FIELD EXPERIENCE USING CORIOLIS MASS METERS - 1

by

B Lawson
Occidental Petroleum (Caledonia) Ltd

Paper 2.4a

NORTH SEA FLOW METERING WORKSHOP 1988
18-20 October 1988

National Engineering Laboratory
East Kilbride, Glasgow

FIELD EXPERIENCE USING CORIOLIS METERS

BRUCE LAWSON - INSTRUMENT METERING ENGINEER

OCCIDENTAL PETROLEUM (CALEDONIA) LTD

INTRODUCTION

During the autumn of 1985 Brooks Instruments held an exhibition at an hotel in Aberdeen to demonstrate the range of equipment they produce. On show at the exhibition was the Micromotion mass flow meter, which operates on the Coriolis principle. As an engineer who spends his life having to design orifice and turbine meters into difficult locations the virtual lack of flow conditioning prior to the meter seemed too good to be true. At the time we identified the following potential advantages of the meter over its more established rival types:

1 Relative ease of installation resulting from apparent lack of flow conditioning requirements.

2 Low maintenance costs and hence low "real" cost of ownership.

3 The potential for use on new developments , particularly offshore satellite developments, where additional savings are of obvious importance.

Following an initial appraisal of the meter it was decided to approach the Department of Energy to investigate their acceptance of the meter for Fiscal service. A D150 meter, rated at ANSI 1500, was procured for trial on the Claymore condensate system.

PRE-INSTALLATION WORK

In view of the declared intention to have a meter of this type adopted for Fiscal duty it was decided to check the manufacturers calibration at SIRA before the field test began. This calibration check was carried out during early May 1986.

The meter was tested in the SIRA No2 flow laboratory. The flowmeter was mounted in a straight, horizontal pipeline of 1.5 inch nominal bore, with an upstream straight length of 15D. The Mass was determined by weighing under static conditions, using a gyroscopic force measurement system. A mass of fluid was diverted into a weightank in a measured time. The mass of fluid was corrected for air buoyancy, following which the mass flowrate was calculated.

The flow meter was initially tested on kerosene at 30 ^{o}Celcius, the test was then repeated using a gas oil as the test fluid at 30 ^{o}Celcius. Throughout the test the temperature was maintained to within 0.2 ^{o}Celcius of setpoint.

The fluid densities were determined using a digital density meter operating on the vibrating tube principle. Fluid viscosities were measured using suspended level viscometers, in accordance with BS 188:1977.

All equipment used during the tests was traceable to UK national standards. The flow measurement uncertainty was estimated to be +/- 0.2% of the true conventional value(95% confidence level)

A schematic of the test loop is shown in figure 1.

<u>SIRA Test results</u>

The densities and viscosities of the two test fluids at 30^{o}Celcius were as follows:

KEROSENE	790.9 Kg/m^3	1.41 cSt
GAS OIL	837.9 Kg/m^3	4.81 cSt

The tabulated results of the tests on Kerosene an Gas Oil are given in figures 2 and 3 respectively. A plot of the results is given in figure 4.

The test results indicated that the meter performed within the manufacturers stated accuracy of +/- 0.4 percent.

INSTALLATION

Following the completion of the work at SIRA the meter was then shipped offshore to Claymore for installation on the condensate system, downstream of the existing Fiscal orifice meter run. The meter was installed in the line in June 1986 however, due to the extremely heavy workload with the Scapa development, the meter was not commissioned until early April 1987.

It was realised that the physical installation of the meter was far from perfect. However, this would test the ability of the meter to cope with a lack of flow conditioning. In an effort to eliminate any later criticism of the installation from the manufacturer, representatives of Brooks were invited to visit Claymore and approve the installation for themselves. No strong objections were received following the visit and the test belatedly began on the 1st May 1987. The meter is shown in figure 5 with the installation given in figure 6 and 7.

