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THE NORWEGIAN TEST PROGRAMME FOR QUALIFICATION OF MULTIPHASE METERS

4.7

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The Norwegian Test Programme for Qualification of Multiphase Meters

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The Norwegian Test Programme for Qualification of Multiphase Meters.

by

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1 Abstract

In 1995 the three Norwegian oil companies, Statoil, Saga and Hydro (SSH) initiated the "SSH" multiphase technology development programme. The joint programme was divided into nine different projects, one being the Multiphase Metering Project. Part of this project was a testing and qualification programme for multiphase meters. Experience gained from simultaneously testing of 4 different multiphase meters at Hydro's high pressure test facility in Porsgrunn shows very interesting results, and tells the users the different meters ability for efficient use at various conditions. The meters tested have been meters from Framo Engineering, Fluenta, Multi-Fluid and Kongsberg Offshore.

The test project took place in a new multiphase flow loop. This advanced flow loop operates at pressures up to 110 bar and at temperatures up to 140 °C. The testmatrix consist of 552 single test points at 3 different temperatures (30-60-90 °C), 4 different pressures (20-45-67-90 bar), on watercut from 0-90% and at gas-liquid fractions between 0-99 %. Different licences in the North Sea have been participating in the project, and base cases for future field development have been used to construct a representative and transferable test matrix. Crude oil from the Oseberg field together with formation water and synthetic hydrocarbon gas have been used in the qualification work.

This paper describes the SSH co-operation, the test facility, the test programme, experience gained from the test campaign and the importance of testing meters at various conditions. The SSH project is now continuing into a new phase aiming for a subsea multiphase meter system installed in a subsea production field in 1997.

2 Introduction

The large economic potential for applying multiphase meters has been the driving force behind the various development projects supported by the oil industry the last 10-15 years. Especially the development of satellite fields will benefit from simplified metering schemes based on multi phase meters, either subsea, topside or as a combination of the two.

The applications of multiphase meter fall into one of two groups:

- WELL TESTING - Testing of a well's performance without using the test separator. The information is used for reservoir management and well operation purposes.

- ALLOCATION METERING - This will be a "fiscal" metering where the multiphase meter measurement is used as a basis for calculating taxation or to apportion production between field owners.

Today several first generation multiphase meters are claimed to be commercially available by the vendors. After a relatively lengthy development phase, the oil companies are now eager to use this cost saving technology within their field development projects. As a result of this, several oil companies have already gained valuable experience with different meters from field trials or even real commercial applications.

The experience gained from the testing of three multiphase meters at Gullfaks B shows that these meters are very efficient for well testing. The time necessary to carry out one well test was reduced to the well switching interval plus a very short test interval. At the best, the accuracy obtained was within +/- 5% of the actual flow rate for oil, water and gas. To achieve this accuracy it was necessary to calibrate the meters on site. The Gullfaks B conditions are, however, considered not to be too difficult for multiphase metering. This is due to relatively good mixing of the phases and a low gas fraction.

As seen by the Norwegian oil companies Statoil, Saga Petroleum and Norsk Hydro (SSH), two main challenges remained unsolved relative to the state-of-the-art for multiphase meters in 1992/1993:

- Provision of a sufficiently broad database for definition of the operational domain for the multiphase meters offered by the vendors, relative to the field conditions.

- Development of a subsea multiphase meter.

The basis for selection of a multiphase meter for a particular well/field had typically to rely on low pressure laboratory fluid tests, or field data for a narrow band of conditions. This was not considered good enough by SSH.

In July this year the first installation of a subsea multiphase meter took place in the UK-sector of the North Sea. This system is dependent on diver assistance for installation and maintenance. Within the SSH companies, diverless intervention was a requirement.

The SSH companies are also involved in development and testing of model based well testing methods. Testing of IDUN is now in progress at Saga's Tordis field. A similar approach has been selected by Norsk Hydro for the Troll Olje development. It is believed by SSH that a combination of multiphase meters and flow models will be parts of simplified metering concepts for several future field developments.

3 SSH - Multiphase Meter Development Project

In 1995 Statoil, Saga and Norsk Hydro initiated the "SSH" multiphase technology development programme. The overall objective is to provide cost effective field development technology for satellite fields based on the application of multiphase technology.

The joint programme was divided into nine different projects, one being the Multiphase Metering Project.

Based on the state-of -the-art in 1994, and the company's field development portfolios, it was decided to focus the activities within this project on two different activities:

1. Qualification testing of promising multiphase meters.
2. Design, fabrication and dock-testing of a system for multiphase metering subsea.

It was also decided that the project should address in detail experiences and improvements of flow model based systems (IDUN or other similar systems).

3.1 Qualification testing of multiphase meters at Norsk Hydro's Research Centre.

At the end of 1994 Norsk Hydro completed a new high pressure test loop in Porsgrunn. This loop was intended for various multiphase and process technology research projects. The availability of a high pressure multiphase flow loop was invaluable for the SSH subsea metering development project, because the rig offered unique possibilities for creating real flowing conditions with large parameter variations. The pressure range was 10-110 bar, the temperature range 20-140 °C and the gas-liquid fraction could be varied from 0 - 100 %. The fluids in the loop should be stabilised crude, synthetic hydrocarbon gas and formation water. It was decided in the autumn 1994 that the test rig should be modified to include test facilities for multiphase meters. The reference measurements were upgraded and a dedicated test section was built.

Four vendors of multiphase meters were invited to participate in the test programme. No multiphase meters from vendors outside Norway were known to SSH to have sufficient potential relative to the requirements for the subsea meter.

The vendors of multiphase meters participating in the test were:

- Fluenta
- Framo Engineering
- Kongsberg Offshore
- Multi-Fluid International

All the vendors claimed they could provide multiphase meters which could measure from 0-100 % of all the three phases (limitations in gas-fractions up to 90 - 95 %)

3.2 Design and fabrication of the subsea multiphase meter.

Based on the qualification test results and other relevant criteria, one or several of the tested meters will be selected as basis for the design and fabrication of the subsea multiphase meter. The development of the subsea meter is estimated to take 1.5 years. The final project phase includes dock testing of the subsea multiphase meter and a long term field test of the meter at an offshore platform.

