
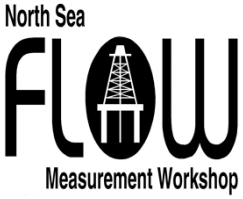


# Experience with Compact Provers on cold Products

by

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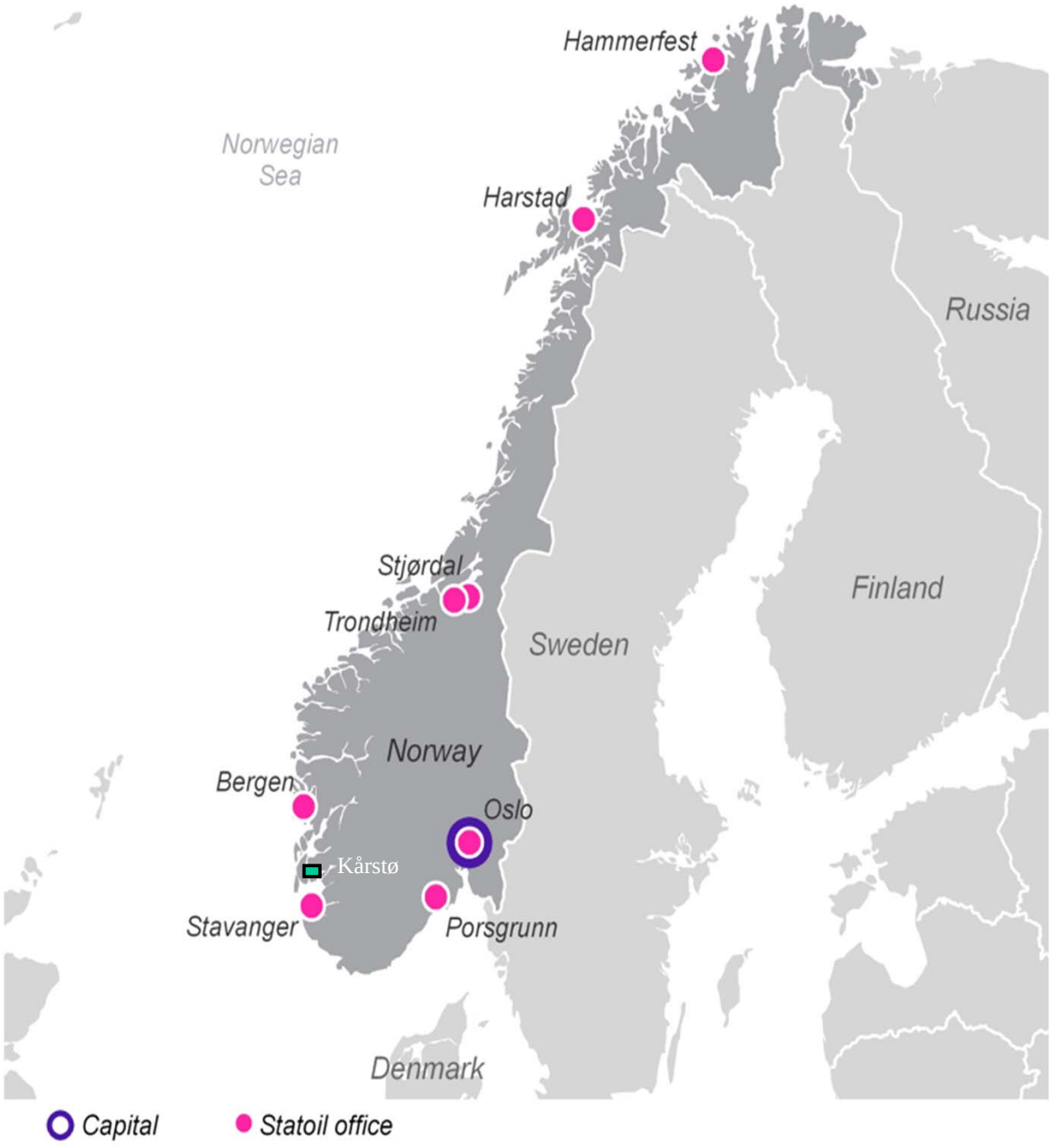
# Location for Kårstø

North Sea FLOW Measurement Workshop



# Overview of the Gas Processing Plant at Kårstø

North Sea FLOW Measurement Workshop

Photo: Øyvind Hagen/ Statoil

# Piston Prover

Kårstø gas processing plant was built in 1984 and started up in 1985. The export were either by pipeline, Statpipe, or by boat. Therefore there were installed one gas metering station and four liquid metering stations.