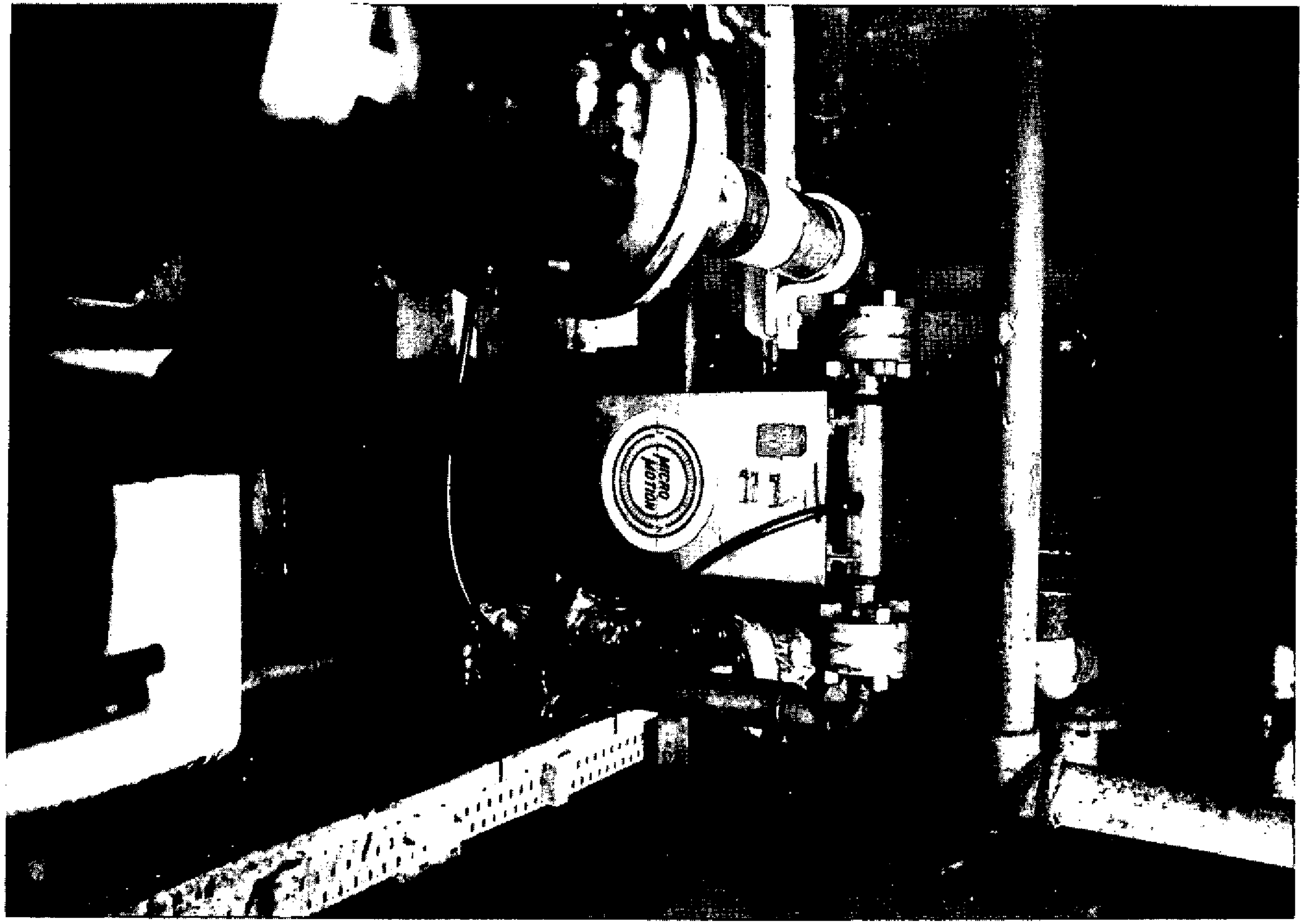
During the test, the meter was zeroed once and no further adjustments or replacements were made to either the meter or electronics.

FIELD TEST RESULTS

It was decided that the only way to test the meter was to record the daily total registered on both the orifice and the Coriolis meter totalisers. The totals on the orifice meter were taken automatically at midnight by the platform metering supervisory computer whilst the Coriolis meter total was recorded manually at midnight. This is not believed to have affected the results of the test by any significant amount.

Figures 9 and 10 show the variation in the Coriolis meter readings in relation to the orifice measurement. It is important to point out that the error, although depicted as being in the Coriolis meter, may just as likely be in the orifice meter. The comparative test was run at the conditions that prevailed on the platform at the time, no variation of the process conditions other than those required to operate the plant were possible. The relatively large negative peak which occurred in mid August was related to a period of unstable plant operation although, the actual cause of error has not been fully identified. It is very interesting to note that, when comparing the above plot with the plot of measured density the significant positive peaks coincide with positive changes in density. This may well be a function of the flow in the densitometer bypass loop associated with the orifice installation. A comparison of the mass and density plots is shown in figure 11.

Figures 12 and 13 indicate the process conditions throughout the test period.