4 Objectives

The objectives for the qualification test project can be summarised as follows:

- To test 4 commercially available multiphase meters that are candidates for being further developed into subsea meters.

- To explore their application envelope and the accuracies under realistic multiphase flow conditions relative to the requirements of field development projects participating in the project.

- To inform field development projects about the performance of multiphase meters. To recommend multiphase meters to be used for Statfjord Nordøst-segment, Gullfaks Satellites and the Åsgard fields (Smørbukk, Smørbukk-Sør and Midgard).

At the same time, the extensive test will provide the vendors with data for further development and improvements of their meters. A major objective is, however, to develop one or several of the existing multiphase meters into subsea meters.

5 Test facility Hydro Research centre, Porsgrunn

5.1 High pressure test loop for multiphase research

5.1.1 The Multiphase Flow loop

The Multiphase Flow Loop (MPFL) at Norsk Hydro, Research Centre Porsgrunn is a circulating test loop for hydrocarbon liquid (crude oil or condensates), hydrocarbon gas and formation water operating up to 110 bar and 140 °C.
The fluids used are recombined to specified composition. Special attention has been given to prevent system contamination by lubrication oil from pumps and compressor.
The pressure in the loop is controlled by a gas accumulator. The flow rates of the individual phases are measured by flow meters and controlled by variable capacity pumps. The circulation capacity of liquid is maximum 60 m^3/h, while the maximum gas capacity is 205 Am^3/h.
The temperature of the fluids are controlled prior to mixing of liquid and gas. All equipment, including all pipes, have electric heat tracing ensuring stable temperature. Simplified flow diagrams are enclosed in figure 1 and figure 2.

After establishing three phase flow the fluids enter the test loop. The loop has a length of 2 x 60 meter with a pipe having a diameter of 77.9 mm. At the end of each of the two loop lengths there are test sections. The multiphase flow meter test section is located at the end of the first length and a test section area equipped with several types of instrumentation adapted for multiphase technology is located at the end of the second length. The instrumentation area includes a traversing sampling valve, measurements of viscosity, capacitance/conductance, shear forces, pressure drop, wall and fluid temperature, density, flow regime detection, corrosion and wall wetting.

5.1.2 *Applications*

The MPFL has three main areas of application; separation studies, multiphase technology (i.e. fluid dynamic-, corrosion-, emulsion-, foam-, wax- and hydrate-) studies and equipment testing and qualification.
In addition to the test sections of the loop also the MPFL separator has been given a special design making it well suited for experiments, mainly separation tests and equipment testing.

5.1.3 *Test of multiphase flow meters*

48 meter downstream the mixing point of the fluids at the very beginning of the test loop, the test section used for the test of multiphase flow meters was connected as a parallel flow line.
In the test section which had the same diameter as the flow loop the multiphase flow meters had a serial installation. Each meter installation was thoroughly discussed with the suppliers before making the test section design layout.

The KOS meter was decided to have a horizontal installation at the same level as the test loop and was placed at the very beginning of the test section, implying a horizontal pipe length of approximately 600 pipe diameters with one 90° bend upstream the meter. 4 meter downstream the KOS meter the FRAMO meter had a vertical installation with inlet at the upper side and with bottom outlet. The next meter installed was the FLUENTA meter which had a vertical installation with upward flow. The distance between the FRAMO and FLUENTA meters was 15 meter, out of which 12 meter was straight and horizontal pipe. Immediate downstream the FLUENTA meter a PETROTECH sampler was installed. The sampler was not part of the test, however, the installation was done to assist the development of a multiphase sampler. The final installations were a MaReMi mixer from SINTEF, Multiphase lab. and the MFI meter. The MFI meter also had a vertical installation with an upward flow direction. The pressure drop signal from the MaReMi mixer were transferred to, and used by, the MFI meter.

5.1.4 *Reference meters*

The multiphase meters measure flow rate through the meter at actual conditions. Hence, reference flow rates are the actual flow rates of each phase oil, water and gas, at the location of each specific multiphase flow meter. Flow rate of fluid fed to the test section is measured by separate flow meters for each single phase of oil, water and gas. These flow meters are installed upstream of the oil/water and Liquid/gas mixing points. Pressure and temperature is measured at the reference flow meters, in the test section, and at each multiphase flow meter.

The oil phase (outlet from separator) may contain several % of water dispersed. A water-in-oil monitor was installed in the oil leg to monitor the water content. However, this meter was never working satisfactory, and water content was determined by taking manual test points for analysis. The uncorrected reference flow rates for oil and water are corrected for water in the oil phase. The water phase contains negligible amounts of oil.

Flow meters and pressure/temperature transmitters, and their associated instrument loops, used to calculate reference flow rates were calibrated, traceable to national or international standards.

Reference flow meters had to be selected with a view to obtain sufficient functionality, reliability, accuracy and turndown. The meter had to comply with piping class requirements of -30 to +150°C and up to 125 bar pressure.

The reference flow meter on gas was a INSTROMET turbine gas meter type SM-RI-G160-80-130-K. The overall accuracy of gas measurement has been calculated to be within an uncertainty of 0.85 %.
The reference meter on crude oil was a KRAL positive displacement meter model OMX 68. The overall accuracy of oil measurement has been calculated to be within an uncertainty of 0.66 %.
The reference water meter was a DANIEL "PT" liquid turbine meter catalogue 1406-1P 2". The overall accuracy of water measurement has been calculated to be within an uncertainty of 2.02 %.

The gas reference meter was certified with natural gas at 32 °C and 50 bar by Nederlands Meetinstituut (NMi), Silvolde. The liquid reference meters were certified by Con-Tech a.s, Stavanger. The certification was done at the same temperature and pressure and with the same crude oil as used the test program.

5.1.5 PVT Calculations

In the MPFL the three reference meters are located close to the separator and not in the test section for the multiphase flow meters. Consequently there are differences in pressure and possible minor differences in temperature between reference meters and multiphase meters in test.
To calculate the correct deviation between reference rates and multiphase meter rates the reference rates are recalculated to multiphase meter conditions.