Together with the metering stations there were also installed 2 piston Provers; both about 6,5m³. One for Propane and one to be shared between butanes and natural gasoline.

The liquid export was not that high in the beginning but it was a lot of problems that had to be solved. The material in the soft seal in the plug valves did not like the Propane. So when this was set in operation it did swell out and caused a lot of problems. The problems for the material was both against the low temperature of -40ºC and the Propane. It took a year before the manufacturer managed to come up with a material that could withstand both low temp and Propane.

But also challenges regarding the piston Prover came up. Leakage over the piston, this was solved with Fluor carbon seals. Another challenge here was the core in the seals. It was first a V-shape to achieve a pressure against the cylinder wall. Unluckily this was also a damage to the cylinder when the seal was worn out. Because then the metal started scratching the inner wall/lining. The whole Prover had to be shipped to Germany to be machined. New lining and honing of the whole cylinder. The material in the piston was changed from aluminium to composite material. After this accident the core in the seals was changed from V shape to spring inside the seal. But since the weight of the piston was high the cylinder got worn out again and needed another trip to Germany. These trips lasted at least 6 months.

Therefore the plant got a dispensation from NPD to run 6 monthly proving against a curve. This have been functioning fine and we have managed to extend the life of the Provers. But the number of batches has increased up to 1100 a year.

To act according to regulations we have to do proving on each batch. To solve this; small volume Provers could be the answer.

# ISO for the piston Prover

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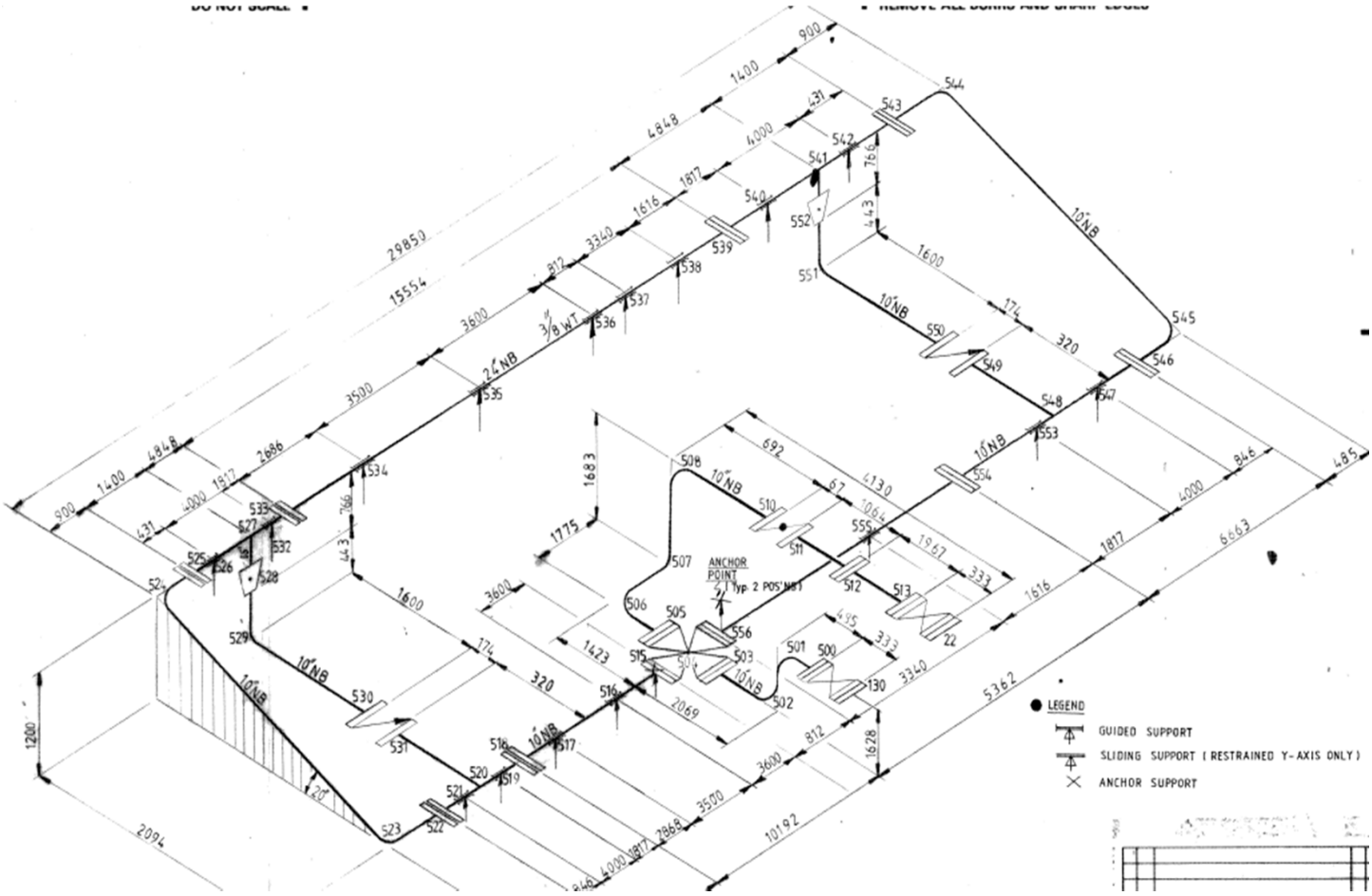
To give an idea of the dimension of the different types of Provers we see here that the piston type Prover is about 30 metres long. Compared to Compact Prover which is about 4 meters long for the same capacity. Also piping arrangement due to use of 4-way valve is eliminated when using Compact Prover.



