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Proving Systems — Methods of Calibration for Displacement and Volumetric Tank Provers — Part 1: Introduction to the Determination of the Volume of Displacement and Tank Provers

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Foreword

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(b) a contact point for the WHO/FAO Codex Alimentarius Commission on Food Standards, and

(c) the National Enquiry Point on TBT Agreement of the World Trade Organisation (WTO).

The work of preparing Uganda Standards is carried out through Technical Committees. A Technical Committee is established to deliberate on standards in a given field or area and consists of key stakeholders including government, academia, consumer groups, private sector and other interested parties.

Draft Uganda Standards adopted by the Technical Committee are widely circulated to stakeholders and the general public for comments. The committee reviews the comments before recommending the draft standards for approval and declaration as Uganda Standards by the National Standards Council.

The committee responsible for this document is Technical Committee UNBS/TC 16, *Petroleum*, Subcommittee SC 2, *Drilling, Development and Production Equipment and Materials*.

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Introduction

Provers are precision devices, defined as volumetric standards, which are used to verify the accuracy of liquid volumetric meters used for custody transfer measurement. Both displacement and tank provers are used to prove a meter in order to obtain its meter factor, which is then used to correct for meter error caused by differences between the metered volume and the true volume. The base volume of a displacement or tank prover, determined by calibration, is an essential requirement in the determination of these meter factors.

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Proving Systems — Methods of Calibration for Displacement and Volumetric Tank Provers — Part 1: Introduction to the Determination of the Volume of Displacement and Tank Provers

1 Scope

This draft Uganda standards covers procedures required to determine the field data necessary to calculate a Base Prover Volume (BPV) of either Displacement Provers or Volumetric Tank Provers.

It will enable the user to perform all the activities necessary to prepare the prover, conduct calibration runs, and record all the required data necessary to calculate the base volumes of displacement and tank provers. Evaluation of the results and troubleshooting of many calibration problems are also discussed.

2 Normative references

The following referenced documents referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

1 FDUS ISO 7278-2:1988 Liquid hydrocarbons — Dynamic measurement — Proving systems for volumetric meters — Part 2: Pipe provers

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
Authorised Authority:
Responsible personnel/institution as indicated or specified in the Petroleum (exploration, development and production) (metering) Regulations, 2016 and subsequent revisions

3.2
Base Prover Volume (BPV)
The volume of the prover at base conditions, as shown on the calibration certificate package, and obtained by arithmetically averaging an acceptable number of consecutive Calibrated Prover Volume (CPV) determinations

3.3
calibration certificate package
A document package stating the Base Prover Volume (BPV) together with the physical data used to calculate the BPV. It also includes the witnessed field data, summary calculations, and the traceability documentation

3.4
Calibrated Prover Volume (CPV):
The volume at base conditions between the detector switches of a unidirectional prover, or the volume of a prover tank between specified “empty” and “full” levels, as determined by a single calibration run. The

calibrated volume of a bi-directional prover is the sum of the two volumes displaced between detectors during a calibration round-trip.

3.5
4 double block and bleed valve
A high-integrity valve with double seals that has provision for determining whether either seal is leaking

3.6
prover calibration pass
A single movement of the displacer between two predetermined detectors.

3.7
6 prover calibration run
One pass of a unidirectional prover or one round trip of a bi-directional prover, or one emptying or filling of a volumetric tank prover, which provides the data which allows the calculation of a single value of the Calibrated Prover Volume (CPV).

3.8
targeted BPV
A term associated with atmospheric tank prover calibration, and refers to adjusting the scales to an even nominal value, such as 500 barrels or 1000 barrels

3.9
traceability
The property of the result of a measurement, or the value of a standard, whereby it can be related to stated references, usually National or International Reference Standards, through an unbroken chain of comparisons all controlled, and having stated uncertainties. It should be noted that traceability only exists, when scientifically rigorous evidence is collected, on a continuing basis, showing that the measurement is producing documented results, for which the total measurement uncertainty is quantified

3.10
HOME position
The combination of one OUT pass followed by one BACK pass of the displacer in a bi-directional meter prover. The OUT pass refers to the flow of the liquid in the FORWARD direction while the displacer moves away from the HOME position. The BACK pass refers to the flow of the liquid in the REVERSE direction while the displacer returns to the HOME position.