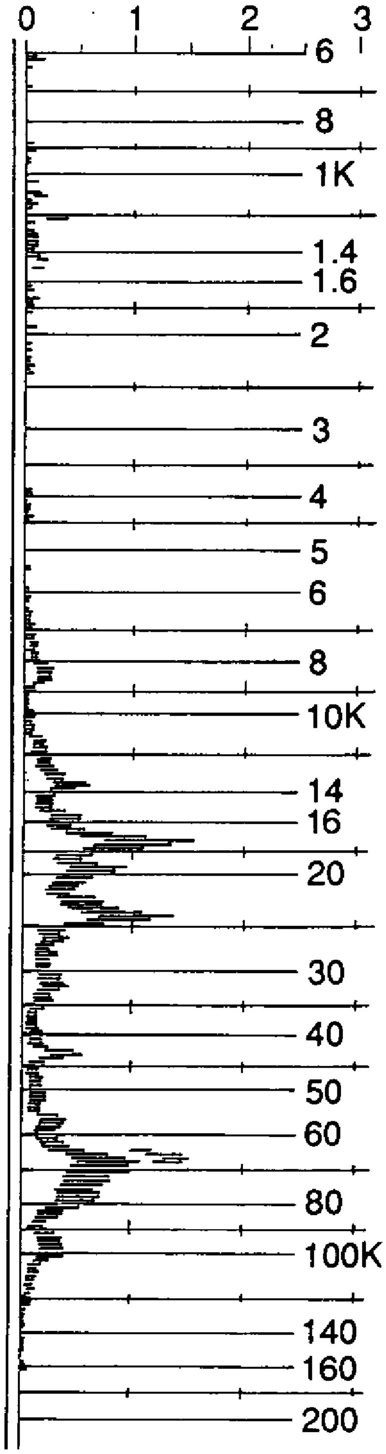


CORIOLIS METER INSTALLATION CLAYMORE

FIGURE 7b

BACKGROUND FREQUENCIES PRESENT ON CLAYMORE MEASURED 1 FOOT FROM OUTLET FLANGE OF CORIOLIS METER

IRD MECHANALYSIS
DATE 19/2/88 OA 4
MACH
POSIT A2 OUTLET IFT
COND
MM/SEC PK 5%BW