# Piston Prover

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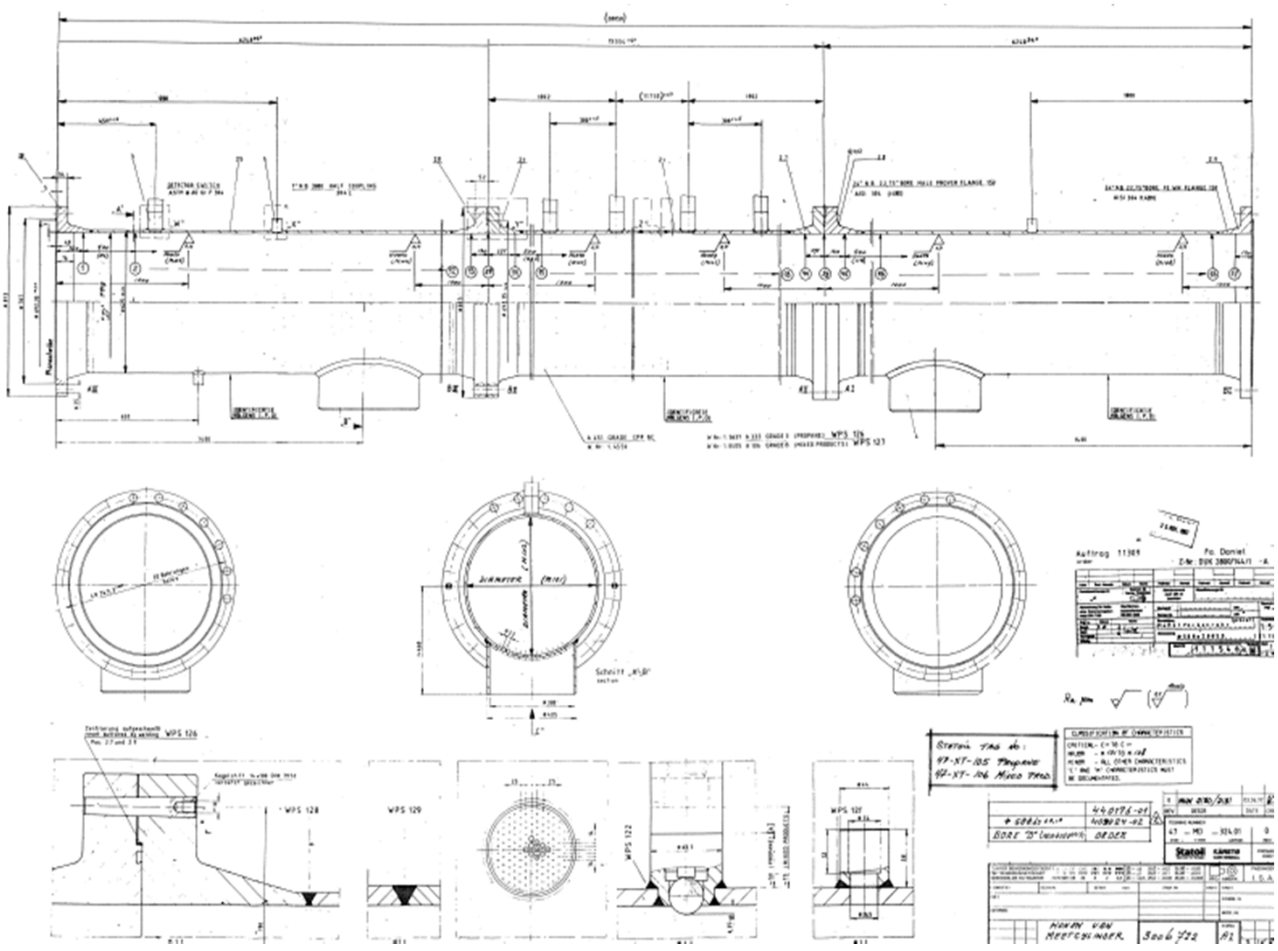
This drawing shows how much of the Prover had to be shipped for machining.