3.10
Witness
Representative of an associated company or organisation having operational, financial or other interests in the custody transfer functions at that facility

4 Symbols (and abbreviated terms)

1 UNBS
Uganda National Bureau of Standards

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

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5 APPLICATIONS

5.1 Prover Calibration

A prover calibration shall be done in accordance to FDUS ISO 7278-2:1988 by the authorized authority after it has been installed at the operating facility and regular calibrations shall be performed according to a predetermined schedule.

All provers shall be re-calibrated at regular intervals. Some provers are to be re-calibrated more frequently than others to minimize the risk of measurement errors or to limit the level of measurement loss by lowering the overall uncertainty of the prover volume. The frequency of use of the prover and the volume throughput measured at the facility should be considered when determining the appropriate frequency for recalibration.

5.1.1 Establishing the possible loss exposure and measurement risk

When establishing the possible loss exposure and measurement risk, and determining a required frequency of calibration for all provers the following items should be put into consideration:

• Volume through the metering system associated with the prover between prover calibrations

• Number of meters regularly proved by the prover and their frequency of proving

• The total yearly value of each product metered

• Service conditions and properties of products being metered and proved

• Whether the prover is portable or stationary

• The different types of products being metered

• The range of properties of liquids being metered

• The required yearly maintenance and repair

• The total overall condition, including detectors and sphere displacer

5.1.2 Portable provers

Portable provers subjected to more severe conditions of operation and the total yearly road usage should be looked at when considering a recalibration frequency.

5.1.3 Recalibration frequencies

Recalibration frequencies for provers shall range from one year up to five-year cycles and in some extreme cases prover recalibrations on three month or six month cycles shall be carried out if necessary.

5.2 Temperature measurements

Temperature measurements are required to be taken at the location where the liquid being displaced exits the prover. Temperature measurements shall be made using certified or calibrated mercury-in-glass thermometers or calibrated electronic temperature devices.

A certified or calibrated thermometer shall be on-site with a certificate of calibration accuracy. The certificate of calibration shall be traceable to UNBS or other appropriate national metrology institute. The certified thermometer shall be used to verify the accuracy of all the other thermometers (working thermometers) used in the calibration procedures. The certified or calibrated thermometer and the working thermometers must agree within ± 0.1°F (± 0.05°C). Alternatively, working thermometers that have been certified to have been verified at three points (e.g., high, mid and low range points) within one year and a day of the time of the

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prover calibration by a thermometer that has a calibration traceable to a national standard may also be used providing that all of them agree among themselves within ± 0.1°F (± 0.05°C).

Electronic temperature measurement devices may be used in the calibration if there is agreement between all the represented parties and as part of the requirement, these device shall be verified before each calibration, this verification shall be carried out against a calibrated or certified thermometer, accurate to ± 0.1°F (0.05°C)...

5.3 Pressure indicators

For water draw calibrations, a pressure measurement is required downstream of the displacer. A connection to fit a pressure measuring device shall be provided between the water outlet from the prover and the pipe work prior to the water entering the test measures. Because of the very low flow rate when the water is flowing only through the solenoid valve, and the resulting minimal pressure drop at that time, it is acceptable to install the pressure measuring device on the calibration unit.

Pressure measurements are usually made using a calibrated dial type pressure gauge that is accurate and readable to one pound per square inch (1-psig) increments, and shall have with it on-site a certificate of calibration accuracy. This certificate of calibration shall be traceable to UNBS or other appropriate national metrology institute and shall be considered valid if within one year and a day of the date of calibration of the pressure gauge. Electronic pressure devices or digital pressure gauges may be used in the calibration if there is agreement between all the represented parties. Their readability and verifiable accuracy shall have exactly the same requirements as those specified for dial type pressure gauges, including an on-site valid certificate of calibration accuracy. All electronic pressure readings shall be rounded to the nearest one pound per square inch (1-psig) for recording.

5.4 Hoses, pumps and connections

All hoses and connectors used shall operate leak free and be suitable for the liquid used in the calibration and for the maximum pressures to be expected throughout the calibration. Hoses used for calibrations should be wire-wound to prevent collapse and to minimize any inflation due to pressure. However, for calibrations using water, soft hoses may be used (if approved by user company policy) on the inlet side, since inflation of the inlet hose has no impact on the calibration. The total length of hoses in use should be kept as short as possible so that the volume of liquid contained in these hoses is minimized.

