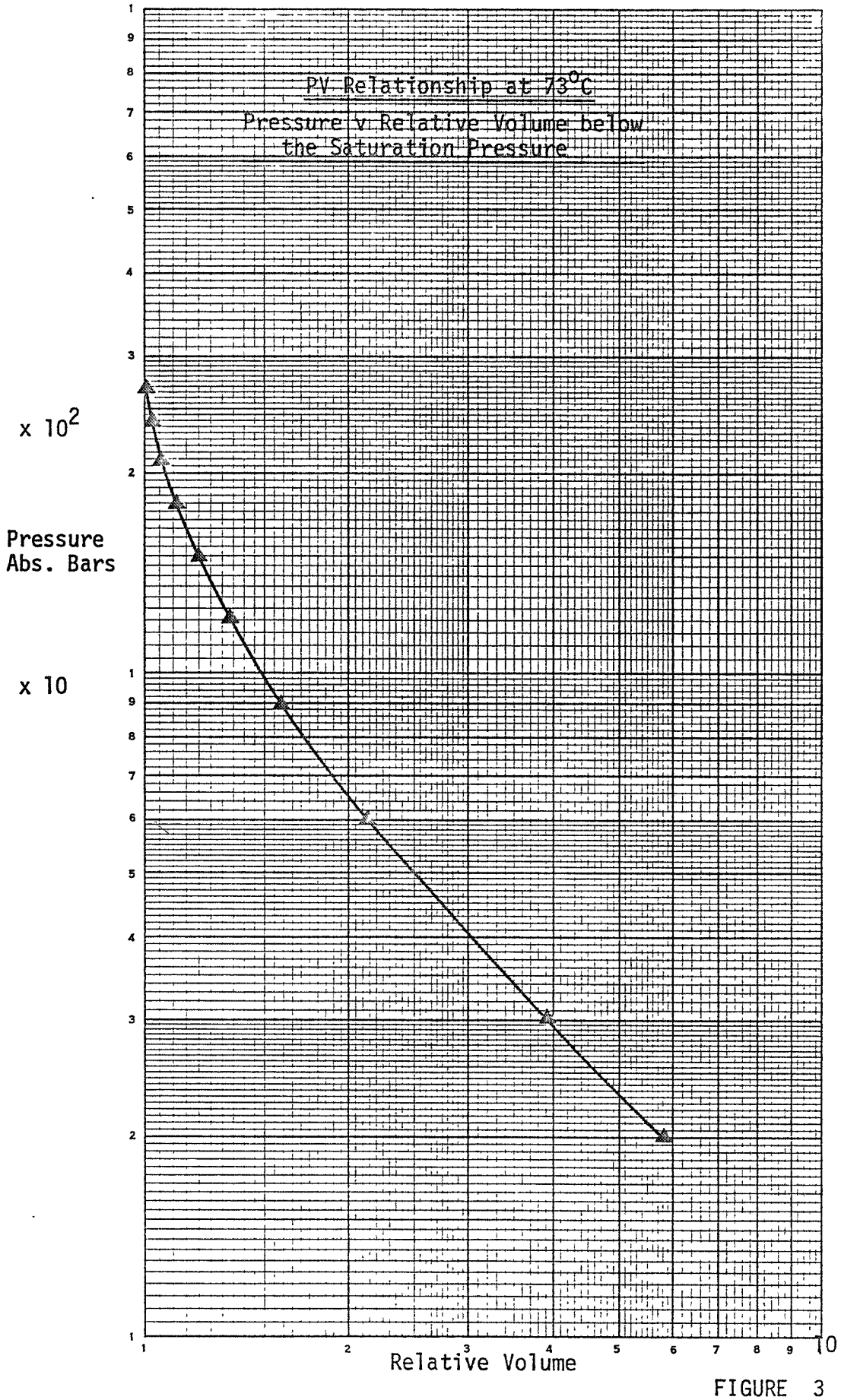

PV Relationship at 73°C
Pressure v Relative Volume below the Saturation Pressure
x 10²
Pressure Abs. Bars
x 10
Relative Volume
10