# Compact Prover 1

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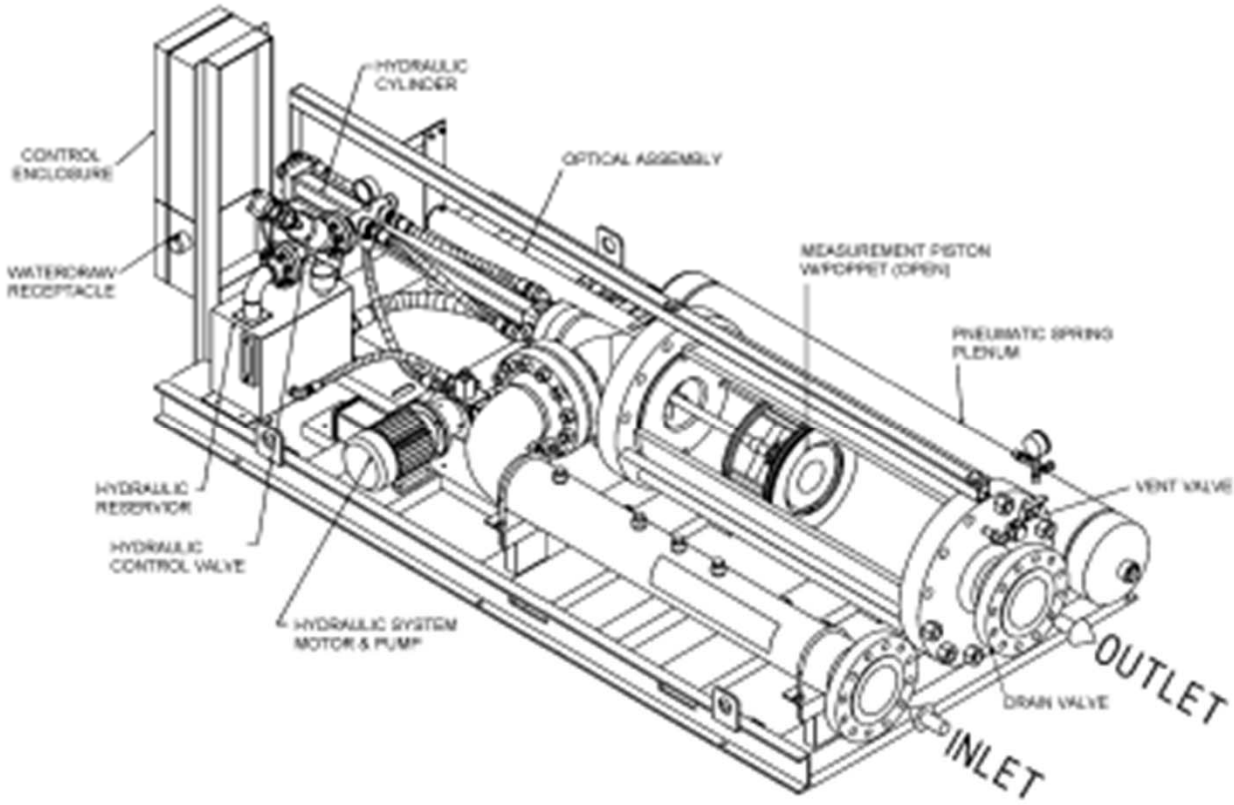
A new Project started in 1998 called KUP. They should design a new propane metering station whit a capacity of 5500m³/h. They came up with a plan to install a compact Prover on the skid. Since they operate on -40ºC it could not be ball Prover. A large piston Prover was out of the question.