The pump (or pumps) used to circulate water throughout the system during calibrations should be in good working condition with no leaks. An electric motor driven centrifugal pump works best, since the flow rate can be easily varied or stopped with the outlet pressure remaining relatively low

6 Field standard test measures

Field standard test measures shall be used as the volumetric standards in the calibration of liquid provers and shall be used for the water draw calibration method

A field standard test measure shall meet specific design criteria and is to be calibrated by UNBS or other appropriate national metrology institute. The test measures will typically range in volume from two litres to 4000 litres, with 2000 litres being the largest size in regular use.

6.1 Procedure of use of Test Measures

Test measures may have a “to contain” and/or a “to deliver” volume. When the “to deliver” volume is used, the test measures are filled and drained, and then left in a wetted condition before use. Only the “to deliver” volume of a test measure shall be used in a calibration. The “to contain” test measure volumes are not used in prover calibrations, because then the test measures must be completely clean and dry before every filling, usually an impractical field operations requirement.

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Two permanently mounted, adjustable spirit levels often installed and located at right angles to each other, on the body of the upper cone of the test measure. These spirit levels are usually equipped with adjusting screws, capable of being sealed, which have protective covers. As part of the preparation of a field standard test measure for calibration, it is recommended that it be filled with water and adjusted until level (usually using the legs). This level position shall then be verified by placing a precision machinist's spirit level across the top of the neck and verifying that the test measure is level in two directions, 90 degrees apart.

After verification, it may be necessary to more finely adjust the test measure position for level by additional changes to the leveling system. The permanently mounted spirit levels shall then be adjusted so that they agree exactly with the precision machinist's spirit level as described above. Once set, the permanently mounted spirit levels should be sealed in place and covered for protection.

This test measure level verification and adjustment procedure is recommended for all test measures prior to them being delivered to the authorized authority for calibration. This is to ensure that the levels on the field standard measure are in agreement with the precision machinist's spirit level when placed across the neck of the standard. On smaller size test measures, circular type bubble levels are sometimes used.

In all cases the UNBS Report of Calibration of a field standard test measure, shall provide the criteria for determining the level state of any given test measure when filled with water. In case of any disagreement between the use of the permanently mounted levels and the use of a precision machinist's spirit level across the top of the neck, the UNBS Report of Calibration definition of the level position for that test measure shall apply

7 Master meter

Master meters with very good linearity and repeatability shall be used for master meter proving. These meters shall be inspected annually to insure their integrity. Master meter performance (review of master meter calibration factors) shall be routinely checked to determine if the master meter is performing properly.. Pressure and temperature instrumentation shall be installed in the meter run.

8 Master prover

A master prover should be designed and sized to work in conjunction with the master meter. The master prover shall not be calibrated by the master meter method. The master prover should be equipped with pressure and temperature instrumentation on inlet and outlet of the prover. All drain and vent valves on the master prover shall either be of the block and bleed type or have other means for checking leakage.

9 Mobile equipment

The prover calibration equipment if mounted on a truck or trailer shall be rigidly constructed and securely mounted on the truck or trailer to prevent deformation or damage during transportation, usage, or storage.

10 Documentation and Record Keeping

All observation data shall be hand written in ink; or collected, recorded, and reported automatically by a flow computer with audit trail capability. All of the observation data shall be proof read against the data input for the calculations before signing any documents. In case of discrepancies or errors discovered at a later date the hand written observation data shall be used to correct the final volume.

The calibration certificate package issued by the authorized authority shall include the Calibration Report with the date of the prover calibration prominently displayed on the front of the Calibration Certificate Package. Other items applicable to the calibration shall also be recorded in the Calibration Certificate Package as follows:

For the Water draw, Master Meter and Gravimetric Methods:

a) the location of the prover

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b) the serial number of the prover

c) the serial number or seal number for each detector switch

d) the owner or operator of the prover

e) the type of prover

f) the material of construction of the prover

g) the inside diameter of the prover

h) the wall thickness of the prover

i) the temperature indicators and pressure indicator used

j) Calibration Certificates for all the temperature and pressure indicators used

k) the displacer type, the size, and the durometer (if applicable)

in the case of multi-volume displacement provers

l) a clear identification of the detectors used for this calibration

m) the physical location of each detector

n) A copy of the handwritten observation documentation (signed by all parties as witness to the original observation data);

o) A copy of the calculation and summary generated documentation

For the Water draw Calibration Method:

a) the field standard test measures used

b) copies of the UNBS Reports of Calibration for all of the field standard test measures used.