FIGURE 3

Differential Vapourisation @ 73°C

Gas Deviation Factor Z v Pressure

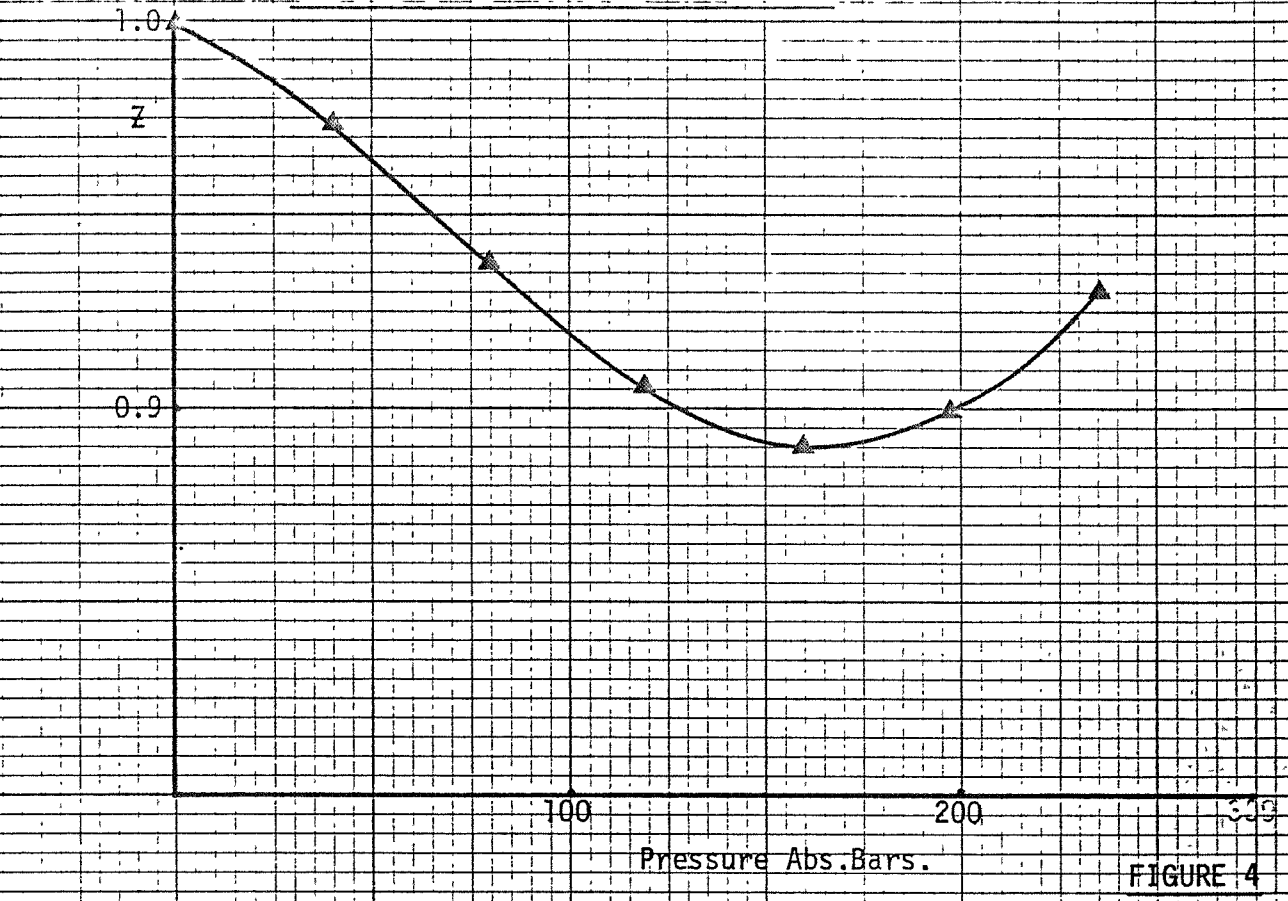