A 24” Prover was ordered and tested on water. It functioned fine on water and temperature above zero degrees. This was hopefully a good start.



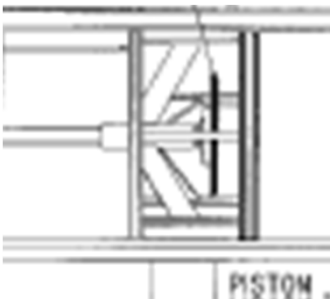

Typical 8", 12", 18", 24", 34" and 40" Cenelec Type

# Compact Prover 1

The volume of the Prover was only 0,25m³ and the proving of a meter did only take 5 minutes. This was very revolutionary. But soon we got problems to get the Prover to find the first switch. A lot of fault investigation was done and suddenly we got it running again. This time it was the changing of the backpressure that made it working. Therefore we had to read the “owners manual” again. And here we found out that the back pressure have to be adjusted if the process pressure increases  with more than 5%. Since we operate over a wide range of pressure. The pressure can vary from 7 barg up to 14 barg. This meant that we had do adjustment every time we should do proving. Only way to solve this was to install an arrangement to do this automatically. So now there is a solenoid to fill backpressure and one solenoid to drain backpressure. In addition there is a pressure transmitter on the backpressure. This pressure is compared to line condition. After we got this installed the calibration have been running much smoother.

The yearly calibration is done with water with a so called water draw. This is normally running as planned. The problems starts when we shall get rid of the water. According to the manufacturer it is not recommended to fill it with methanol to trap all the water. The procedure was to dry out with air. Then hot air. Then changing over to Nitrogen gas. First cold and then heated Nitrogen gas. The goal was to get a dew point less then -40ºC. In the beginning this could take several weeks. After reaching the correct dew point the Prover was filled with Propane. The system at Kårstø is designed so that it is possible to run a batch in recirculation mode. So when we tried to do a proving in a test batch the result was very bad. Repeatability ended on 50%. We discovered that the piston poppet valve was frozen in open position and there is no way to get this closed but gas free the system and heat it up above freezing point for Hydrates.( this can be higher than zero degrees)

# Compact Prover 1




We experienced then that the water trap in the slide bearings did not evaporate during the drying period. The get around this problem we found out that we should operate the piston during the drying process. By running the piston the poppet valve would also open and close. By this method we got rid of most of the water. The last action before filling the Prover was to position the piston in mid position. Then the poppet valve is closed. When we then launch the piston the piston will hit the obstruction in the end of the cylinder and the process pressure will open the poppet valve.