Hence, each multiphase flow meter will have its own, specific reference flow rates, reflecting the operating conditions at that particular flow meter.

The recalculation takes the following changes into account:

- Change of fluid densities due to change of pressure and temperature.
- Change of gas and oil rate due to possible condensation of gas.

5.2 Fluid properties

5.2.1 Physical properties

The composition of the hydrocarbon gas through the test program was as follows: 96 - 98 % methane, 0.3 - 0.6 % ethane, 0.5 - 0.3 % propane, 0.3 - 0.5 % C_4+ and 1.8 - 1.0 % nitrogen. The exact composition is dependent on actual pressure and temperature and mass transfer between the crude and the gas at each test condition.

The crude oil used in the test was taken from the test separator at Oseberg A when operating at low capacity without addition of oil field chemicals.

The water used in the test was made up from purified fresh water added 5 % NaCl, 0.5 % $MgCl_2$ and 0.5 % $CaCl_2$, i.e. totally 6 % salt in water.
Measured conductivity in water: 92 mS/cm at 20 °C.
At the end of the test the salt content was reduced to approx. 5 % causing a reduction in conductivity to 80 mS/cm.

5.2.2 Real system vs. model system

Further experiments on flow technology on behalf of the SSH group will bring more knowledge of the characteristics of real hydrocarbon system related to multiphase flow. However, based on the test we find differences in foaming -, emulsion - and in flow characteristics compared to an Exxsol based model system. A real hydrocarbon system (Oseberg crude oil) forms more stable foam and more stable and viscous emulsions at low temperatures. We also found that dispersed flow was established at lower velocities than in a model system, implying a more easy mixing of gas and liquid.
Based on the observed foam stability, causing liquid entrainment in separator gas exit, addition of defoaming agent was found to be necessary.

5.2.3 Flow regimes

By using a vertically installed high frequent measuring gamma densitometer the average density of the multiphase flow was measured vs. time. The instrument which is installed in the instrumentation area of the loop has a location corresponding to the first multiphase meter, i.e. at a distance equivalent to approximately 600 pipe diameters downstream last installation. The densitometer configuration is adapted for identification of flow regimes of gas/liquid systems and the main purpose is to identify regimes with and without slug flow.
The following types of flow regimes were observed: Slug, slug/dispersed, annular, stratified, stratified/wavy, stratified/dispersed and dispersed.
The tendency is to dispersed flow at relatively low rates and to increased slug flow with decreasing pressure and increasing watercut.

5.3 Data processing

The outputs from each multiphase flow meter were rates of gas, oil and water and their separate measurements of temperature and pressure.
The FLUENTA and the MFI meters gave two sets of rates; rates based on pressure drop (MaReMi mixer on the MFI meter and venturi on the FLUENTA meter) and rates based on cross correlation.
All rates were expressed as m^3/h, temperature in degrees Celsius and pressure in bar.

Each test point was defined to last at least 15 minutes with stable flow conditions. Every 10 second updated signals were imported from the Multiphase meters to the Plant Information logging System (PI). Consequently each test point consisted of at least 90 individual meter readings. The average value of these numbers were used for data processing in Excel. To observe abnormal variation in readings the standard deviation of each reading were calculated. All meter readings having high standard deviation have been controlled, both by looking into each value logged in PI and by looking into data logged on the correspondent individual multiphase flow meter.
The results and the belonging calculations from the test are separately stored in Excel version 4.0 tables. Each meter have five tables of 40 to 220 rows and of 80 to 90 columns.

6 Test programme

The test program included totally 552 test points at different combinations of pressure, temperature and flow rates. The program was performed at four pressure levels; 20, 45, 67 and 90 bar, at three temperature levels; 30, 60 and 90 °C, at gas superficial velocities from 0 to 12 m/s and at liquid superficial velocities from 0.1 to 2.5 m/s implying watercuts from 0 to 90 % and GORs from 0 to 99 %.

Basis for the test matrix was data from the participating field development projects/ licenses wrt. expected well/flowline flow rates, gas volume fractions, watercut etc. over the lifetime of the fields.

Relative to the field conditions, the new test facility at Norsk Hydro's plant at Herøya in Porsgrunn has some limitation wrt. maximum flow rates for gas and liquid flow. These limitations were not fully known prior to the test because Norsk Hydro did not have any experiences with operating the rig with crude oil. The commissioning of the test loop took place in December 1994 to February 1995, with diesel oil and nitrogen.

6.1 Test matrix

The main technical data for the test rig including the test section with multiphase meter installed are as follows:

- Temperature range: 4 - 140 °C
- Maximum pressure: 110 bar
- Diameter of test loop: 3"
- Capacity of water: 40 m^3/h (2.4 m/s)
- Capacity of oil: 40 m^3/h (2.4 m/s)
- Capacity of gas: 205 Am^3/h (12.3 m/s)

Due to the capacity of the different pumps in the test rig the maximum pressure drop was 6 bar. The section where the multiphase meters were installed created a pressure drop which was not taken into account when specifying the maximum flow rate. The maximum gas flow rate during the multiphase meter test was 204 m3/h. The maximum liquid flow rate was found to be 42 m3/h. The Oseberg crude was found to be oil continuous for watercuts below 65 % and water continuous for watercuts above 65 %.

The flow patterns (flow regimes) experienced during the test depended on pressure, fluid properties and superficial gas and liquid velocities. The pipe length (no. of diameter) upstream the meter section was close to 50 m (> 600 D). This means that fully developed flow patterns were established upstream the meter test section.

Since the pressure will have a strong influence on the flow regimes, it was decided to use the majority of the 550 available test points at 20 bar (35%) and 90 bar (35%). At 20 bar the slug envelope was significantly larger than at 90 bar. This is mainly due to a smaller density difference between the liquid and the gas at higher pressures. In order to investigate if the meters' accuracy is significantly influenced by temperature, three different temperatures 30, 60 and 90 °C, were chosen.

The initial tests showed that there were significant difference between the 20 bar test points and the 90 bar test points wrt. performance of the multiphase meters. It was therefore decided to add two additional, but smaller, matrixes at 45 and 67 bar. These additional tests were conducted at a fixed temperature of 60 °C. The test programme was concluded with some special tests for repeatability, bypassing of the Framo-mixer and investigation of the influence of altering the salinity of the formation water.