FIGURE 4

Gas Gravity (Air = 1.00) v Pressure

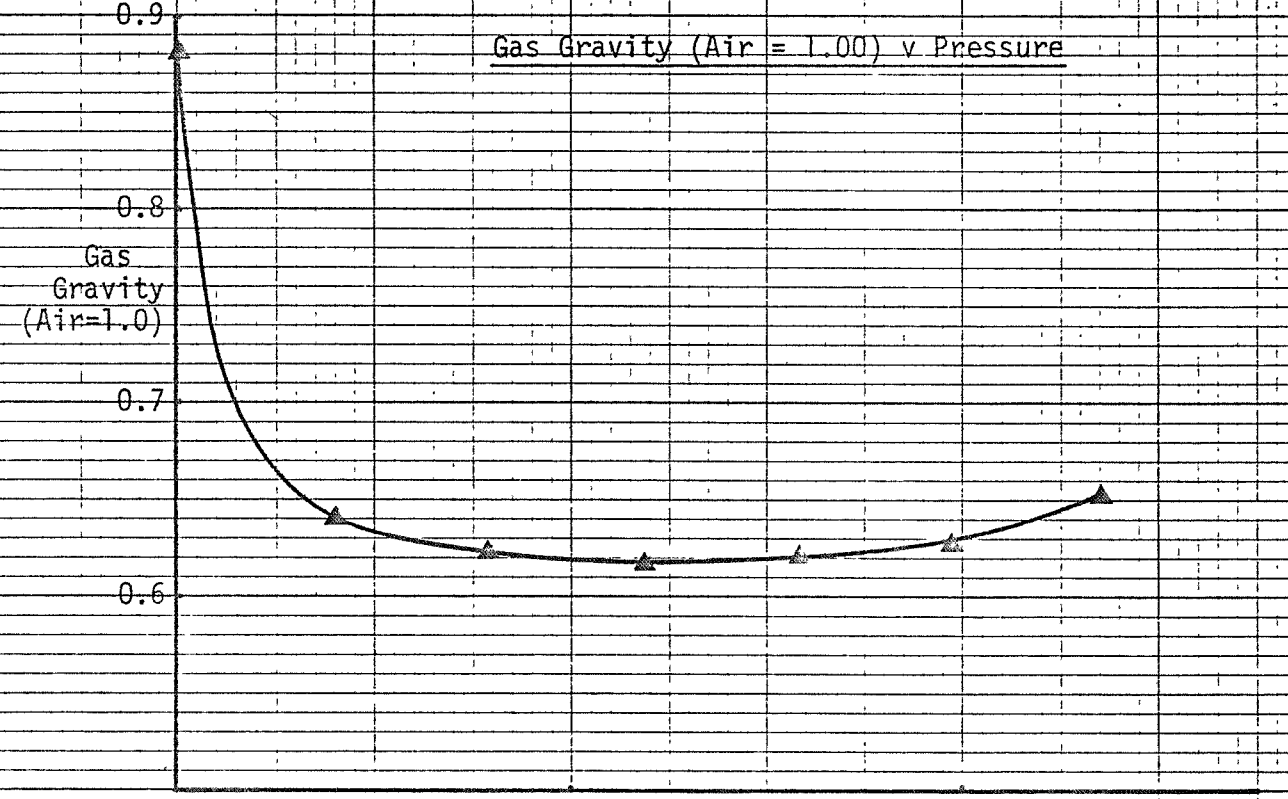


FIGURE 5

Differential Vaporisation at 73°C