For the Master Meter Calibration Method:

a) the serial number of the master prover

b) the type of master prover

c) the material of construction of the master prover

d) the inside diameter of the master prover

e) the wall thickness of the master prover

f) Calibration Certificate Package for the Master Prover

g) the type of master meter

h) the size of master meter

For the Gravimetric Calibration Method:

a) Calibration Certificates of the Standard Weights

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b) Calibration Certificate(s) of the Weigh Scale

Note: This method under development so list is incomplete

11 Calibration Troubleshooting Guide

Full records of the complete data collected during all the calibration runs, whether valid or invalid, shall be recorded and kept in a systematic manner.

The primary source of a questionable measurement can normally be identified as one or more of the following as specific to the calibration method:

a) Air in the system

b) Hydrocarbons in the system (when water is the calibrating medium)

c) Leaks in the system

d) Temperature or pressure instability

e) Errors in determining test measure measurements

f) Malfunctioning isolating valves

g) Malfunctioning solenoid valves

h) Damaged or under-inflated sphere displacer

i) Damaged or improperly fitting seals

j) Wear in the piston displacer

k) Contamination to the circulating (calibration) medium

l) Damaged or contaminated field standard test measures (for the waterdraw method)

m) Damaged master meter or master prover (for the master meter method)

n) Damaged weighing device or weight standards (for the gravimetric method)

o) Damaged temperature and pressure measuring devices

p) Malfunctioning prover detector switches

q) Damaged or deteriorating internal surfaces of the prover

r) Damaged or leaking sphere interchange

s) Damaged or leaking four-way valve

t) Human error

u) Measuring equipment errors

Each of the above sources must be carefully examined until the cause of the abnormal measurements is found.

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12 calibration witnesses

The Authorised Authority/OFFICER shall perform the calibration in the company of several others who are designated as the witnesses.

All the parties attending the calibration as witnesses (representatives of other involved interests), shall be equally responsible for the successful outcome of the calibration. It follows that all the witnesses should, therefore, be involved in all the required calibration activities

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Annex A
(informative)

Supplementary information on meters

A.1 Types Of Provers

A.1.1 Unidirectional—Sphere Provers with Mechanical Detectors

These types of unidirectional provers are subdivided into the following two categories depending on the manner in which the displacer is handled..

A.1.1.1 The manual-return unidirectional prover

The manual-return unidirectional prover, sometimes referred to as the measured distance, is an elementary form of an in-line prover that uses a section of pipeline as the prover section. Prover detector switches that define the calibrated volume of the prover section are placed at selected points along the pipeline. A displacer-launching device is placed upstream from the prover section, and receiving facilities are installed at some point downstream from the prover section. Conventional launching and receiving scraper traps are usually used for this purpose. To make a proving run, a displacer (a sphere or specially designed piston) is launched and allowed to displace the reference volume before being received downstream and manually transported back to the launching site. This type of prover is no longer in common use.

A.1.1.2 The circulating-return unidirectional prover

The circulating-return unidirectional prover, often referred to as the endless loop, has evolved from the prover described above. In the endless loop, the piping is arranged so that the downstream end of the loop crosses over and above the upstream end of the looped section. The interchange is the means by which the displacer is transferred from the downstream to the upstream end of the loop without being removed from the prover. The displacer detectors are located inside the looped portion at a suitable distance from the inter-change. Continuous or endless prover loops may be automated or manually operated.

A.1.2 Displacement type bi-directional provers with free displacers

There are three types of bi-directional provers: the sphere prover with mechanical detectors; the piston prover with magnetic detectors and check valves; and, the piston prover with mechanical detectors and check valves. These types of bi-directional provers have a length of pipe through which the displacer travels back and forth, actuating a detector switch at each end of the calibrated section. Suitable supplementary pipe-work and a reversing valve or valve assembly that is either manually or automatically operated make possible the reversal of the flow through the prover. The main body of the prover is often a straight piece of pipe, but it may be contoured or folded to fit in a limited space or to make it more readily mobile. A sphere is used as the displacer in the folded or contoured type; a piston or sphere may be used in the straight-pipe type..

A.1.3 Displacement type meter provers with captive displacers

A prover having a captive displacer has an attached shaft or rod, which moves with the displacer. The displacement of the shaft is constant except that it moves into and out of the calibrated section during a calibration run. Thus a prover with a captive displacer and a shaft attached to one end will have an upstream and a downstream volume. If a shaft is attached to both sides of the displacer and they have equal area displacement, the upstream and downstream volumes are equal. There is often one or two other detector and/or guide rods attached to the captive displacer.