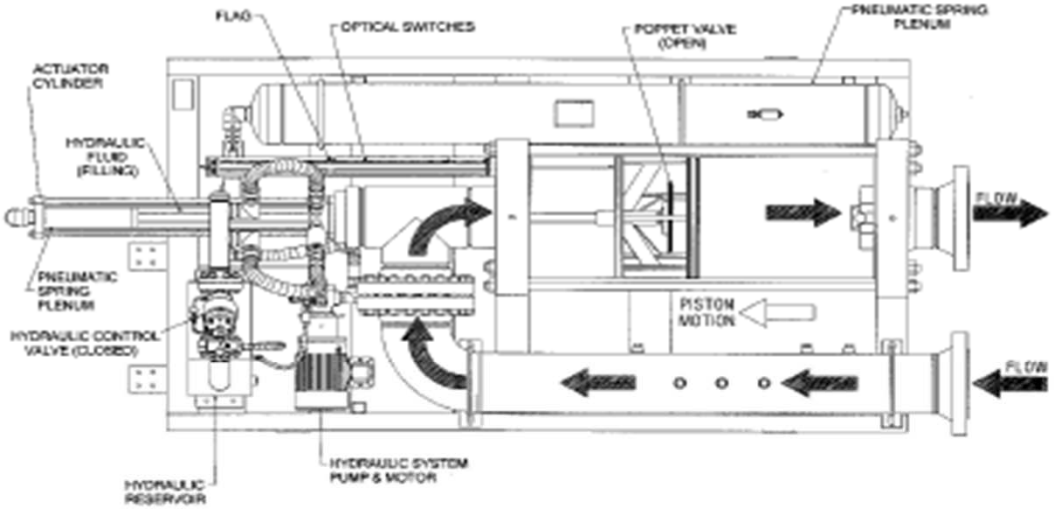



Figure 3-5. Piston Returning to Upstream Position

Early it was observed that it is not easy to know the position of the piston. (The design should consider to have a window in the cover for switches)