Oil Volume Factor Bo v Pressure

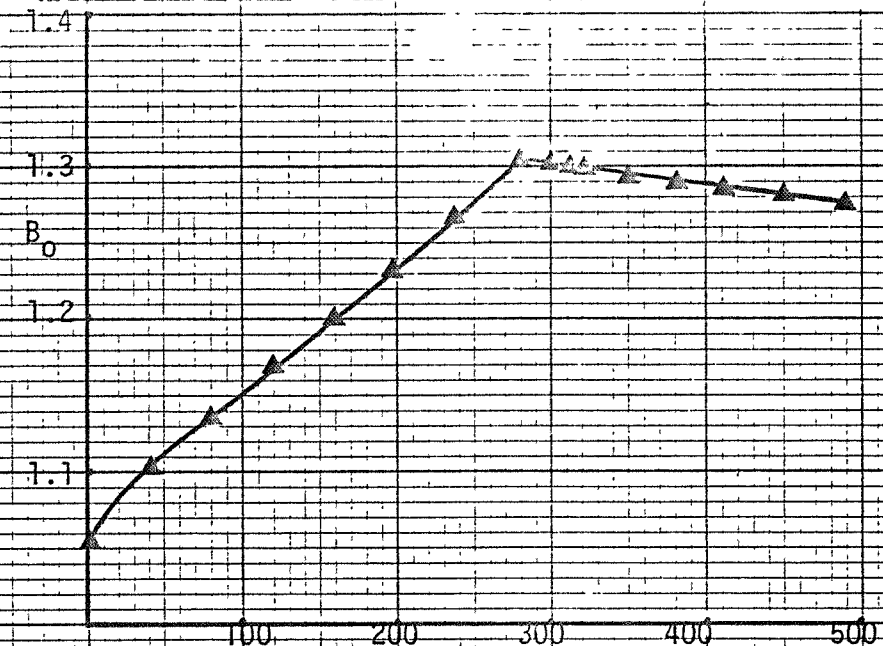


FIGURE 6

Cumulative GOR v Pressure

