A PARTNERSHIP DEVELOPMENT BETWEEN STATOIL AND MOISTURE SPECIALIST MCM, RESULTS IN REDUCED COSTS OF OWNERSHIP AND IMPROVED DATA IN THE FIELD OF WATER IN GAS MEASUREMENT.

Data and site services supplied by Statoil
Report signed onto by;

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ABSTRACT

Statoil use moisture analysers for determining water content in natural gases within 'on- shore' and 'off- shore' applications on a variety of gas compositions. Often instruments require frequent recalibration due to contaminants and handling issues which increase maintenance costs and prolong downtime. Due to the logistics difficulty of transporting instruments to and from shore for revalidation, many operators use bottled certified 'test' gases as a method for checking and adjusting instruments between calibrations. A review of validation records by Kollsnes highlighted that no steady or predictable change was affecting the instruments and that adjustments were necessary both to increase and decrease observed readings at unpredictable intervals. This suggested a variety of reasons may have been responsible for the lack of repeatability observed, including contaminants, test methods or validation procedures. It was subsequently shown that a more stable and repeatable ' on-line' validation system, in conjunction with better handling techniques of instruments at dry gas levels, significantly improved the uncertainty budget and extended the service intervals, reducing the overall cost of ownership. By adopting these changes Statoil was able to collect reliable moisture content data in less time and with greater traceability.

In recent years Statoil have replaced many of their spot check moisture analysers with devices fitted with temperature controlled Silicon sensors. These instruments were selected, amongst other reasons, for their ability to dry down rapidly and respond much faster than traditional analysers, allowing Statoil to achieve shorter measurement times and improve confidence in the collected data through the use of temperature controlled sensors. In order to optimise the performance in the range of most interest (40 ppm), it became apparent that improvements in the validation and handling techniques of such instruments would also be necessary. Statoil, having good working relations with MCM, the supplier of these instruments, entered into a development program with them in order to improve the areas most likely to generate results; These were;

1. **To develop a test methodology to improve the storage and handling of the portable moisture analysers.**

2. **To identify whether the latest instrumentation would have performance benefits over the present equipment and achieve Statoils declared objectives.**

3. **To provide a validation system that could match the performance of the analysers.**

4. **Reduce the cost of ownership by eliminating the use of expensive consumable gases.**

Existing Methodology

Data collected by Statoil (Graph 1) shows the spread of results between portable moisture measuring instruments used daily on natural gas at Kollsnes from 1997 to 1998. When the instruments fell outside +/- 3 degrees tolerance they were to be sent for recalibration. In an attempt to reduce the calibration frequency Statoil and MCM worked closely together implementing a number of changes to the operating methodology in order to reduce the spread of data observed. It was established that better repeatability of collected data could be achieved with the existing instruments by adopting just a few simple, but significant, practical changes relating to the handling and storage of the instruments. Graph (ii) shows the spread of these results following the implementation of these new procedures. It was suggested that additional improvements could also be achieved by improving the validation method. It was felt that the existing method lacked sufficient stability and repeatability to make any meaningful instrument adjustments at the moisture levels of most interest to Statoil. MCM claimed that if instruments were not sufficiently dried down to a repeatable value before checking with the test gas then this combination of effects would result in over compensation following any adjustment, and be seen as poor repeatability.

MCM highlighted several facts relating to uncertainty of using bottled gases to support this view. They were;

1) ISO Standard 6141 requires that the amount of the gas or gas mixture in supplied mass, or in supplied volume at specified reference conditions (pressure and temperature) shall be stated on the suppliers certification. Particular care should be taken when interpreting bottled gas certificate data (with respect to testing moisture analysers) in order to establish whether the data is expressed in mole fraction or volume fraction as such analysers are often calibrated in terms of volume fraction. In the latter case a common reference temperature used is 15 degrees Celsius. However, most laboratories operate at 21degrees or warmer. Consequently, the water volume concentration may, therefore, be different to that stated on the certificate due to 'wall' effects (adsorption/desorbtion) caused by any temperature gradients.