The test was divided into 11 different test series. In each series the superficial velocities and watercut were changed. All possible flow regimes were then covered by the test.

Series	Pressure (bar)	Temp. (°C)	Special test	No. test points
I	20	60		158
II	90	60		158
III	20	90		44
IV	90	90		49
V	20,90	30	(low temp)	26
VI	45	60		32
VII	67	60		58
VIII	67	60	(low salinity)	10
IX	67	60	(Repeatability	8
X	67	60	(Bypass Framo)	4
XI	67	60	(Vendors wish)	5

Table 1: Test programme

Tests with a very low watercut (0 to 1%) were also included. This was done in order to simulate a water breakthrough in a well. This would enable us to see if the meters could detect this phenomenon very early.

Previous experience with multiphase meters has shown that varying the salinity of the water strongly affects their performance. A special 10 point test sequence was therefore carried out in order to investigate this phenomena. 10 test points in the 67 bar matrix were repeated with a salinity reduced from 6 wt% to 5 wt%. This salinity change was meant to represent the situations in wells when the produced water is changing from formation water to a mixture of formation and injected water.

6.2 Calibration and meter modifications

The vendors agreed that after calibration of the meters, no modifications were to be made on the meters during the 20 bar test period. Before switching to 90 bar, each vendor was allowed to implement minor changes and to recalibrate the meter with upgraded density information.
In separate meetings with each vendor prior to the testing, the vendors accepted this procedure. A test agreement was then signed by all the companies. Furthermore, it was agreed that any subsequent modification should be applied for by the vendors and approved by SSH before implementation.

6.3 Presentation of test results

It is very important to present the results well arranged since the amount of test data is very large. The main guidelines for the presentation can be summarised into the following:

- The results from each vendor is presented separately.
- The results is divided into pressure level. Three presentations wrt. oil, water and gas flow rates are given for each pressure level.
- Differentiation is made between oil- and water-continuous flow.
- The flow meters results are illustrated in two different ways on the same page to show performance. The first method is a XY plot, where the abscissa represent the reference while the ordinate represent the flow meter (XY plot). In the second method the ordinate is the absolute difference between the meter and the reference.
- 10 % uncertainty band is superimposed on each plot to illustrate the accuracy of the meter.
- A method for more detailed evaluation is prepared. This evaluation shows the meters performance and accuracy regarding gas-volume fraction, watercut, actual fraction, total liquid flow and water cut measurement.

Examples of presentation of test results are shown is fig 3. The results are evaluated in 5 different levels. In level 1 the flow rates for each phase are shown. Level 2 shows the total liquid flowrate and the deviation in watercut. In level 3 the relative deviation for oil, water and gas are presented as a functiion of gas fraction. Level 4 and 5 are also showing relative deviation for each phase as a function of watercut (level 4) and as a function of the actual phase (level 5).
No detailed test results will be presented in this paper. It is difficult to present results from such a large test, including meters from four different vendors, in a representative and complete manner. The results are owned by the license groups funding the test.

7 Experience gained in the test programme

The results obtained in the Porsgrunn test have shown that it is very important to demonstrate the different meters performance over a wide range of operating conditions.

Testing at different pressure levels above 20 bar have shown that some of the multiphase meter principles are pressure/flow regime dependent whereas other principles have proved to be more or less pressure/flowregime independent. For one of the meters the test has revealed that the meter is not yet applicable for high pressure applications. For the three other meters the best results are obtained at the highest pressure levels in the test. The temperature variations are not showing any significant impact on the meters performance.

For several of the meters, important improvements have been made during and after the test period based on the experience obtained. Some of the vendors have implemented or improved their flow models to compensate for velocity difference between liquid and gas (slip) etc. These models have to be pressure and site independent to prove their efficiency.

Use of differential pressure devices to measure flow velocity have been proven to be very efficient for most of the test conditions. It is also seen that the velocity results are generally very good at as low pressure drops as 30 - 40 mbar.

The testing has demonstrated the different meters performance over a large range of conditions. The most important experience is maybe that the meters can be used at gas-volume fractions as high as 95-96 % with satisfactory results. For the electromagnetic meters it is today more difficult to measure in water-continuous flow than in oil-continuous flow. Only one of the meter has demonstrated that it can detect a water break-through in a well. That is, a minor change in watercut from 0 % till 2 %. To obtain this sensitivity it is of key importance to calibrate the meter in a proper way.

The testing has demonstrated, for three of the meters, an accuracy levels within a 10 % confidence interval for the majority of the test results for all three phases. This is satisfactory knowing the wide range of test conditions going from 0 % gas to 98 % gas etc.

Although the results are generally positive, the testing and the first experience after commissioning of the meters have revealed weak features for some of the meters. It is important to concentrate work on the calibration procedures. It is not a practical way in field applications to modify calibration constants looking at results from the reference measurements. We do expect that we at the end of this year will see improved meters from all vendors compared to the versions tested in Porsgrunn!

8 Conclusions

The testing of four commercially available multiphase meters has been very important for the three Norwegian oil companies Statoil, Saga and Norsk Hydro in their efforts to qualify and select multiphase meters for key applications. After the test campaign, the basis for selection of a multiphase meter for a particular well/field can now rely on high pressure test results over a wide range of conditions. These results, together with previous field experiences demonstrate that 3 of the meters have reached a maturity level that is satisfactory for the oil industry to consider the technology qualified and applicable for both topside and subsea applications.

For 3 of the meters the results showed a generally good performance, especially at high pressure levels. The meters are different and they are all having strong and weak features. When selecting multiphase meters, the test results will be compared with the actual predicted production profile for each well/field.

The SSH co-operation on Subsea Multiphase Meter Development is now entering into the next phase aiming for a subsea multiphase meter to be implemented early 1997.

Acknowledges

The following field development projects/licenses are supporting the programme:

- **Åsgard** (Smørbukk, Smørbukk Sør and Midgard).
  Partners: Statoil, Mobil, Neste, Agip, Total, Norsk Hydro, Saga, Deminex.