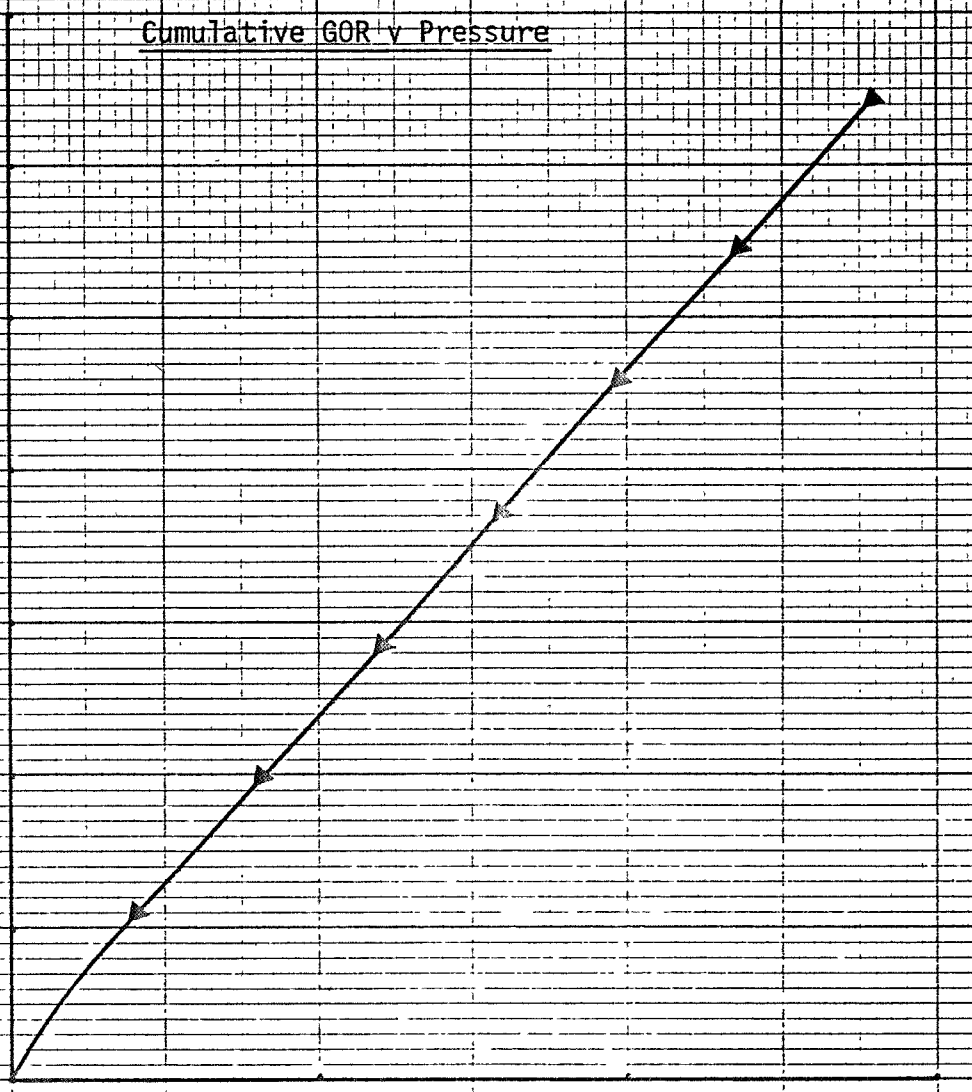


FIGURE 7

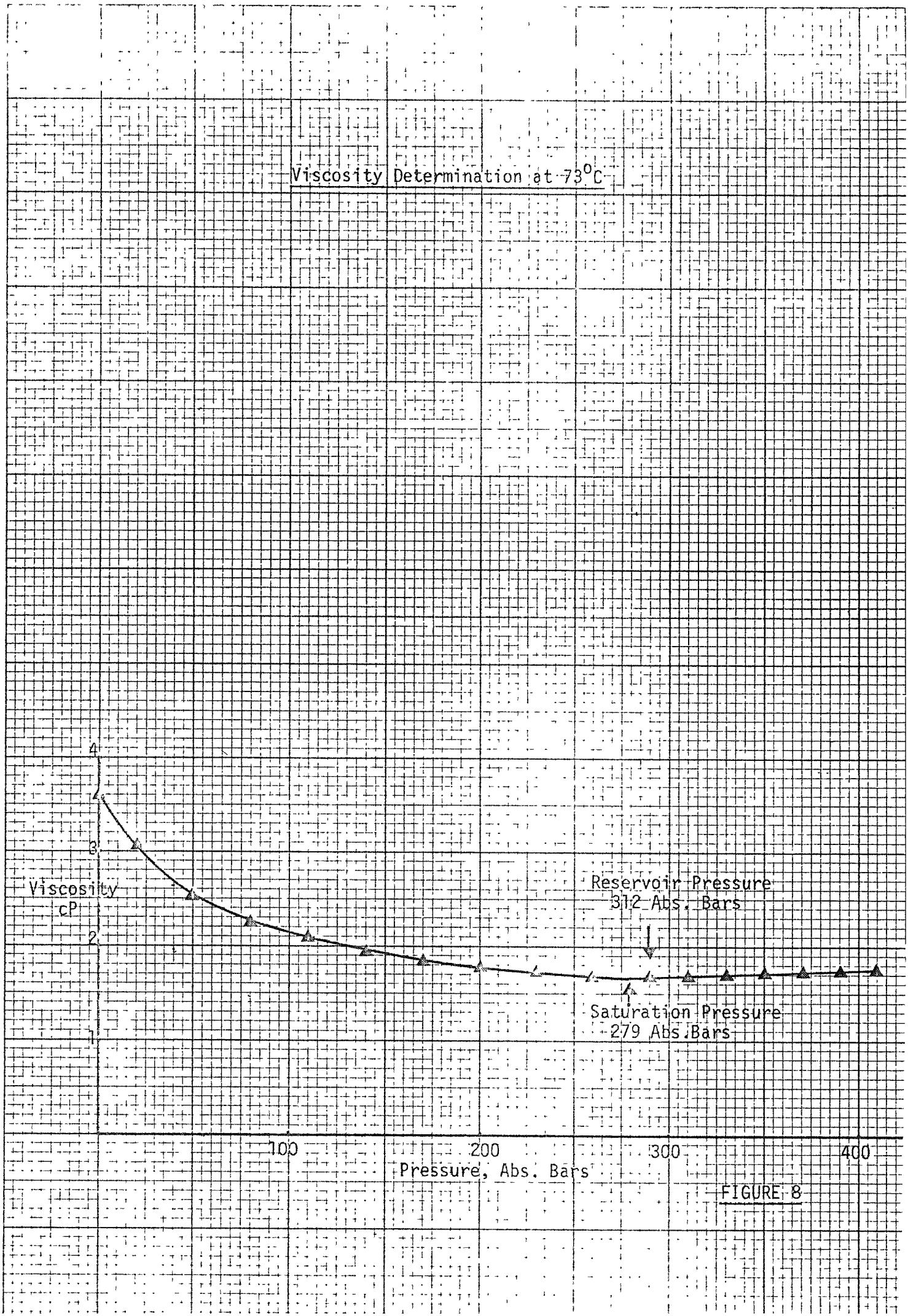
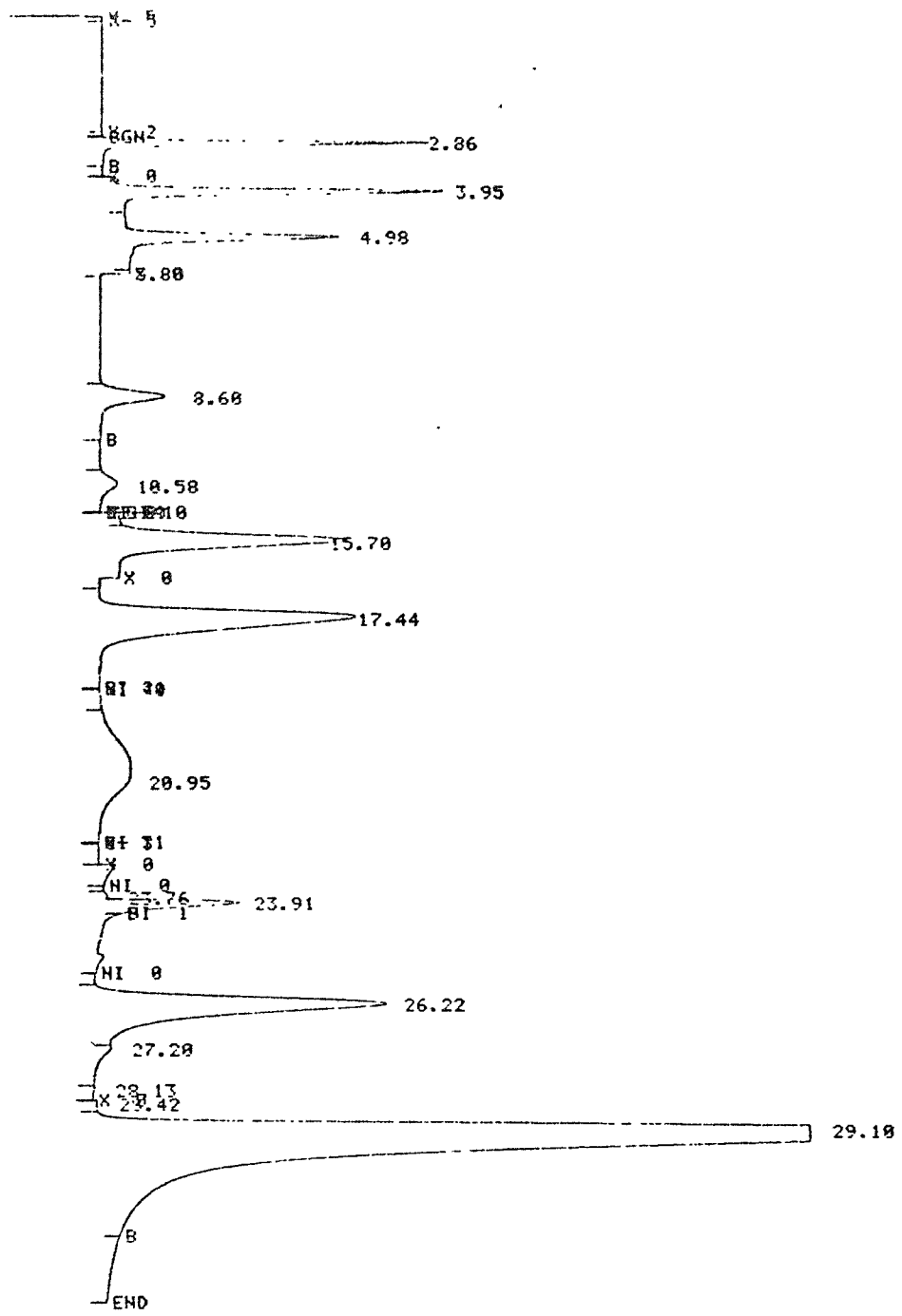