2) Manufacturers ensure that bottled 'calibration'gas mixtures are rolled for several hours prior to certification to ensure a homogenous mixture and temperature equilibrium. In practice there may be some contribution to uncertainty of the output value if bottles are not rolled prior to useage, which may be difficult to quantify in practice.

3) The stated uncertainty of determinations made on such bottles by a manufacturer is typically +/- 5%. This is in addition to any other uncertainties associated with operator handling and hookup of wet components. The choice of components and length of pipework directly affects the time it takes for these gases to reach equilibrium.

4) Validation methodology varies between operators. Some may decide, due to the high cost of purchase and transport of bottled 'calibration' gases, to pre- purge pipework, regulators and instruments to equilibrium with a less expensive inert gas such as Nitrogen or dried Air. Others may use the 'calibration' gas itself to condition the system to equilibrium. Each approach has different practical and commercial implications giving rise to different sources of uncertainty and therefore a spread of results.

From practical experience it would not be possible to reduce overall uncertainties of measurement until a more stable and reproducible validation system and handling methodology was implemented.

Modifications to Handling

MCM prepared a validation system to their own design and specification, together with a mechanical modification to two of the existing portable moisture analysers used by Statoil. In the previous methodology it was known that appropriate exposure to 'dry' gas purging, or 'wet' level checking with 'certified' gases of a sufficiently stable quality, was not always repeatable, as the purging times vary significantly depending on a number of variables including the condition of components used and the ambient humidity of the day. The modifications proposed would enable the equipment to be transported, and held, in a dry condition between validation and testing without affecting the electronics or measuring principle in any way. By doing so the equipment could be kept within its operating range at all times. This would enable instruments to settle to equilibrium much faster, reduce their exposure to potential contaminants and reduce both sampling time and risk for the operators.

Changes to the Validation System

The validation system consisted of a an automatically regenerating molecular sieve drier generating dry gas to a manifold with several outlets. One stream of dry gas was then continuously fed through a moisture generator to give a stable and continuos 'wet' gas level which was monitored by a high precision moisture meter acting as a reference hygrometer. The users were asked to continue monitoring natural gas test points using the new methods and validation techniques, with the same modified analysers. Any results and any adjustments they might make were to be recorded for analysis.

Instrument Technology

It was proposed that the latest analyser from MCM which had a resolution of 0.1 ppm and a graphical interface would provide the resolution and performance benefits to achieve Statoils objectives. In order to establish whether the improved resloution could be applied to Kollsnes gas the analyser was exposed in the lab under carefully controlled conditions to the equivalent of 2 months gas sampling. This instrument demonstrated significant improvements over the existing analog portables and was shown to keep within specification throughout its test period. The use of such an instrument was shown to be a valuable upgrade as and when greater accuracy may be required.

Traceability

In order to provide an audit trail the hygrometer would be routinely sent for recalibration back to MCM in order to define the uncertainty on the generated moisture. In this way the repeatability of the transfer standard hygrometer was to be established through normal ISO calibration practice. The provision of a continuos supply of clean moisturized gases of known water contents, as defined by the transfer standard hygrometer, eliminated the need for operators to wait for pipework and components to settle. This improvement in traceability and repeatability of validation values over the previous methodology were expected to be significant. This approach had the added benefit of ensuring that the transfer standard device was protected from contamination by residing permanently on clean gas, helping to extend the service interval of the system.

Results

The results of these changes clearly indicated the importance of establishing a stable dry gas reference for both purging and adjustment of the hygrometer. It became apparent that keeping the instrument in a dry purge condition prior to making any field test or adjustment was of great benefit in improving repeatability and extending the service interval, by helping the sensors to elute volatile contaminants from their surfaces between measurements. From Graph (iii) the improvements in repeatability are recorded. The improvements in the stability and repeatability of both the validation method and handling changes are demonstrated by the close level of agreement between the reference hygrometer and the portable moisture meters over several weeks. A contamination effect, when it occurs, is clearly seen as a deviation. When Statoils acceptable tolerances were exceeded, the operators could make an adjustment.

Conclusion

The primary objective to improve repeatability of field determinations has been achieved by making mechanical modifications to the analysers.