- **Statfjord Nord** (PL037).
  Partners: Statoil, Mobil, Esso, Conoco, Shell, Saga, Enterprise, Amerada Hess.

- **Gullfaks Satellites** (Gullfaks Sør, Rimfaks and Beta-ryggen).
  Partners: Statoil, Saga, Norsk Hydro.

- **Vigdis**
  Partners: Statoil, Saga, Esso, Idemitsu, Norsk Hydro, Elf, Deminex, DNO.

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2. Communication and test evaluation reports from the vendors:
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   - Kongsberg Offshore AS
   - Multi-Fluid Int. AS

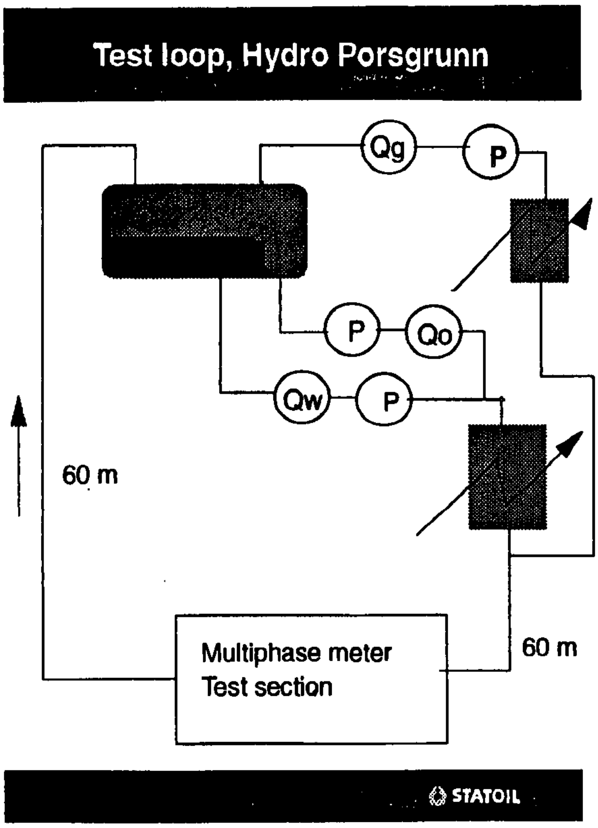


Fig 1 Multiphase Test Loop

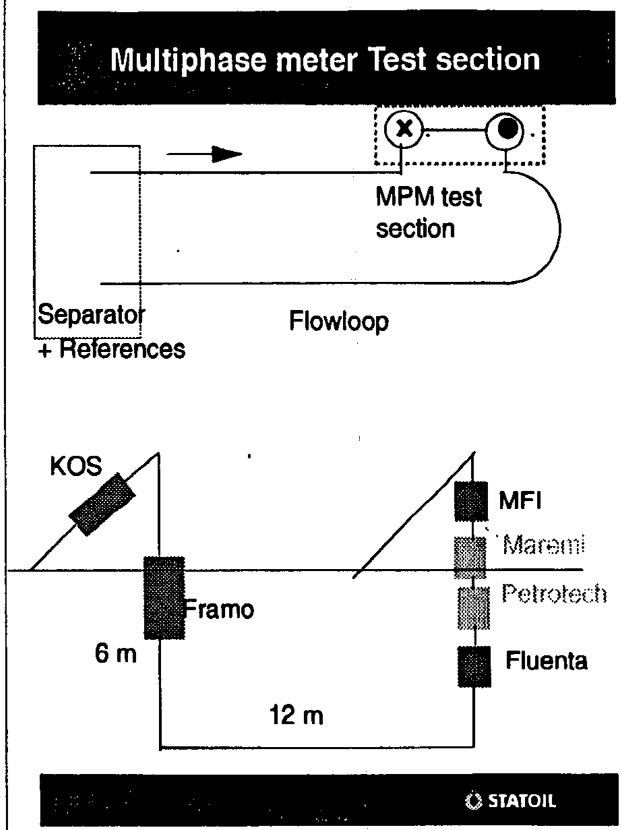
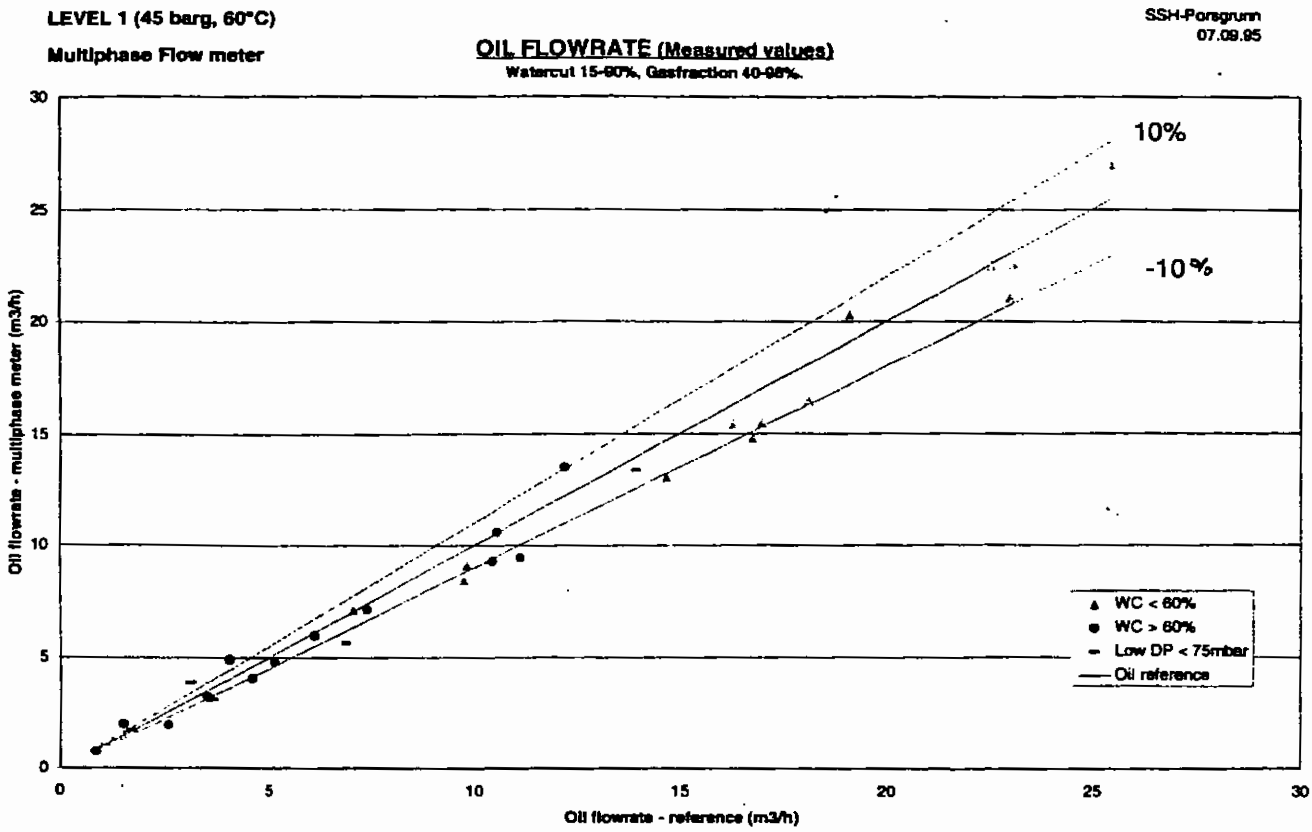