# Prover 1 details

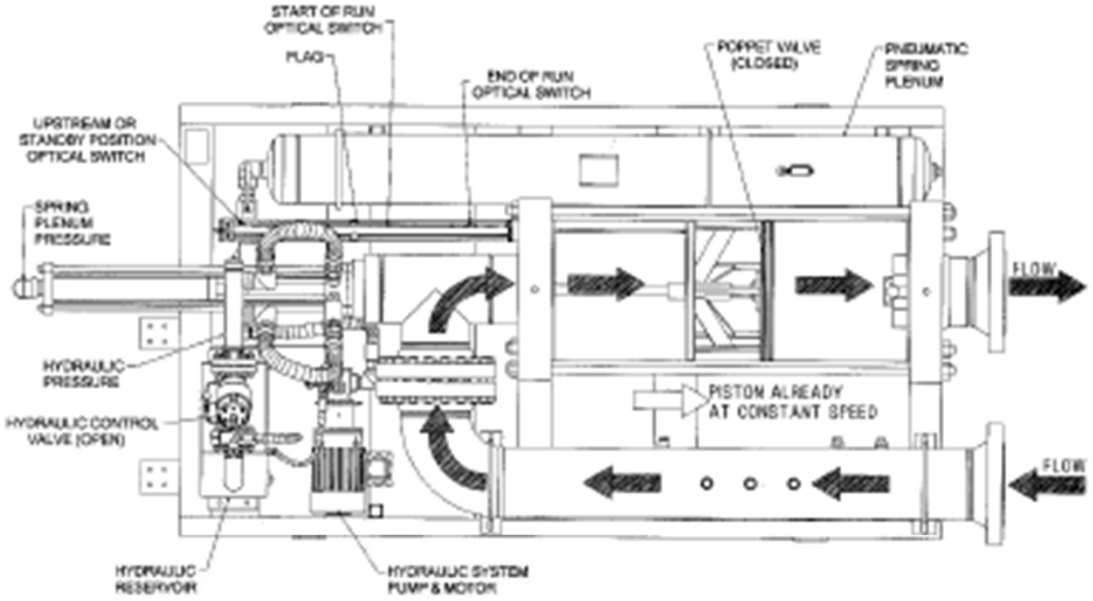



Figure 3-3. Proving

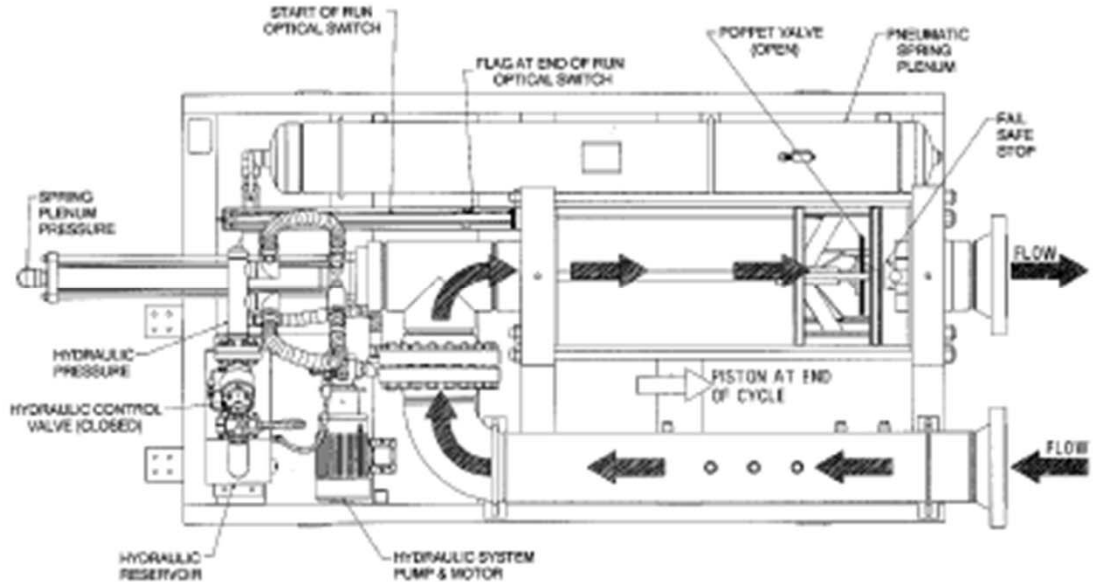



Figure 3-4. End of Proving Run

2011/09/27 14:55 Kårstø Propan Eksport Målestasjon KOS FCM 212

TURBINMETER KALIBRERING OG KORREKSJONSFAKTORER

Last nummer : 20110931-1

Navn : TIELRODE

Lasting startet : 2011/09/27 13:01

Status : FERDIG

Rørnormal Volum Sm3 **: 0.250601** Linje Nr. : 4

| Forsøk Nr. | Antall Pulser | Linje Temp GrdC | Linje Trykk barg | Rørnorm Temp GrdC | Rørnorm Trykk barg | Volum Strøm m3/h | Meter K-faktor P/m3 |
|---|---|---|---|---|---|---|---|
| 1 | 1664.5 | -40.90 | 8.82 | -40.98 | 9.90 | 1272.52 | 6634.25 |
| 2 | 1663.9 | -40.91 | 8.84 | -40.96 | 9.90 | 1277.76 | 6632.60 |
| 3 | 1664.0 | -40.91 | 8.85 | -40.96 | 9.92 | 1280.08 | 6632.82 |
| 4 | 1663.8 | -40.94 | 8.79 | -40.98 | 9.87 | 1287.28 | 6632.04 |
| 5 | 1664.2 | -40.91 | 8.80 | -40.96 | 9.90 | 1277.66 | 6633.76 |
| 6 | ### | ### | ### | ### | ### | ### | ### |
| 7 | ### | ### | ### | ### | ### | ### | ### |
| 8 | ### | ### | ### | ### | ### | ### | ### |
| 9 | ### | ### | ### | ### | ### | ### | ### |
| 10 | ### | ### | ### | ### | ### | ### | ### |

Gj.snitt

Siste 5

Forsøk 1664.1 -40.92 8.82 -40.97 9.90 1279.06 6633.09

K-faktor i bruk: 6632.25

Repeterbarhet: **0.035** Differanse.....: 0.01

| Forsøk Nr. | CPSP Tetthet | CTSP | Rørnorm Tetthet | CPSM | CTSM | Linje |
|---|---|---|---|---|---|---|
| 1 | 1.00012 | 0.99821 | 580.137 | 1.00005 | 0.99754 | 579.901 |
| 2 | 1.00012 | 0.99821 | 580.159 | 1.00005 | 0.99754 | 579.964 |
| 3 | 1.00012 | 0.99821 | 580.246 | 1.00005 | 0.99754 | 580.046 |
| 4 | 1.00012 | 0.99821 | 580.118 | 1.00005 | 0.99754 | 579.933 |
| 5 | 1.00012 | 0.99821 | 580.305 | 1.00005 | 0.99754 | 580.106 |
| 6 | ### | ### | ### | ### | ### | ### |
| 7 | ### | ### | ### | ### | ### | ### |
| 8 | ### | ### | ### | ### | ### | ### |
| 9 | ### | ### | ### | ### | ### | ### |
| 10 | ### | ### | ### | ### | ### | ### |

