IP CODE OF PRACTICE FOR PIPE PROVERS

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PAPER 2.4

NORTH SEA FLOW METERING WORKSHOP 1984

16-18 October 1984

National Engineering Laboratory
East Kilbride, Glasgow

"THE NEW I.P. CODE OF PRACTICE FOR PIPE PROVERS"

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1. INTRODUCTION

1.1 On the 10th December, 1982, a Petroleum Measurement Committee called Working Group PMD 1 first met under the Chairmanship of Mr. J.M. Waring (I.C.I.) to prepare a Code of Practice for Pipe Provers. Initially it was envisaged that a separate Code for "Compact Provers" would be prepared but very quickly the conclusion was reached that a "Compact Prover" could not be treated in isolation since (a) the same Performance Criteria has to be met whatever prover is supplied and (b) with current developments when does a "conventional prover" become a "compact prover"? Convention has not reached such a decision.

2. PROVER STANDARDS

The existing standards used internationally for specifying meter provers are :

Institute of Petroleum	:	Petroleum Measurement Manual Part X - Meter Proving. Section 1 - Tentative 1979. "Field Guide to Proving Meters with a Pipe Prover",
American Petroleum Institute	:	Manual of Petroleum Measurement Standards, Chapter 4 Proving Systems, including, 4.3 Small Volume Provers 4.6 Pulse Interpolation
ISO/DP. 7278/3	:	Liquid Hydrocarbons - Dynamic Measurement - Proving Systems. Part 3 : Pulse Interpolation Techniques.

Norwegian Petroleum Directorate 1984.

"Regulations for fiscal measurement of oil produced in internal waters, in Norwegian territorial waters and in the part of the Norwegian Continental Shelf which is subject to Norwegian sovereignty".

3. PROPOSED LAYOUT OF INSTITUTE OF PETROLEUM CODE.

The following are the Draft Chapter Headings and Synopsis used as the basis for preparing the Code.

3.1 Introduction and Scope
3.2 Classification of Pipe Provers
3.3 Performance Requirements
3.4 Sizing of Provers
3.5 Design Considerations

3.6 Equipment
3.7 Installation
3.8 Operation and Calculations
3.9 Calibration and Traceability
3.10 Analysis of Uncertainty.

The guidelines used to prepare these sections were as follows.

3.1 Introduction and Scope

Brief general description of a pipe prover and background to its use in the oil industry. Brief mention of conventional and more modern compact types. Highlight areas of difficulty e.g. checking of seals. Scope and purpose of I.P. Code.

3.2 Classification of Pipe Provers

A decision to be made as to how the classification should be made, i.e.

sphere/piston or
bi-directional/uni-directional or
conventional/compact

All three methods of classification should perhaps be mentioned, although constant reference to all three throughout the document will lead to confusion.

3.3 Performance Requirements

Repeatability, both short and long term. Base volume to remain constant over a stated flowrate range. Overall uncertainty requirements (refer to chapter 8 and 9).

3.4 Sizing of Provers

Guidance to the selection of diameter and base volume from given specification of maximum and minimum flowrate, pressure loss, displacer velocity and detector repeatability. Mention of pulse interpolation.

3.5 Design Considerations

Recommendations, for the design of the prover and associated equipment in order to achieve the performance requirements laid down in chapter 3. Particular areas which should be mentioned are end chamber design and run up lengths, displacer design, the elimination of pressure surges either during the run or when displacer is brought to rest, the need for block - and - bleed valves and for checking the performance of any seals in the displacer.

3.6 Equipment

Guidance for the selection of displacers, detectors, valves, thermometers and pressure measurement equipment. Pulse interpolation methods (reference to ISO Standard) and data collection systems.

3.7 Installation

Location of prover in relation to meters being proved, need for access for calibrating prover, location of thermometry and pressure measuring instruments, location of relief valves and filters. Use of four detectors. Avoidance of dead legs. Guidance on the installation of electrical equipment including instrumentation.

3.8 Operation and Calculations

This should contain procedures for proving meters and for subsequent calculations needed for pressure and temperature corrections etc. Mention should be made of the need for meter factor control charts, although this would be discussed in detail in the document on proving turbine and PD meters (field guide).

3.9 Calibration and Traceability

Procedures and calculations for calibration of provers by both water draw and master meter method. Recommendations as to what methods to use in particular circumstances. Calibration of both conventional and compact provers to be described.

Evidence of traceability of meters, tanks etc., used as references. Procedures for establishing traceability. Frequency of calibration and the use of control charts.

3.10 Analysis of Uncertainty

Consideration of all the sources of uncertainty, both systematic and random, in the proving of a meter by a pipe prover. Listing of all sources required together with recommended method of combining the uncertainties. Worked example to illustrate the technique.

4. PROGRESS IN PREPARING THE CODE

The committee subdivided into groups to prepare the separate sections which were then reviewed within the committee as a whole. The status in mid July 1984 (when this paper was prepared) is as follows.