INSTRUMENT POWER OFF

IRD MECHANALYSIS
DATE 19/2/88 OA 4
MACH
POSIT A2 OUTLET IFT
COND
MM/SEC PK 5% BW

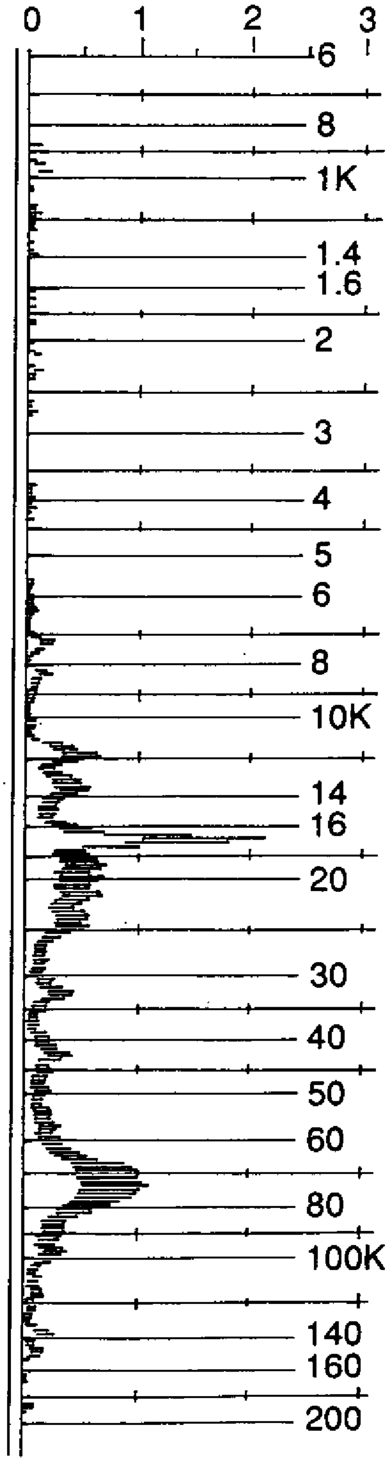


FIGURE 8

CLAYMORE CONDENSATE
COMPARISON OF CORIOLIS METER VS ORIFICE PLATE

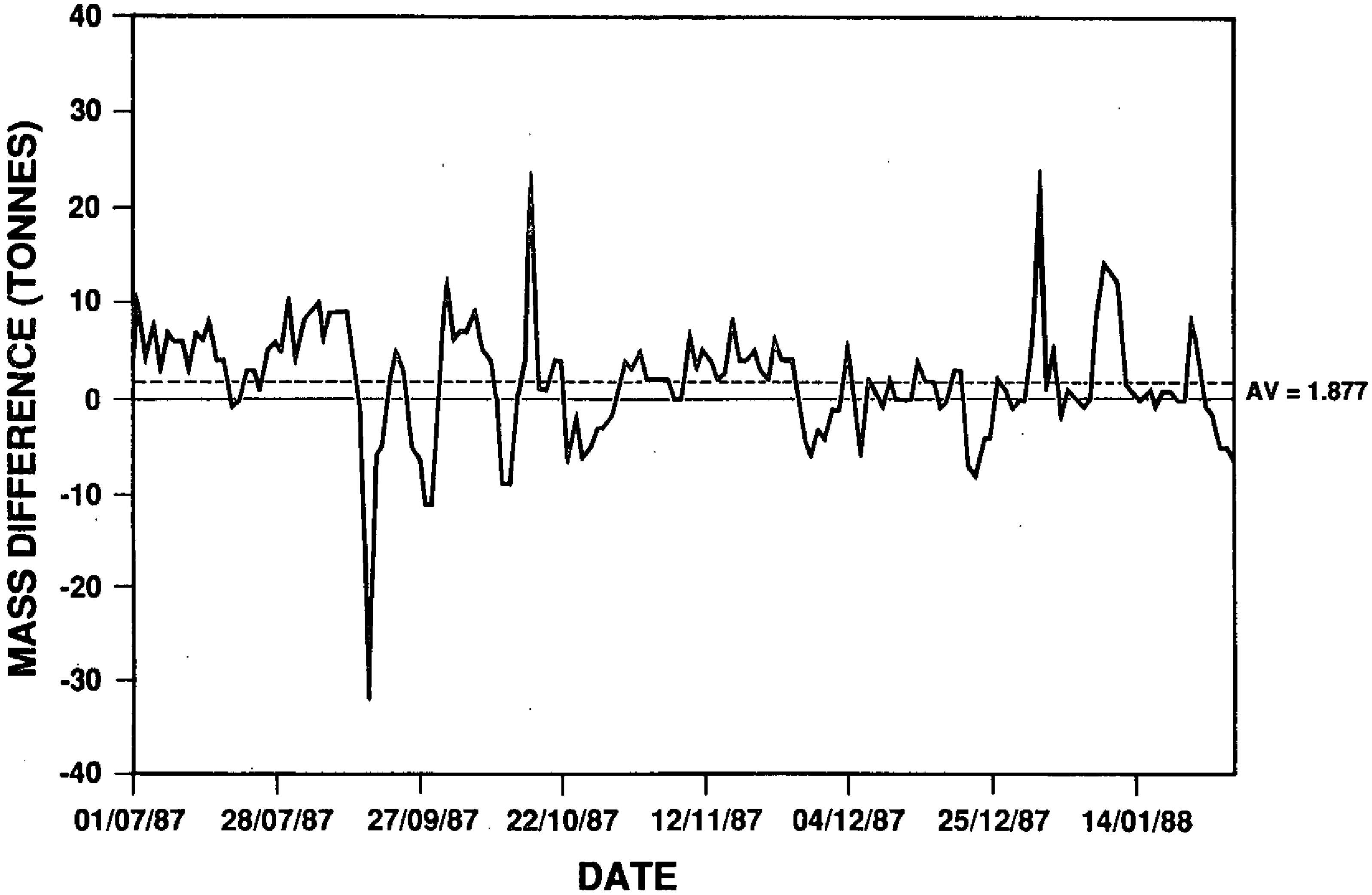


FIGURE 9

0424