Maintaining a dry gas condition within the pipework and sensor assembly, has been shown to be important, particularly during transport to and from a test point, following validation. By minimizing the ingress of ambient air, the instruments have been maintained within their operating range, and therefore have been less susceptible to shifts in calibration and the effects of hysterisis. The performance improvements resulting from these changes can be seen from a comparison of the initial data from 1998 and that from July 2000. The spread of data between the same instruments has been reduced significantly following the modifications and implementation of the new handling methodology. Contamination effects, such as observed in chart1,A become evident much earlier. This allows corrective action to be taken quickly and so improves confidence in the analyser.

Service intervals have been significantly extended.

The development of a continuos validation system, which generates a continuos source of stable 'dry' and 'wet' moisture levels, enabled the operator to keep the instruments in best condition at all times. Improved methodology has reduced the storage and handling procedures for operators. A direct benefit has been that instruments could be checked on demand, without having to consume expensive test gases, or have to wait for a long time in order for pipework to settle to equilibrium. As an equilibrium condition was already established, many of the uncertainties associated with moisture contribution from pipes and fittings were eliminated. Indirectly the convenience and ease of use of the system promoted more frequent revalidation's, and so improved the reliability and overall Quality of collected data for Statoil. From chart 1 it is seen that checks were carried out every 2 days on average.

The cost of ownership is expected to pay back within 18 months.

This is based upon the consumption and current price of certified gases that would be necessary to provide the same frequency of validation, allowing one hour for stabilisation and reading, at a flow of 500 ml/min.on each of the 'dry' and 'wet' gas levels. For the reasons given, the repeatability would not be as good and the operators involvement would be increased. This payback period would be dramatically reduced if the certified gases were allowed to purge through pipework continuously as the new system does.

Summary

Modifications to handling procedures have improved repeatability.

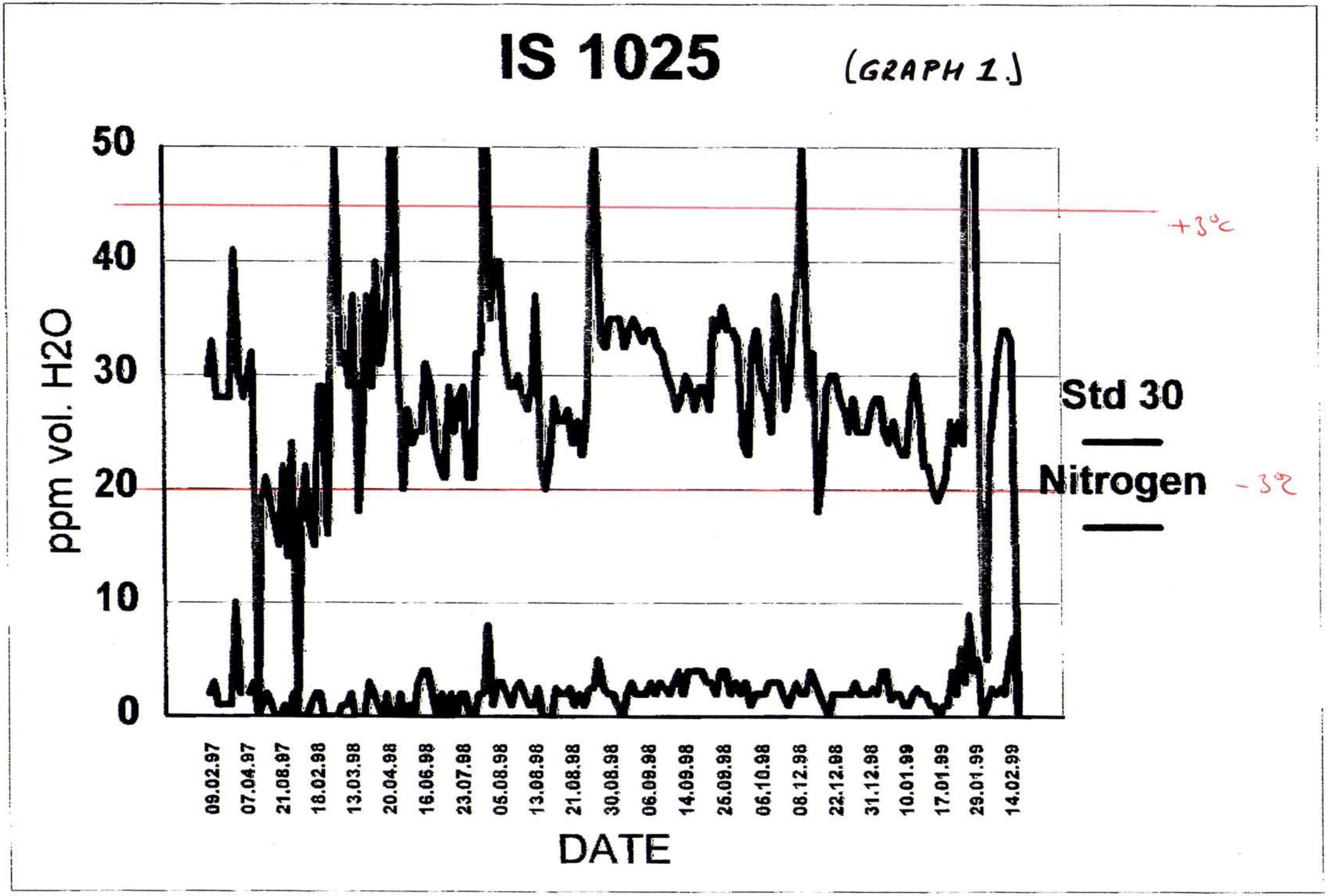
The use of a continuos validation system has significantly extended service intervals.