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Since these type provers have externally mounted optical detectors, the thermal effect on the steel may not be the same for the area aspect as for the linear aspect. For example, if both the prover chamber and the mounting that defines the linear distance between the detector(s) were the same, the thermal effects would be the same. But in many cases, a prover chamber might be made of a type of stainless steel while the detector(s) mounting which defines the linear distance between the detector(s) might be made of a special alloy having a different thermal coefficient of expansion. In terms of a prover calibration, the main effect is that it is necessary to obtain both a prover barrel temperature and a detector temperature

A.1.4 Displacement type meter provers with multiple volumes

If a displacement prover has multiple volumes, each volume shall be considered to be a stand-alone and independent prover volume.

Each of these prover volumes shall be calibrated by a separate and independent calibration. Each calibration shall meet the same criteria as described in the detailed calibration procedures.

A.1.5 Atmospheric tank provers

An atmospheric tank prover is a volumetric vessel with an upper neck, upper sight glass, upper scale, and an upper and lower cone usually separated by a cylindrical section. Different types are identified by the way in which their bottom "zero" is defined.

Atmospheric tank provers are described below:

• Bottom-weir type: This prover has a bottom neck beneath the lower cone. The bottom neck may or may not have a sight glass and scale, but in any case it has a fixed bottom “zero” defined by the weir.

• Dry-bottom type: This prover usually does NOT have a bottom neck under the lower cone. The closed bottom drain valve defines the bottom “zero” just as on a field standard test measure.

• Wet-bottom type: This prover has a bottom neck beneath the lower cone. The bottom neck always has a sight glass and scale. The bottom “zero” is defined by the “zero” on the scale. In practice, readings above and below the “zero” in the lower neck are common

A.2 Equipment

A.2.1 Prover detector switches

A detector switch is a high precision device mounted on a prover, which is used to detect the passage of a displacer. The calibrated volume of a prover is the amount of fluid that is displaced between two detector switch positions. Additional detector switches may be used if more than one calibrated volume is required on the same prover, or they can also be used to signal the entrance of a displacer into the sphere resting chamber. Several types of detector switches are described below.

- Mechanically Actuated Detector Switches
- Proximity-Type Magnetically Actuated Detector Switches
- Optically Actuated Detector Switches..

A.2.2 Launching chambers and transfer chambers

In both unidirectional and bi-directional provers, an area must be provided in which the displacer can rest when not in use. In bidirectional meter provers, this space is defined as a launching chamber. Bi-directional provers using sphere displacers require launch chambers at both ends of the prover pipe. Piston type bi-directional provers do not require expanded launch chambers at either end of the prover pipe because the

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flowing stream does not go around the piston, but is diverted upstream of the launch chambers by means of check valves. On unidirectional meter provers, a transfer chamber is used in combination with one or more valves, to store the sphere away from the flowing stream, and to provide a means to re-launch the displacer when required.

A.2.3 Sphere interchanges

On unidirectional provers, the sphere interchange provides a means for transferring the sphere from the downstream end of the proving section to the upstream end. Transfer of the sphere may be accomplished with several different combinations of valves or other devices to minimize bypass flow through the interchange. A leak-tight seal between the upstream and downstream sides is essential and must be verified before the sphere reaches the first detector switch of the proving section..

A.2.4 Four-way valves

The four-way diverter valve is used on bi-directional provers to change the flow direction through the prover. It is designed to handle low-pressure differentials, and has a double block and bleed feature to verify the sealing integrity of the valve.

A.2.5 Displacers

In a displacement prover, the displacer is used to form a seal so that the flow pushes it through the measuring section. This seal prevents flow from bypassing the displacer, which is critical to the accurate calibration of the prover. The displacer actuates detector switches, which define the volume of the prover. There are three common types of displacers.

- Sphere Displacers
- Piston Displacers
- Captive Displacers—Piston with Shaft (Rod)..

A.2.6 Valves, relief valves, drains and vents

The unidirectional prover sphere handling interchange, the bi-directional prover four-way valve, and all valves located between the calibrated section of the prover and the calibration unit, shall seal without any visible internal or external leakage when in a closed position

All valves located on the prover system and in-line, up to the test measures, that are part of the calibration, and operating in an open position, shall be regularly inspected for any signs of external leakage. Any leakage will cause an error in the certified volume.

A.2.7 Solenoid valves and logic circuits

Solenoid valves and logic circuits may be used for any method of prover calibration. The discussion below is a short introduction to the subject.