CLAYMORE CONDENSATE
COMPARISON OF CORIOLIS METER VS ORIFICE PLATE

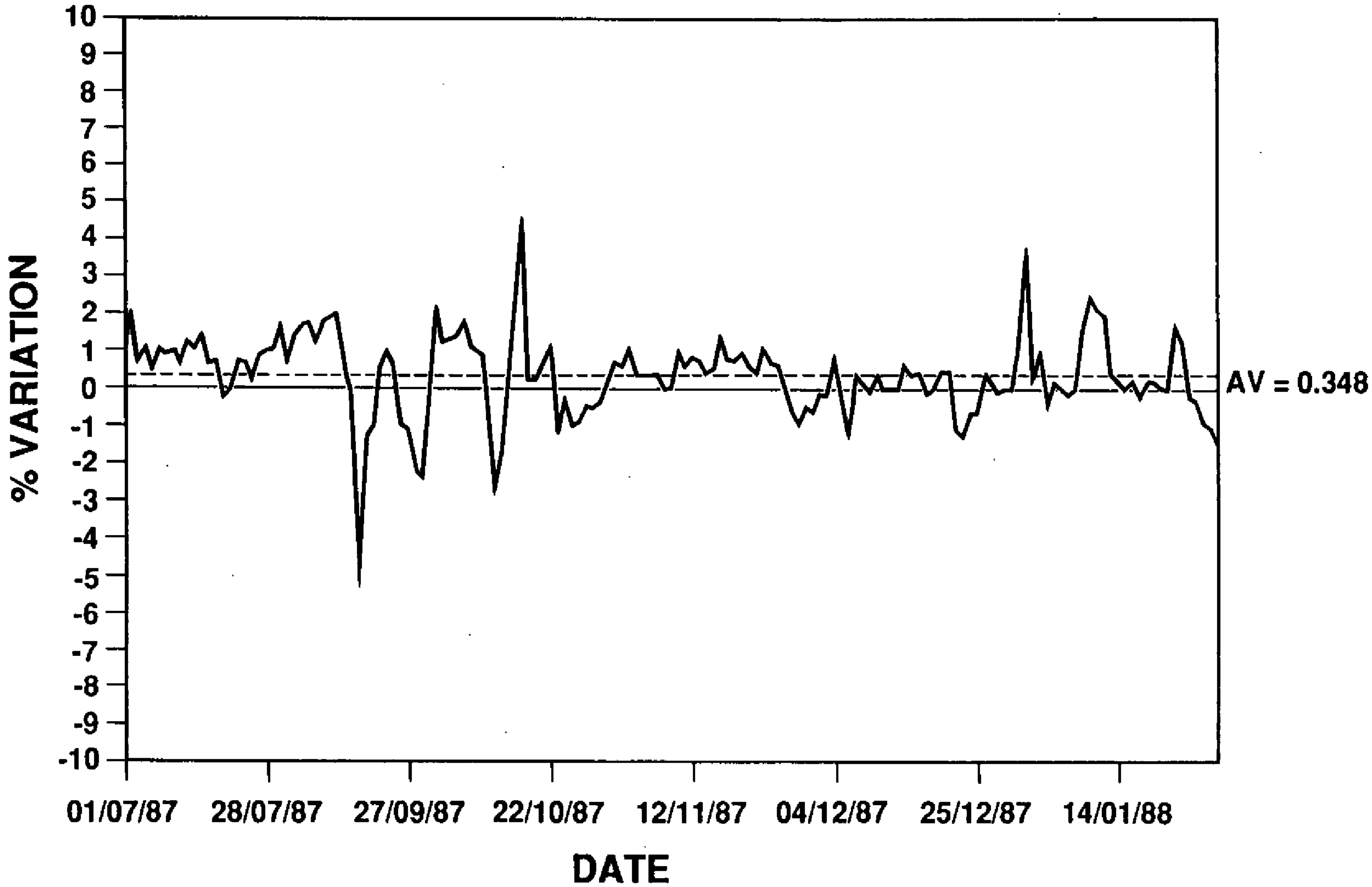


FIGURE 10

0424

CLAYMORE CONDENSATE
MASS DIFFERENCE Vs OBSERVED DENSITY

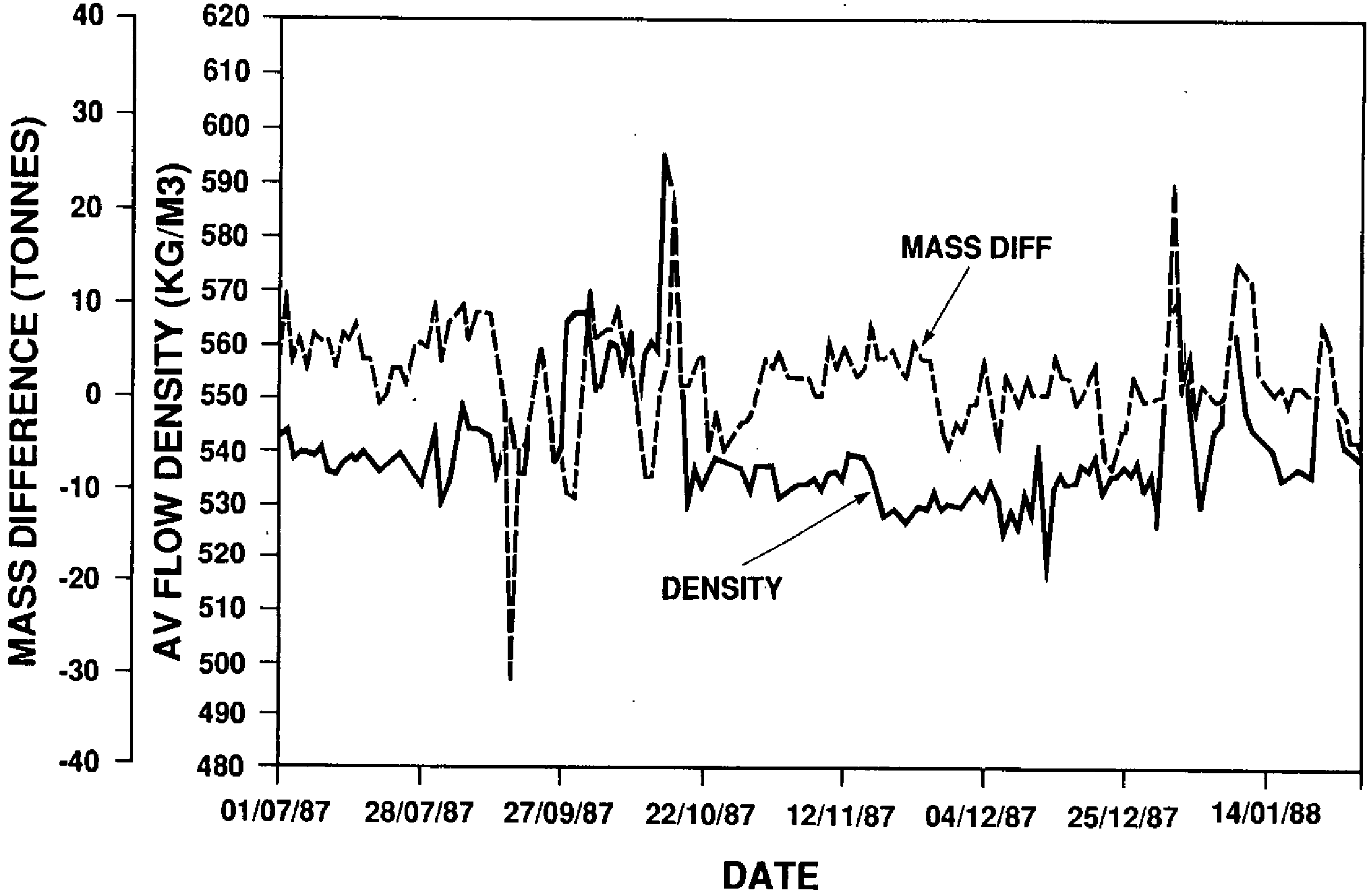


FIGURE 11

0424

CLAYMORE CONDENSATE
VARIATION OF AVERAGE FLOWING DENSITY