Quality and reliability of data has been improved.

Cost of ownership has been reduced.

New technology developments can provide a secure upgrade path.

The partnership program has resulted in a significant improvement in repeatability and confidence in the readings taken by an operator, and allowed Statoil to identify a more reliable and cost effective validation method for water content monitoring in Natural Gas.


IS 1025
(GRAPH 1.)
ppm vol. H2O
50
40
30
20
10
0
+3σ
-3σ
Std 30
Nitrogen
09.02.97
07.04.97
21.08.97
18.02.98
13.03.98
20.04.98
16.06.98
23.07.98
05.08.98
13.08.98
21.08.98
30.08.98
06.09.98
14.09.98
26.09.98
06.10.98
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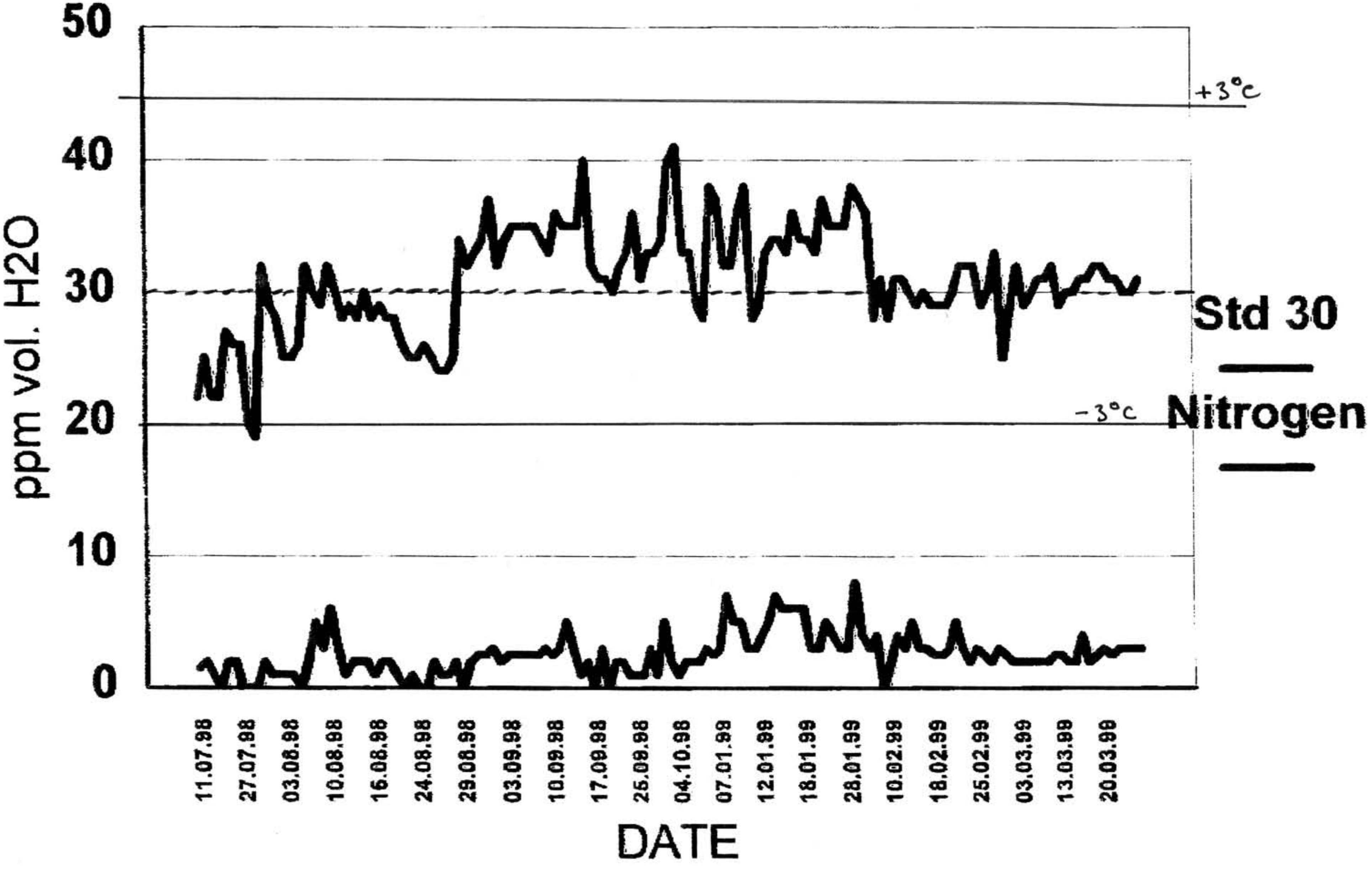
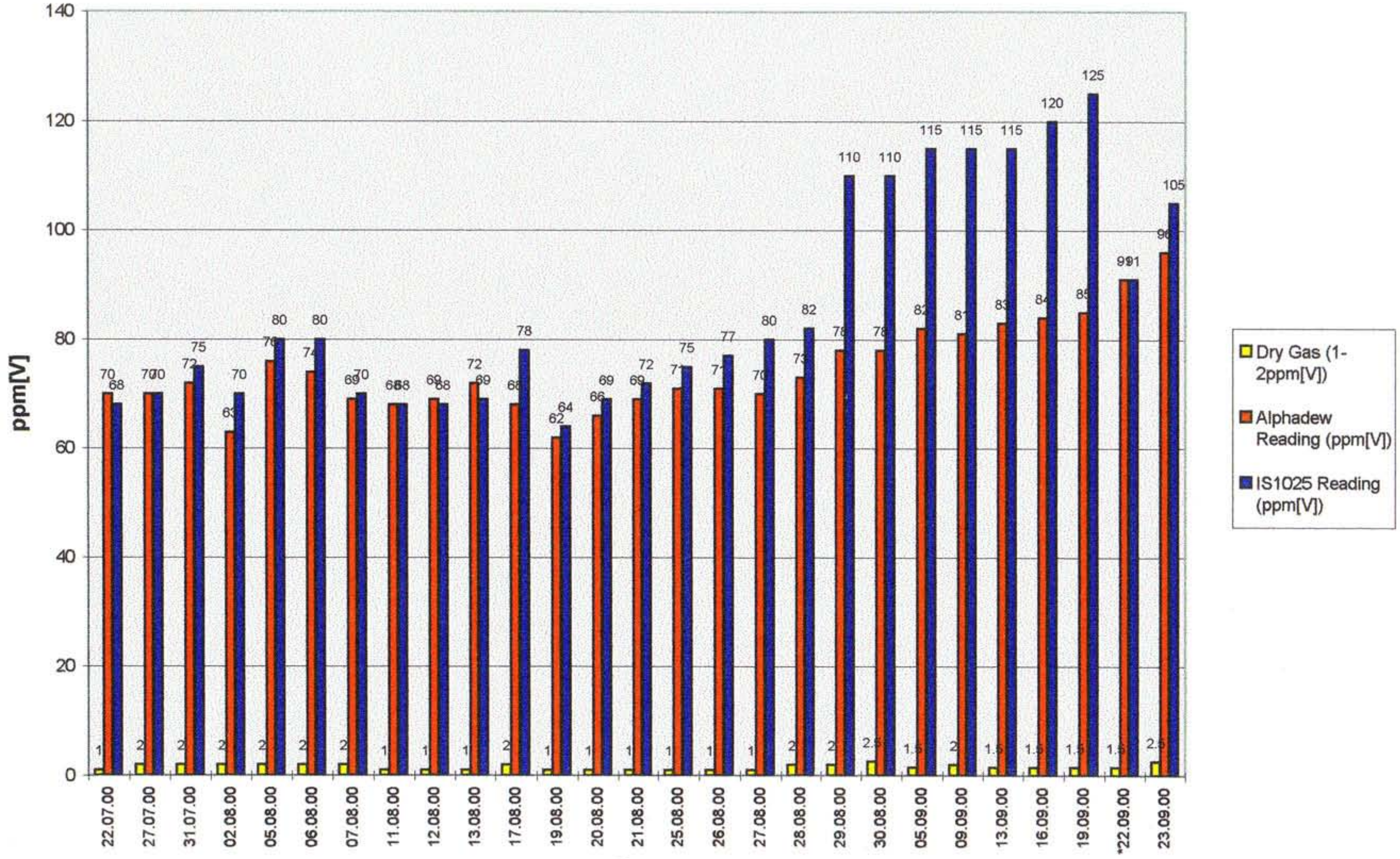
14.02.99
DATE