4.1 Introduction and Scope

This section has been left until the bulk of the Code has been prepared but the scope will cover all types of provers.

4.2 Classification of Pipe Provers

Provers have been classified into four main types, namely:
(a) Uni-directional sphere prover (U/S)
(b) Bi-directional sphere prover (B/S)
(c) Uni-directional piston prover (U/P)
(d) Bi-directional piston prover (B/P)

The 'compact prover' does not necessarily fall into any of the above classifications but has the following characteristics:-

1) The calibrated volume would be no more than one-tenth the typical U/S or B/S provers for the same maximum flowrate.

2) A precision-bore cylinder containing a piston whose position is detected by normally a non-mechanical device.

3) A system to interpolate pulses between the primary pulses emitted by the meter being proved.

4.3 Performance Requirements.

Short-Term Repeatability

When a master-meter technique is used to calibrate the prover five successive proving runs shall be within a range of 0.02 per cent. Using the water draw technique three successive proving runs shall be within a range of 0.02 per cent.

The prover device must exhibit flowrate independence.

Estimated Total Uncertainty

The estimated total uncertainty in the mean of a batch of 5 proving runs shall not exceed $\pm$ 0.05 per cent.

4.4 Sizing of Provers

This section highlights points to be considered in sizing a prover taking care not be preclude future developments in prover design but making clear that whatever design is proposed it must meet the requirements of Chapter 3.

The chapter draws attention to the fact that the following factors must be taken into consideration when sizing a prover : Displacer velocity, prover pressure drop, detector repeatability, pulse discrimination technique, flowrate, the uncertainty of associated instrumentation and the computer or microprocessor (if used).

4.5 Design Considerations

A number of factors must be considered prior to deciding on the basic design. These are:-

1. Whether the prover is mobile or fixed
2. Number and size of meters to be proved.
3. Extent of automation
4. Flow rate range
5. Chemical and physical properties of liquid
6. Whether there is continuous flow through the prover
7. Hazardous area classification
8. Power supplies and utilities available at site.
9. Space and weight restrictions
10. Whether prover is insulated and above or below ground.

Having examined these parameters then the basic prover type as defined in Chapter 2 will be selected.

This Chapter then highlights more detailed parameters to be determined e.g. launch and receive details for displacer, displacer velocity, detection devices, connections to prover, valve integrity etc.

Valve integrity caused extensive discussion in the committee since we must now consider internal and external valves in the prover. Currently the proposed statement is as follows:-

"Prover valves must be leak tight. The method for demonstrating leak tightness will be agreed between the supplier and the customer and where applicable the relevant authority."

4.6 Equipment

This Chapter gives details of the following items of equipment.

1. Material Requirements
2. Temperature Measurement
3. Pressure Measurement
4. Valves
5. Displacer
6. Detectors
7. Internal Finish of Prover Barrel
8. Calibration Connections
9. System Control

4.7 Installation

This Chapter highlights the items which must be taken into account for Installation. This covers Mechanical Installation, Electrical Installation, Further General Installation Requirements and Commissioning and Testing.

Mechanical Installation includes such items as pressure codes, proximity of prover to meters, drainage, corrosion, access connections etc.

Electrical Installation highlights the need to abide by the relevant Electrical Safety Code in addition to the power and earthing requirements etc.

The General Installation Requirements include such items as safety interlocks to prevent unauthorised tampering, adequate lighting and access for operation and fire fighting etc.

Commissioning and Testing highlights the need to perform these functions to a well documented procedure preferably with the manufacturers personnel being in attendance.

4.8 Operations and Calculations

This Chapter has still to be written but should contain the procedures for proof runs with the calculations correcting for pressure and temperature etc.

4.9 Calibration and Traceability

In line with the importance of this topic for meter provers this Chapter looks like being the largest in the Code.

It will be subdivided into an Introduction and Scope followed by Prover Calibration by the, Water Draw, Gravimetric, Master Meter/Prover Tank, Master Meter/Master Pipe Prover and other Methods. A method of selection is then provided.

The Chapter provides the requirements for reference measures, traceability, correction factors and uncertainty.

This Chapter should be acceptable to the Department of Energy requirements and hopefully to the Norwegian Petroleum Directorate in order that the Code be acceptable for Fiscal Measurement.

4.10 Analysis of Uncertainty

This has still to be completed.

5. CONCLUSIONS

(i) The Code is nearing completion and hopefully will be completed early next year.

(ii) It has been decided that a separate Code for Compact Provers is not a meaningful proposition and that a Code on Provers should be all embracing.

(iii) The Code is written for an audience of engineers who have some appreciation of provers but require, a standard to work to, pitfalls to avoid and helpful guidelines to follow. It does not go into every last detail of prover manufacture and assembly on the assumption that this is better left to the experts.

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.