Fig 2 Multiphase Meter Test Section



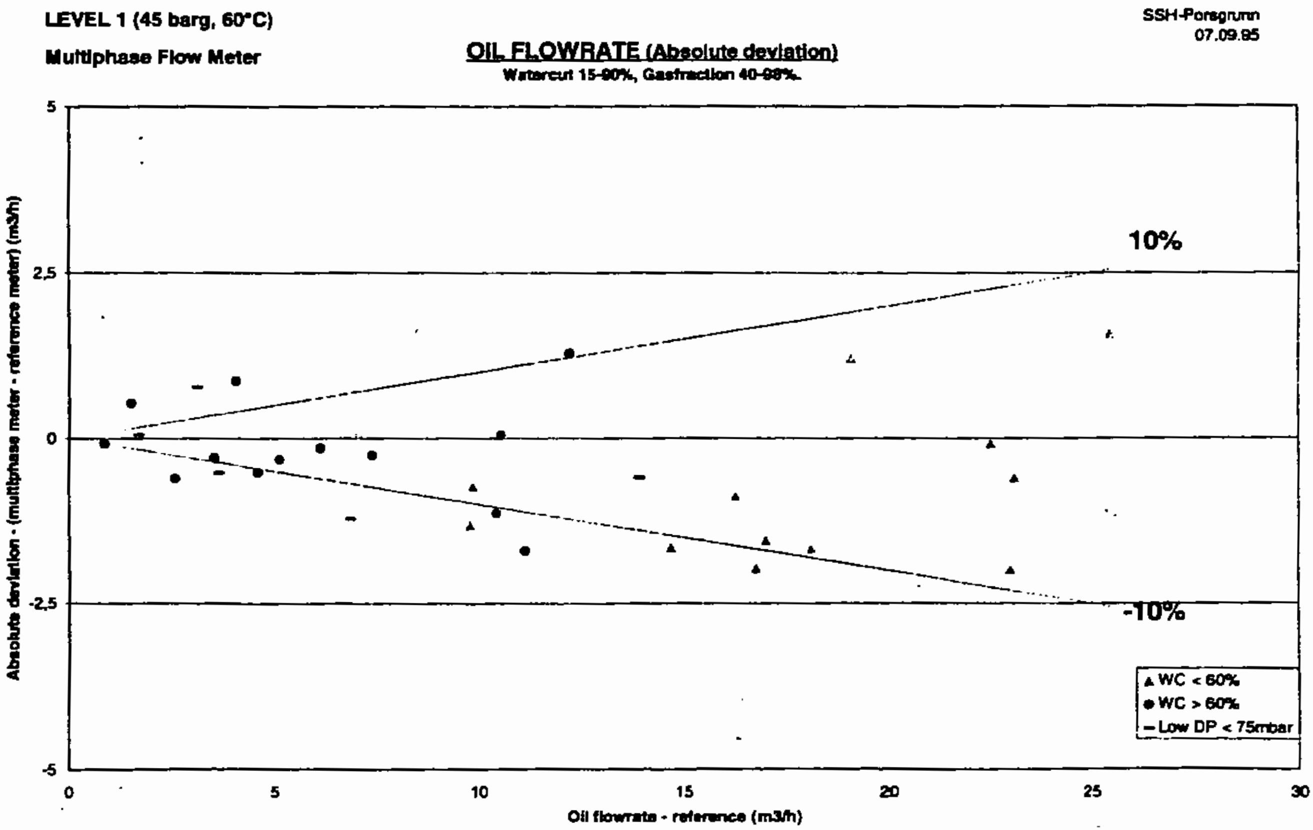
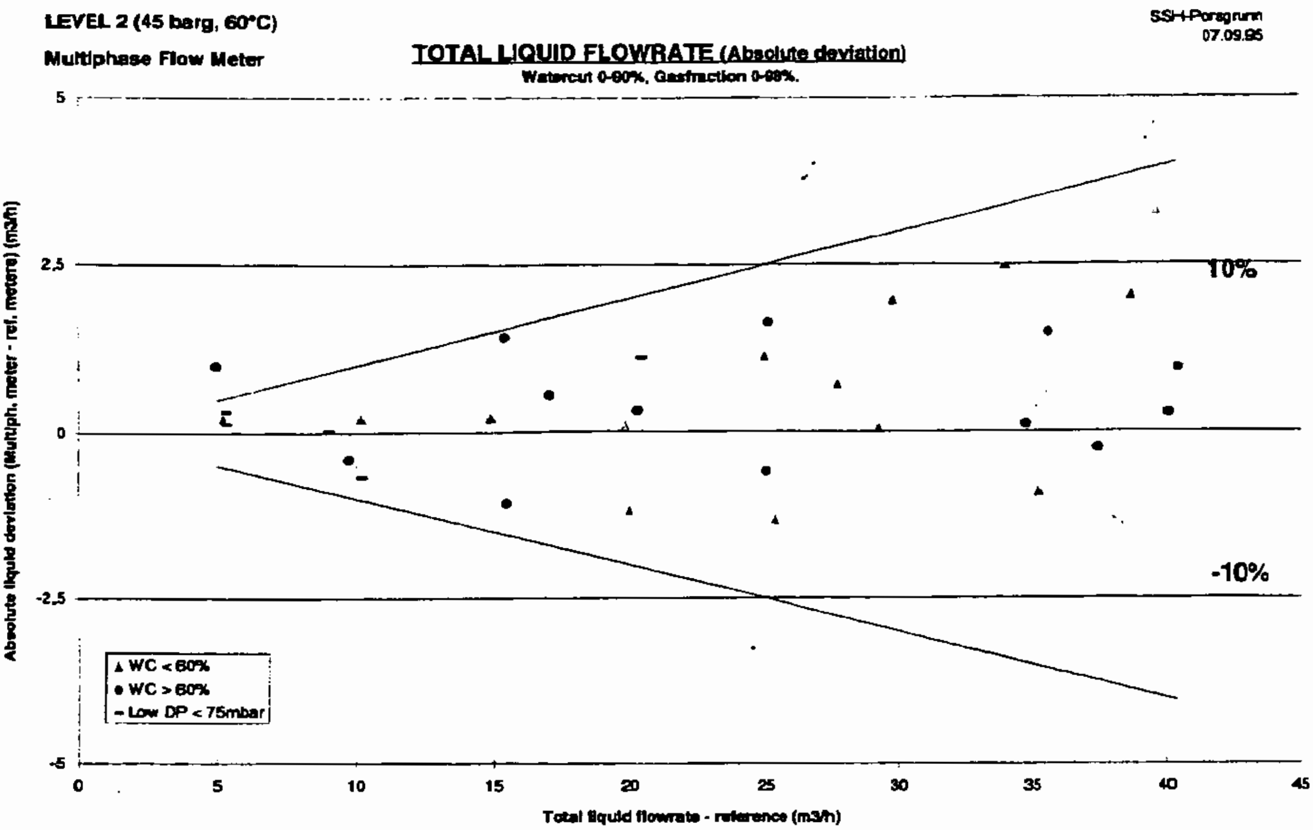