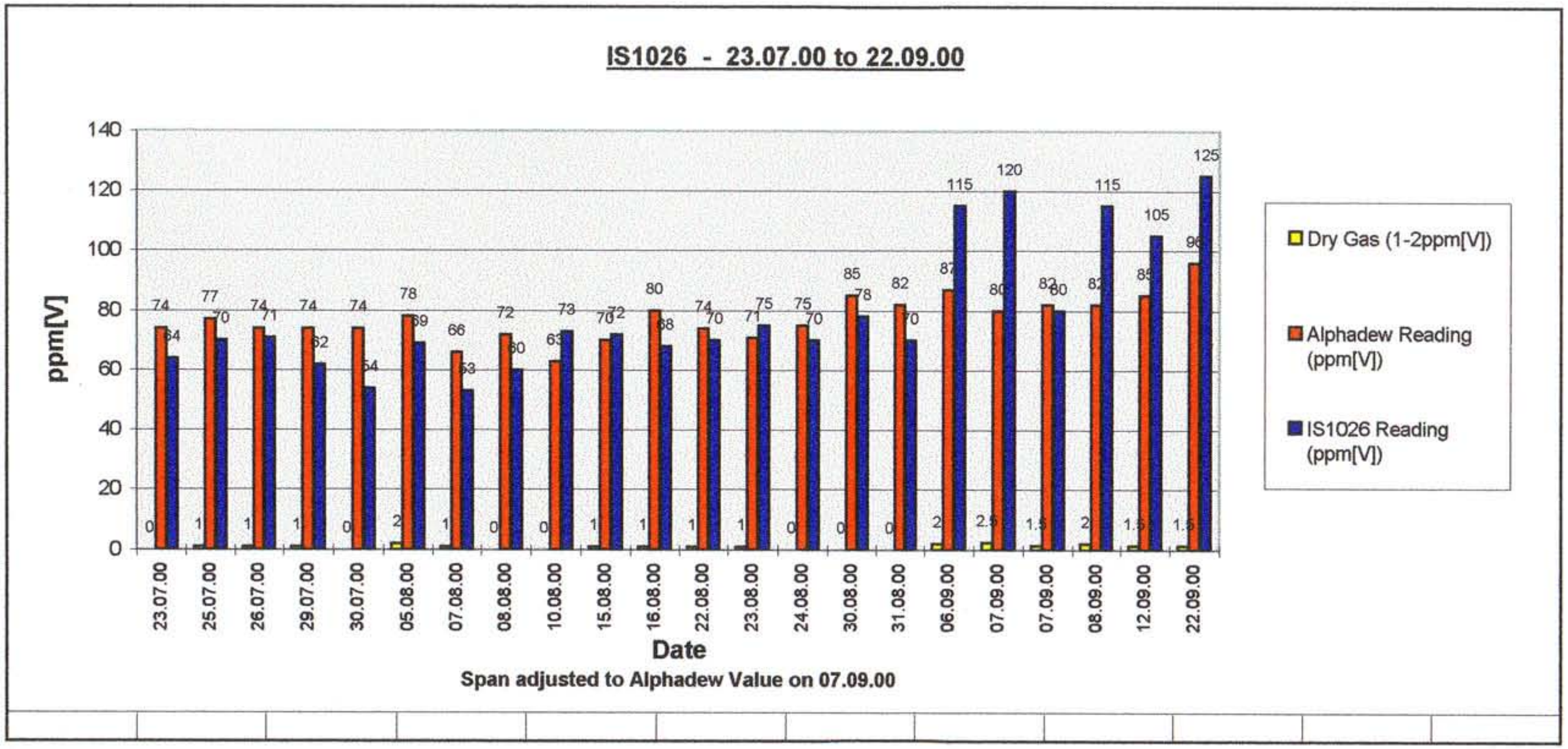
0347 GRAPH (ii)