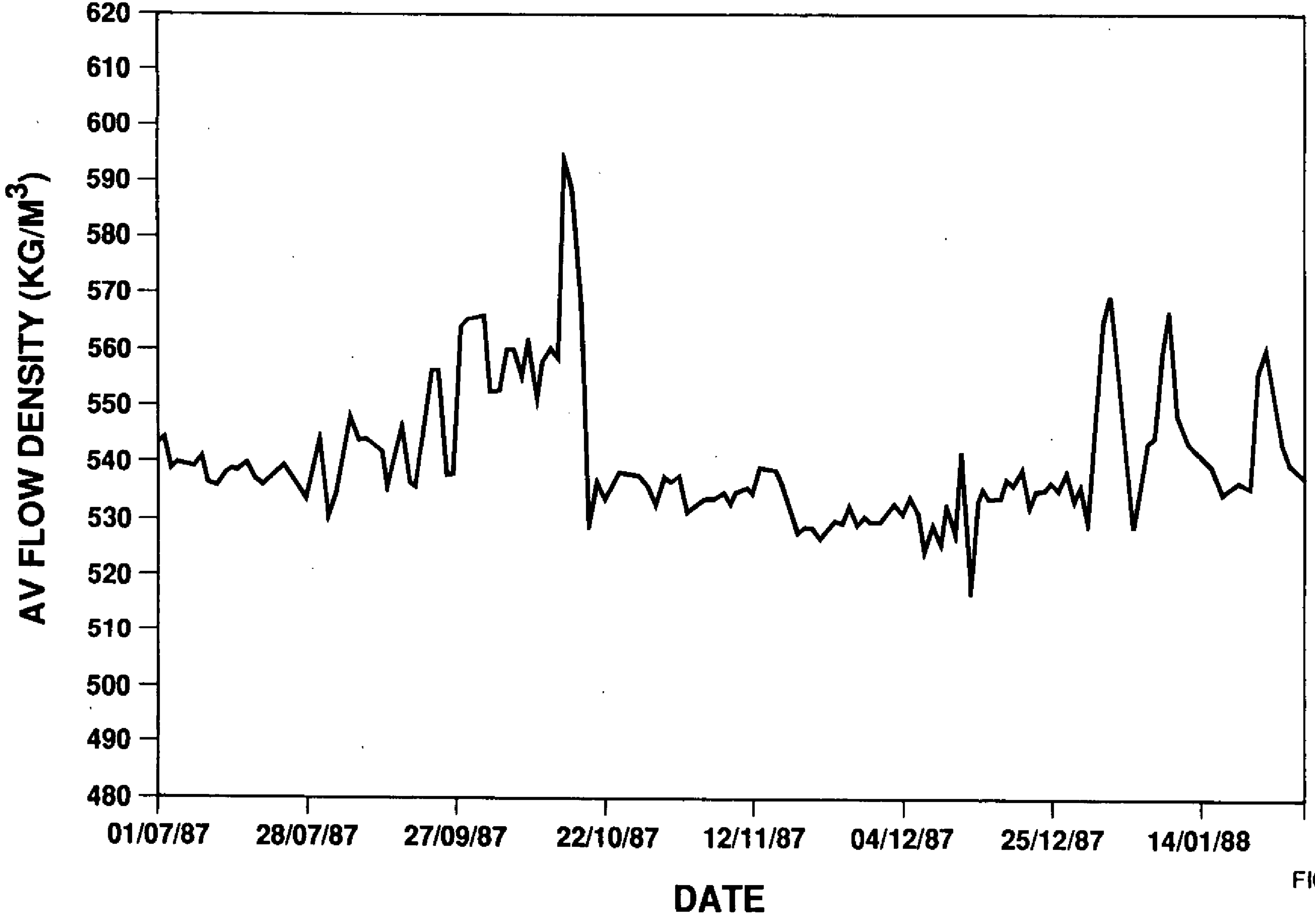


FIGURE 12

0424

CLAYMORE CONDENSATE
VARIATION OF DAILY FLOW, PRESSURE AND TEMPERATURE

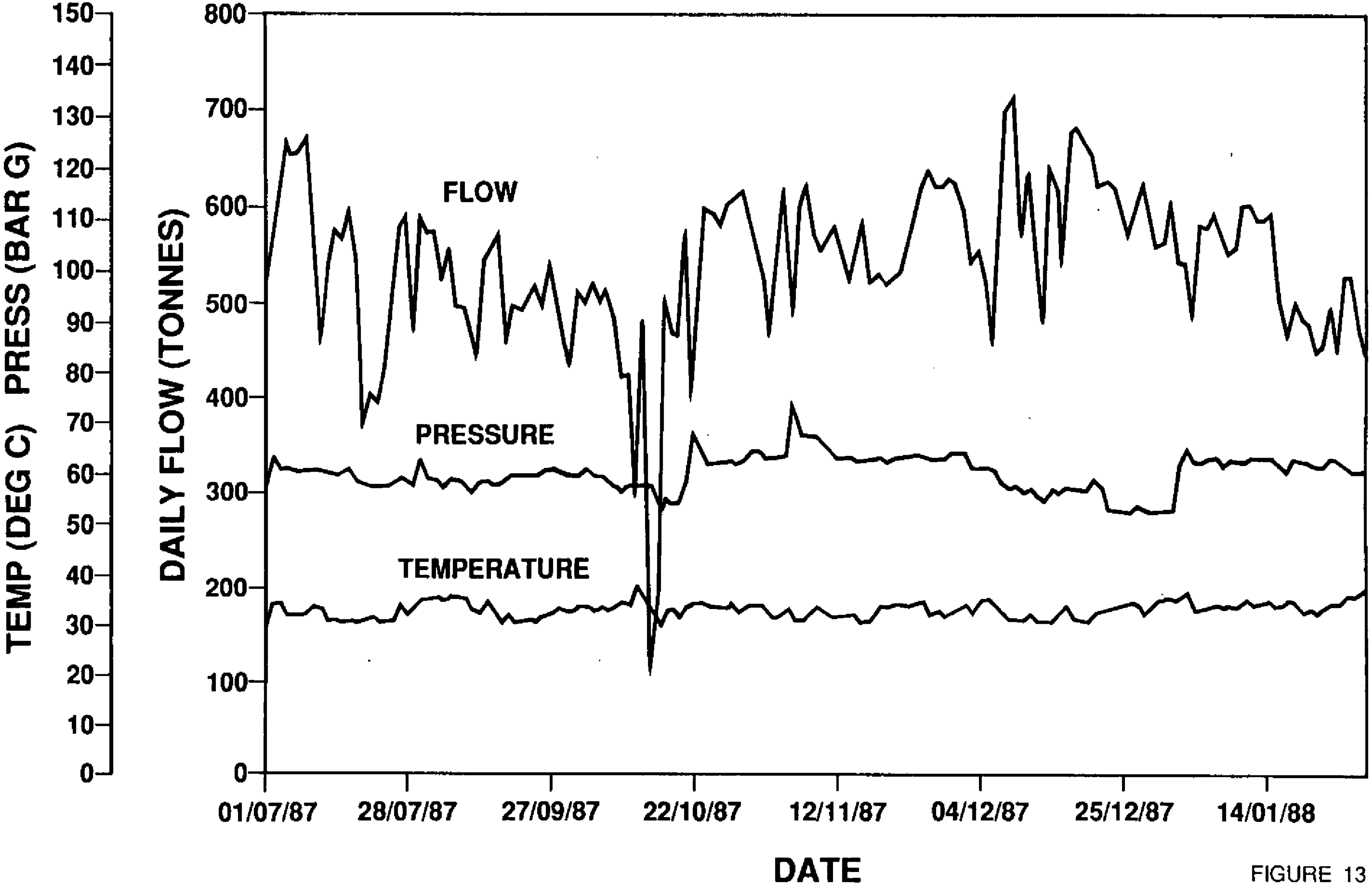


FIGURE 13

0424

D150 MICROMOTION METER
POST INSTALLATION CALIBRATION
VEENENDAAL JUNE 1988