Fig 3a. Presentation of test results Level 1



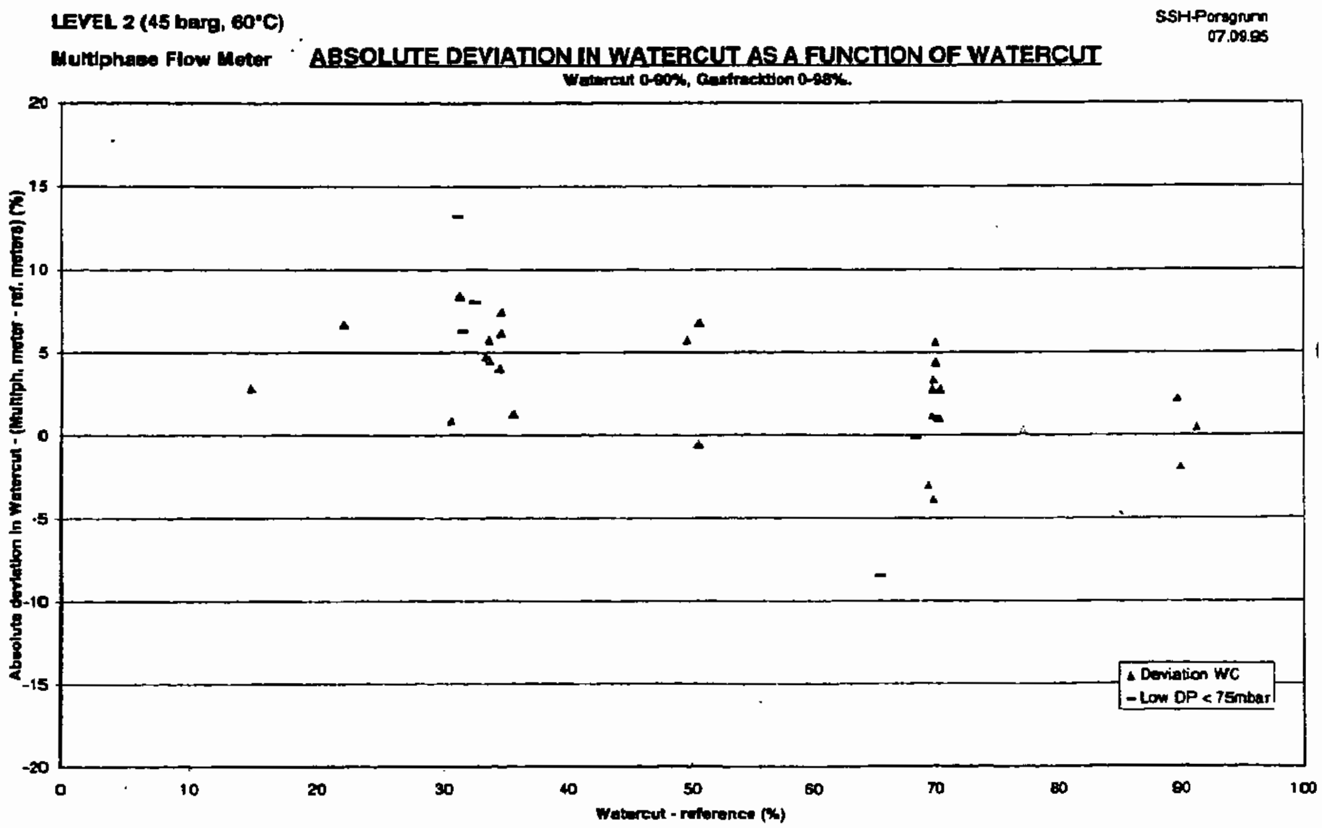
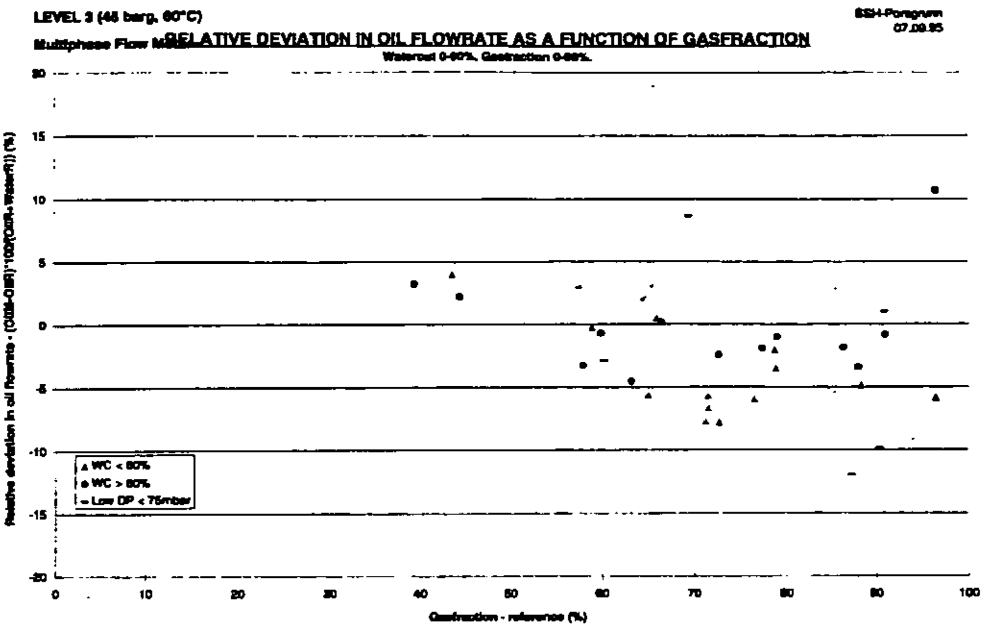
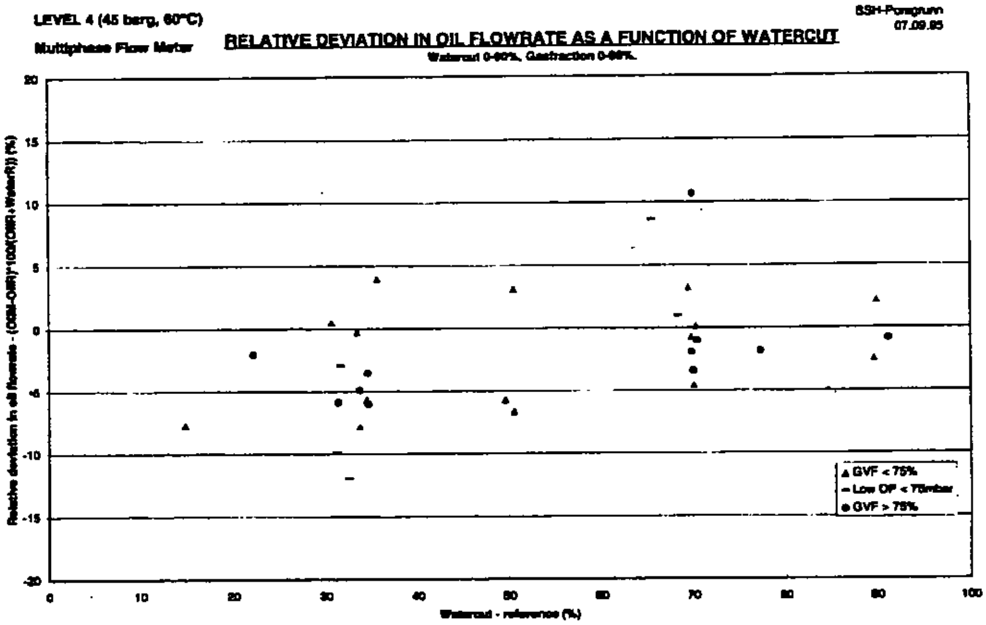