IS1025 - 22.07.00 to 23.09.00

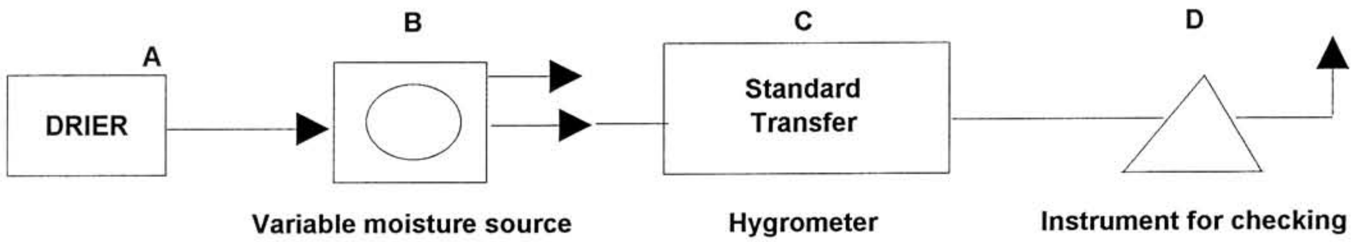


* Span adjusted to Alphadew Value


IS1026 - 23.07.00 to 22.09.00
ppm[V]
140
120
100
80
60
40
20
0
23.07.00
25.07.00
26.07.00
29.07.00
30.07.00
05.08.00
07.08.00
08.08.00
10.08.00
15.08.00
16.08.00
22.08.00
23.08.00
24.08.00
30.08.00
31.08.00
06.09.00
07.09.00
07.09.00
08.09.00
12.09.00
22.09.00
Date
Span adjusted to Alphadew Value on 07.09.00
Dry Gas (1-2ppm[V])
Alphadew Reading (ppm[V])
IS1026 Reading (ppm[V])

Transfer Standard System

In order to validate, between routine measurement, the readings obtained with a moisture meter it is possible to establish a simple to use validation method as described below:-



MCM will supply a 2 column heat generated molecular sieve drier (A) that provides particulate fine dry air to the moisture generator (B).

This dry air is then split into two streams to give a dry gas of less than 1 vpm output and a moisturised stream variable over the range of the instrument (B). Either output can be supplied to the transfer standard hygrometer and its moisture content read off the instrument (C).

This is used a an input for checking any portable hygrometer and enabling local adjustments to be made.