A.2.7.1 Water draw calibrations

Solenoid valves, used in water draw calibrations, are a combination of an electromagnetic plunger and an orifice to which a disc or plug can be positioned to either restrict or completely shut off a flow. Orifice closure occurs when the electromagnet actuates a magnetic plunger. Typical orifice sizes range from 3/32 to 1/4 inch. Solenoid valves may be two-way or three-way acting.

Solenoid valves are actuated by detector switch closures and are usually arranged to stop the water flow to drain and divert it into the test measure or vice-versa. The use of a solenoid valve reduces the uncertainty in valve closure to stop the test measure filling when the displacer contacts the second detector switch. Other

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uses of the solenoid valve during the prover calibration permit the recording of the stop/start sequence at the same exact repeatable conditions every time. Solenoid valves control the final approach of the displacer so that it arrives at the same exact position each time that it actuates the detector switch..

A.2.7.2 Water draw, master meter and gravimetric calibrations

A logic circuit is defined as an electronic device or devices used to govern particular sequences of operations in any given system.

They can gate or inhibit signal transmission in accordance with the application, removal, or combination of input signals. They have become a necessary aid in calibration and provide assistance in locating and tracking the position of the displacer. At the actuation of a detector switch, the logic circuit is programmed to notify the operator, generally by means of visible or audible signals, of the position of the sphere displacer. Solenoid valves mounted above the test measures work in conjunction with the prover detector switches through the logic circuit as follows:

• A single cable to both prover detector switches.

In this configuration any time a detector switch is gated the logic circuit will NOT tell the operator specifically which detector switch was actuated.

• A separate cable to each prover detector switch.

In this configuration any time a detector switch is gated the logic circuit will tell the operator specifically which detector switch was actuated.

It is possible to perform prover calibrations without the use of logic circuits by direct wiring between the prover switches and the solenoid valves. Careful observation of the activation of the detector switches and the solenoid valves will be necessary by the operator to continuously track and follow the location of the sphere displacer, since external-signaling devices will not be available in this situation. General industry practice, however, is to make use of logic circuits when they are available

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APPENDIX B
(Informative)
CALIBRATION WITNESSES

One technician usually performs the calibration in the company of several others who are designated as the witnesses. Company employees from the same or other divisions are often involved and occasionally federal, state or local government officials will be present. However, all the parties attending the calibration as witnesses (representatives of other involved interests), shall be equally responsible for the successful outcome of the calibration. It follows that all the witnesses should, therefore, be involved in all the required calibration activities.

Some of these required items are listed below. Generally, all the witnesses shall be ready to assist, advise, and participate in whatever tasks are necessary to produce a speedy, successful and accurate calibration:

• Validate the traceability of equipment by checking the calibration dates and the availability of valid calibration certificates and other records.

• Witness the cleanliness and interior condition of the prover.

• Witness the inspection and sizing of the sphere displacers or pistons.

• Witness the inspection and all maintenance of the detector switches.

• Witness the verification of the temperature and pressure devices.

• Witness all general set-up activities including setting up the liquid circulation, venting of the air, and leak checking.

• Witness patrolling of the area for leaks during the calibration runs.

• Witness checking the integrity of block valves during runs.

• Witness checking the integrity of four-way valves during runs.

• Witness checking the integrity of sphere interchanges during runs.

• Witness the filling and general operation of the test measures (waterdraw) or the general operation of the master meter and master prover.

• Witness the filling and general operation of the prover being calibrated.

• Witness and check that the test measures are level when read (waterdraw).

• Witness test measure scale readings and interpolations (waterdraw).

• Witness temperature and pressure readings and interpolations.

• Witness the draining of test measures and the adherence to draining times (waterdraw).

• Witness the accurate determination of necessary temperatures and pressures.

• Keep or witness the recording (hand written) of all the calibration data as log entries.

• Where requested, offer advice in troubleshooting all problems and difficulties, and assist with the reading of thermometers and gauges.

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- In general, witness the resolution of all the operations, processes and problems encountered.

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Bibliography

[1] API MPMS 4.9.1 1st Edition, October 2005 Manual of Petroleum Measurement Standards Chapter 4-Proving Systems Section 9-Methods of Calibration for Displacement and Volumetric Tank Provers Part 1-Introduction to the Determination of the Volume of Displacement and Tank Provers [2] ISO #####-##:20##, *General title — Part ##: Title of part*

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