Viscosity Determination at 73°C
Viscosity cP
4
3
2
1
Reservoir Pressure
312 Abs. Bars
Saturation Pressure
279 Abs. Bars
100
200
300
400
Pressure, Abs. Bars

FIGURE 8

APPENDIX 1

Chromatogram of Gas from C_1 -



PERKIN-ELMER PART No. 332-1910

036

ANAL 1 DET 1 METH 2 2 FILE 100

RUN 1 STATOIL 235 FLASH FROM 14068 45 16 : 54.2 10 / 1 / 80

SENSITIVITIES 150 6

TIME	AREA	BC	RPT	RF	C	NAME
2.86	2.9932		0.270	0.898	1.3440	PROPANE:
3.95	5.1784	T	0.373	0.264	0.6825	ISOBUTANE:
			0.425	0.267		H2S:
4.98	6.3368	T	0.470	0.293	0.9282	N-BUTANE:
8.60	1.7255		0.812	0.564	0.4866	ISOPENTANE:
10.58	0.5582		1.000	0.559	0.1557	N-PENTANE:
15.70	8.8988	V	1.483	0.401	1.6238	CO2:
17.44	19.8876		1.648	1.217	6.6252	ETHANE:
20.95	4.8382		1.988	0.442	0.8987	C6 PLUS:
23.91	2.0885		2.259	0.488	0.4001	OXYGEN:
26.22	12.4968	T	2.478	0.425	2.6554	NITROGEN:
29.10	56.4745		2.758	2.933	93.1488	METHANE:

PERKIN-ELMER PART No. 332-1910

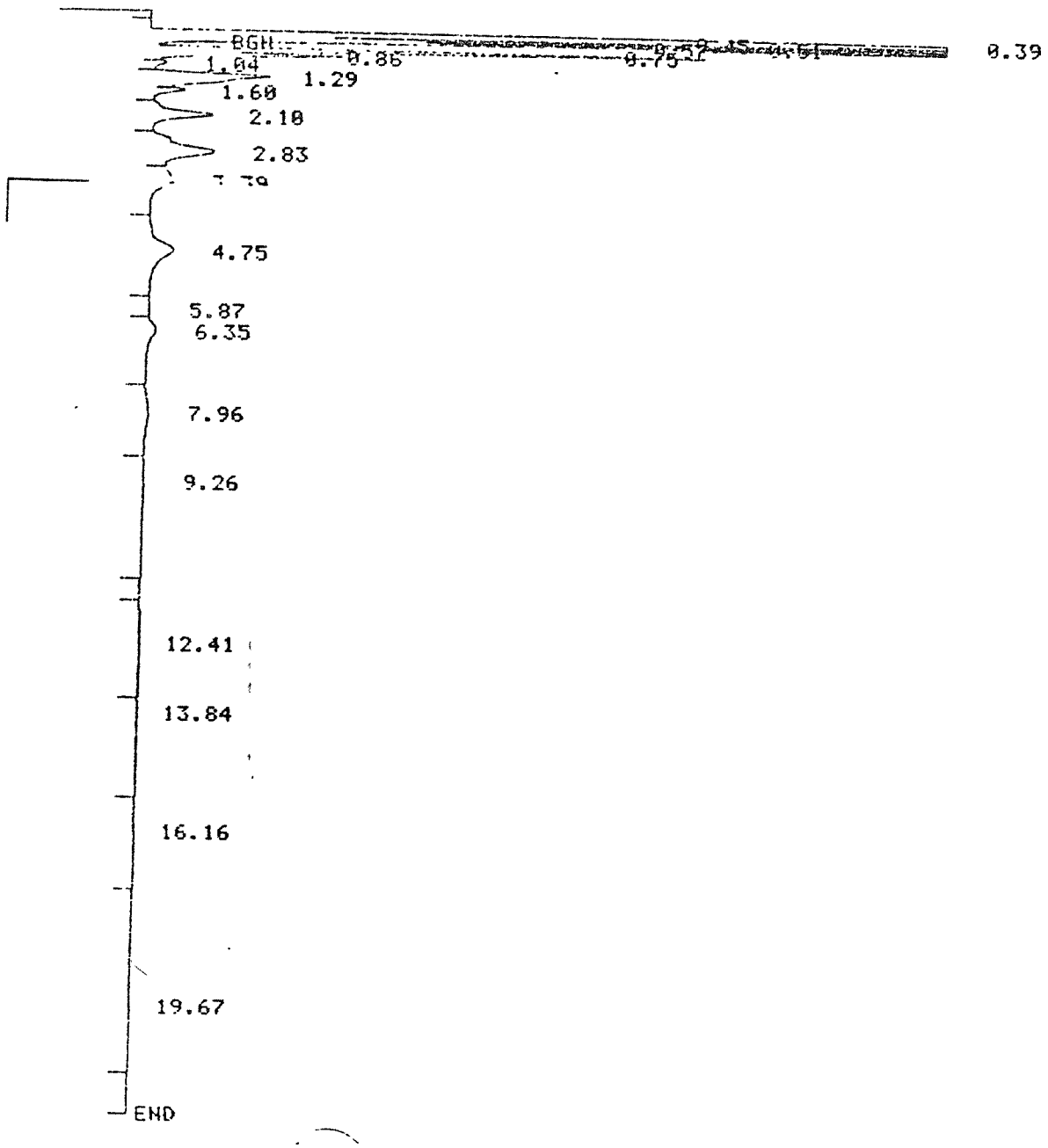
INST 1 METH 33 FILE 93

RUN 1 STAT 235 FLASH FROM 14068 45

SENSITIVITIES 150 6

APPENDIX 2

Chromatogram of gas from iC_5 - C



INST 1 METH 33 FILE 93

RUN 1 STAT 235 FLASH FROM 14068 45 19 : 15.5 10 / 1 / 80

TIME	AREA	BC	RRT	RF	C	NAME
0.75	10.9030	T	0.221	1.067	0.5817	ISOPENTANE:
0.86	4.1315	T	0.253	0.938	0.1938	N-PENTANE:
1.04	0.6150	T	0.306	0.778	0.0239	ISOHEXANE:
1.29	7.3337	T	0.380	0.778	0.2853	ISOHEXANE:
			0.408	0.778		ISOHEXANE:
1.60	1.4746	T	0.471	0.778	0.0574	N-HEXANE:
2.10	4.2011	T	0.619	0.627	0.1317	ISOHEPTANE:
			0.745	0.627		ISOHEPTANE:
2.83	6.4752	T	0.834	0.627	0.2030	ISOHEPTANE:
3.39	3.5648	T	1.000	0.627	0.1118	N-HEPTANE:
4.75	4.6284	T	1.401	0.534	0.1236	ISOOCTANE:
5.87	0.5503	T	1.731	0.534	0.0147	ISOOCTANE:
6.35	1.7848	T	1.873	0.534	0.0477	ISOOCTANE:
7.96	1.2111	T	2.348	0.534	0.0323	N-OCTANE:
9.26	0.6387	V	2.731	1.000	0.0319	'
12.41	0.3712	T	3.660	0.539	0.0100	ISONONANE:

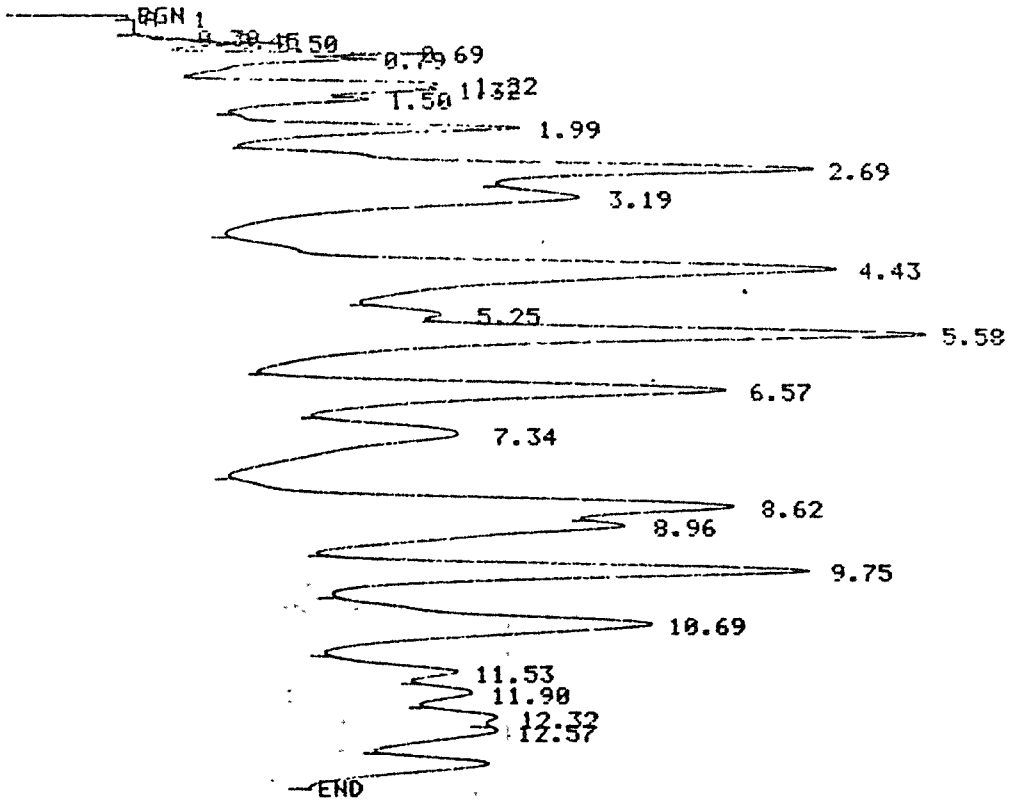
APPENDIX 3

Chromatogram of Residual Oil C_1 - C_9

INST 1 METH 24 FILE 70

RUN 1 STAT 235 FLASH FROM 14068 45

SENSITIVITIES 150 8



INST 1 METH 24 FILE 70

RUN 1 STAT 235 FLASH FROM 14068 45 11 : 39.1 10 / 1 / 80

SENSITIVITIES 150 8

TIME	AREA	BC	RRT	RF	C	NAME
0.45	0.0522	H	0.068	1.470	0.0115	IC4:
0.50	0.1993	H	0.076	1.470	0.0439	NC4:
0.69	0.4017	H	0.105	1.470	0.0886	IC5:
0.79	0.7232	H	0.120	1.470	0.1595	NC5:
			0.144	1.290		IC 6:
1.22	0.6744	H	0.185	1.290	0.1305	I C6:
1.32	0.7100	H	0.200	1.290	0.1374	N-C-6:
1.50	0.7972	H	0.228	1.290	0.1543	N-C-6:
1.99	1.9616	H	0.302	1.400	0.4119	I C7:
2.69	4.3524	H	0.409	1.400	0.9140	I C7:
3.19	4.0854	H	0.485	1.400	0.8579	N-C-7:
4.43	7.0153	H	0.674	1.230	1.2943	I C8:
5.25	1.4839	H	0.799	1.230	0.2738	I C8:
5.58	5.9865	H	0.849	1.230	1.1045	I C8:
6.57	4.4851	H	1.000	1.230	0.8275	N-C-8:
7.34	3.9291	H	1.117	1.270	0.7485	I C9:
8.62	4.5060	H	1.312	1.270	0.8584	I C9:
8.96	3.7646	H	1.363	1.270	0.7172	I C9:
9.75	4.7547	H	1.484	1.270	0.9058	I C9:
10.69	5.8864	H	1.627	1.270	1.1214	N-C-9:
11.53	2.3702	H	1.754	1.000	0.3555	!
11.90	2.2836	H	1.811	1.000	0.3425	!
12.32	1.8938	H	1.875	1.000	0.2841	!
12.57	2.7657	H	1.913	1.000	0.4149	!