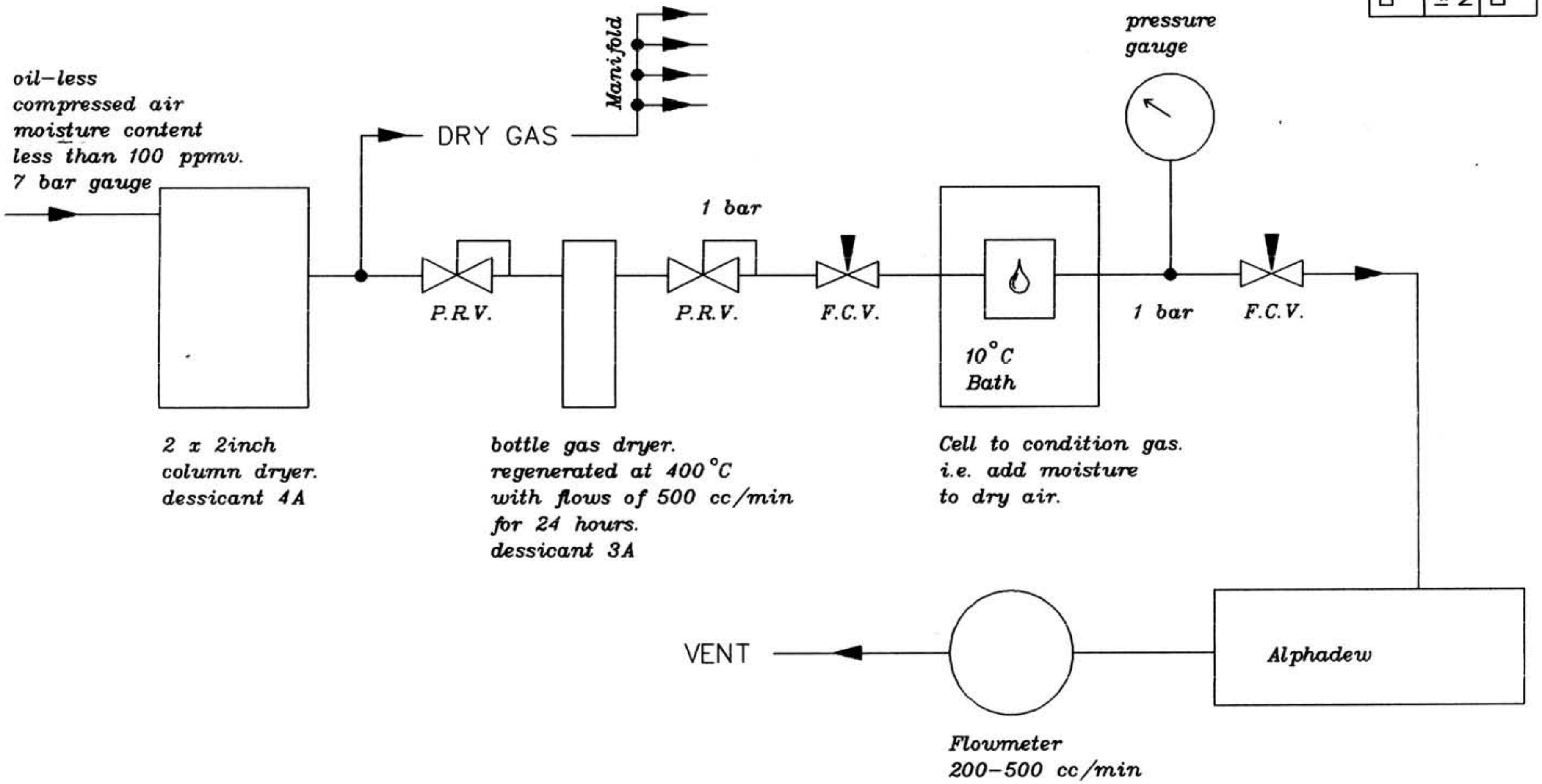
It includes 3 traceable calibrations per year on the transfer standard unit (C) and full maintenance of the drier/moisture source. By ensuring that the transfer standard is kept on clean dry gas and the system components are routinely serviced the integrity of data is maintained.

The system can be used to check any hygrometer accepting an atmospheric pressure input and provides useful data on service and contamination levels of each hygrometer.

Enc.

Proposed Validation System for Kårstø

Initial Set-Up



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