Fig 3b. Presentation of test results Level 2





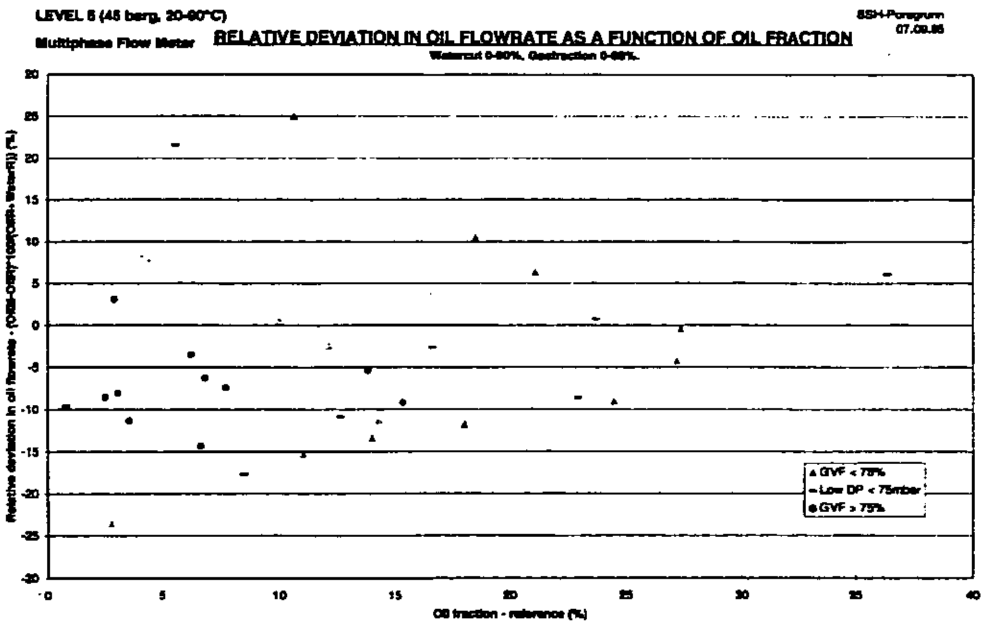


Fig 3c. Presentation of test results. Level 3 - 4 - 5