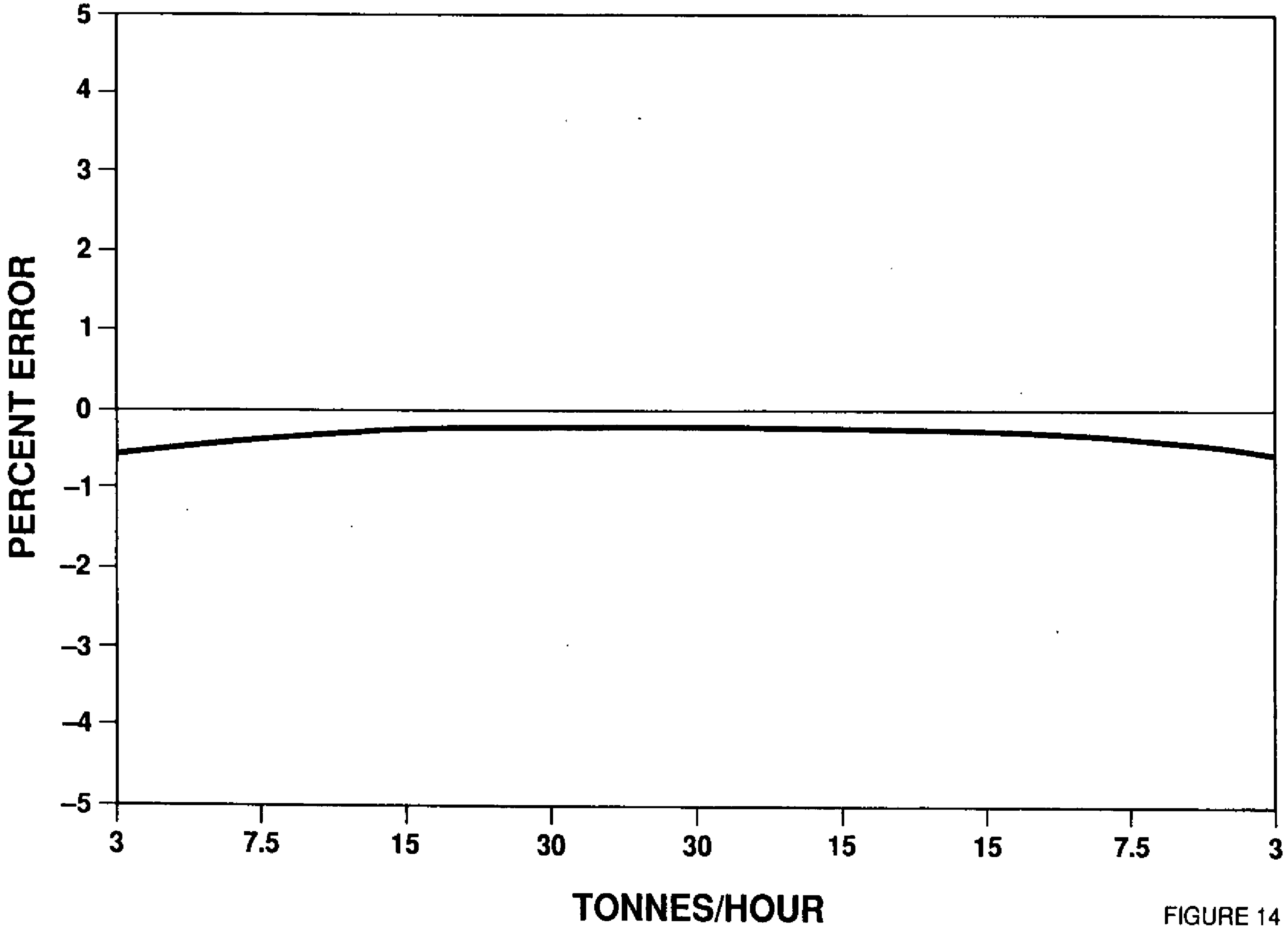


FIGURE 14 0424

DIAGRAM OF CALIBRATION FACILITY AT BROOKS INSTRUMENT PLANT VEENENDAAL HOLLAND

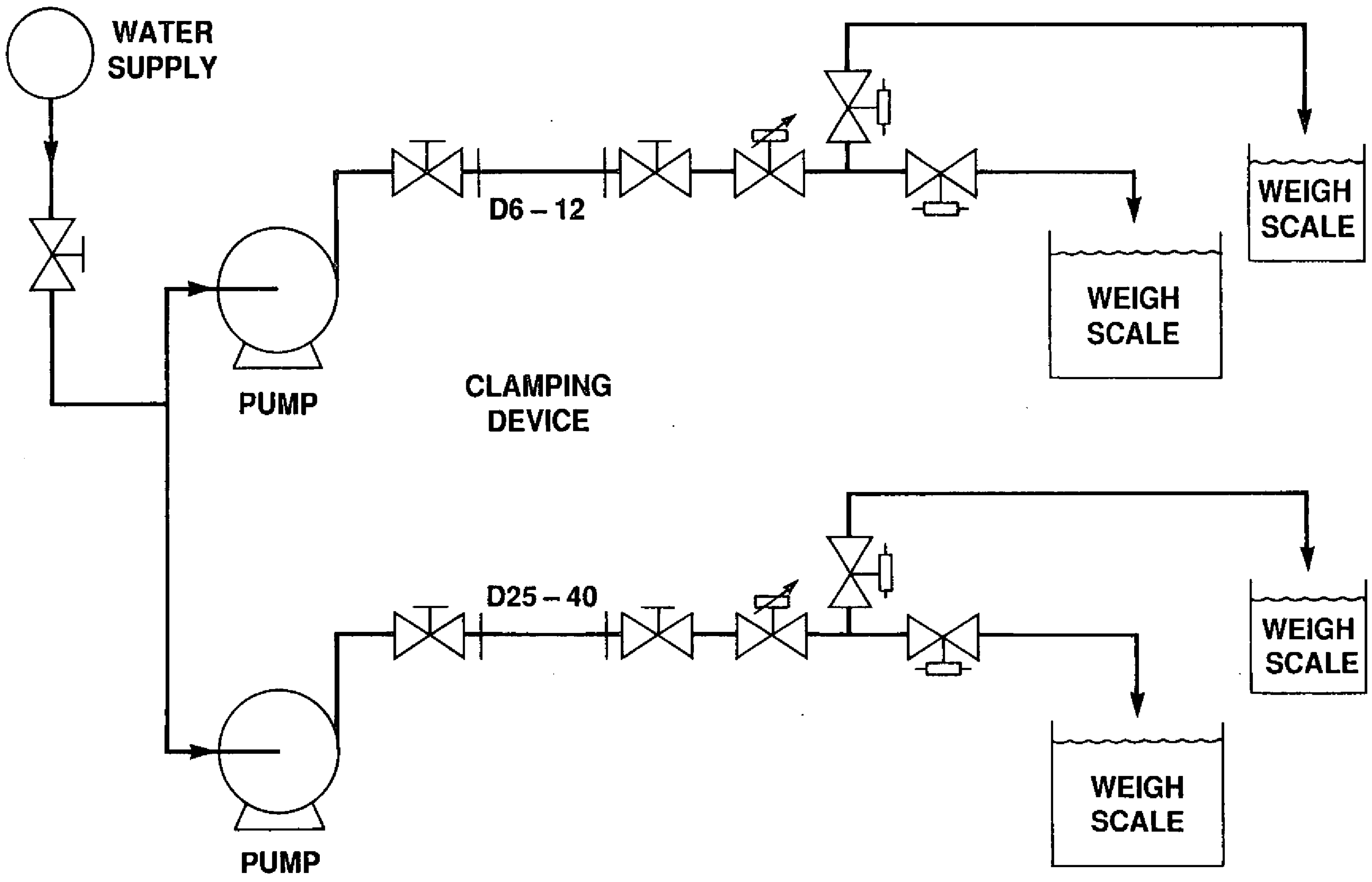


FIGURE 15

0424

PROPOSED CORIOLIS METER TYPICAL HOOK-UP

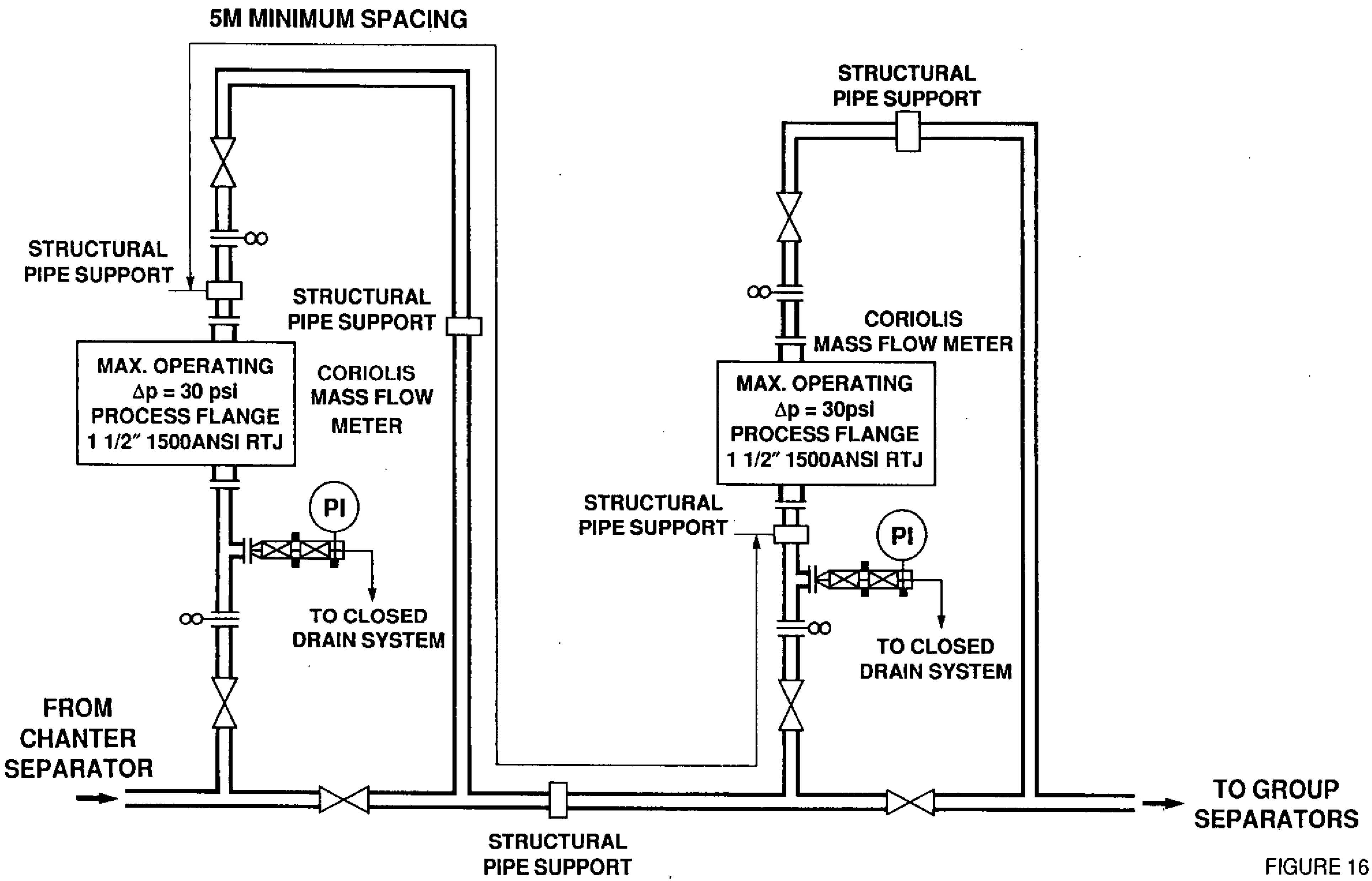


FIGURE 16
0424

References

[1] Paper presented at the North Sea Flow Measurement Workshop, a workshop arranged by NFOGM & TUV-NEL

Note that this reference was not part of the original paper, but has been added subsequently to make the paper searchable in Google Scholar.