Gj.snitt

Siste 5

Forsøk 1.00012 0.99821 580.193 1.00005 0.99754 579.990

# Compact Prover 2

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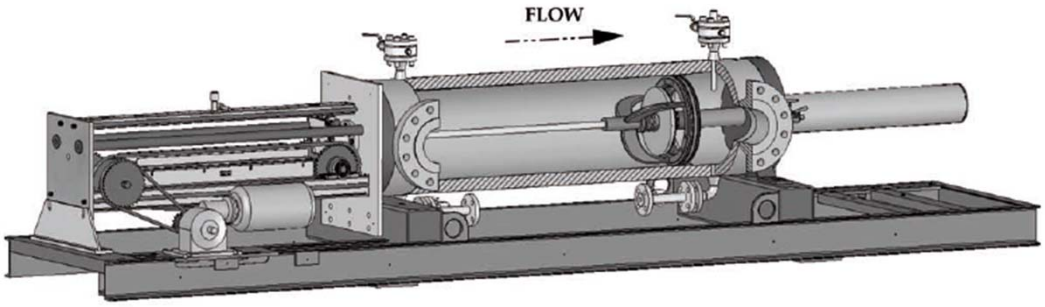
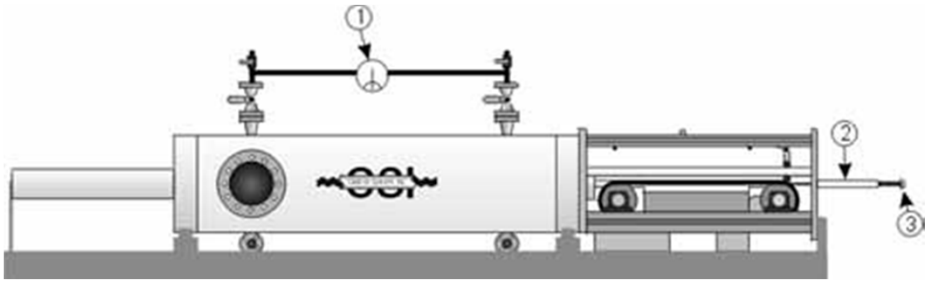
In 2009 we started up a new project were the old metering station from 1984 should be replaced with new metering stations with a Prover for each of the new stations. Based on experience of the old compact Prover and that the new product should be a second generation of the same product. The Prover chosen was a different brand that already was installed.




As we can see there is no hydraulic pulling the piston. The functionality of the pulling device was very simple. A motor running and stopping by means of a motor stopping switch. The operation of the poppet valve is the same as compact Prover 1. One of the biggest difference on these two Provers is that the piston rod is coming out in the open air. This means that it is very cold and therefore all the water in the air will be trapped on it. So when returning inside the cylinder the seals will be broken. To avoid this there is a nitrogen purge system over the "machine part" of the Prover. The system is controlled by a P&F ( Pepperl&Fuchs) unit and will be alarming if the purge fails.

# Compact Prover 2

To dry out Compact Prover 2 is a bit more complicated. It is not straight forward to move the piston. There is a tool to push the piston when we do the leakage check over the Piston. But this tool can't push the piston all the way. And in addition there is a need to open up the "cold Pack" to mount this tool. The illustration shows the tool and how it function.




The piston has to be pulled up by the chain and then pushed downward with the tool. The drawback is that the "machine room" is now containing humidity from the air and has to be dried out before putting into service.

Since all wetted parts inside the Prover are of a material that will withstand Methanol there is an opportunity to dry out the Prover by means of Methanol. To do this we must be sure that all the material inside valves etc. also can withstand Methanol. Otherwise will this method not be allowed.

For Kårstø this is not a problem for Propane but it will be for the metering stations for the Butanes.

# Conclusion:

- When handling cold products its always nice to know position of moving parts without dismantling the everything. When looking at these two Compact Provers its not easy to see the position of the piston. There should have been a window to see this without disturbing insulation, purge or anything else.
- Even though the Prover skid is made for cold operation it is not easy to get it fully insulated. We have an open invitation the manufacturer of these skids that they can come to us and see how it works in real life.
- When working over a wide pressure band be sure to have an automatic back pressure control function that blocks the Prover if the system is not functioning
- If there is a purge system installed be sure that it has indication for the overpressure and that it alarms if it fails. It is also necessary to have.
- Use alcohol when you need a short cut to dry out the Prover. (*And use water to dry out the operator.)*

## Remarks:

When Europe have the ATEX the rest of the world don't. Which means that the ATEX certification has to checked both against electrical parts but also against mechanical parts. It happens that the mechanical part is forgotten when getting the certification. The get a recertification takes very long time and can easily delay a project.

References.


1. Daniel drawings located at Kårstø from 1984
2. Illustrations from Emerson Daniel Brooks brochures at internet
3. Illustration from Honeywell Enraf Calibron brochures.