DOMESTIC WATER METERS: INFLUENCE OF VARIOUS FITTINGS AND INSTALLATION CONFIGURATIONS ON ACCURACY OF 15 MM WATER METERS

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Executive summary

The investigation into the effects of various fittings and installation configurations has become a necessity in view of the strict water loss controls brought by the promulgation of the new Water Services Act, 1997 (Act 108 of 1997), and the pending draft National Water Supply Regulations. Many of the water services authorities will base their work on reducing unaccounted-for water on SABS 0306:1999, a standard on the management of potable water in distribution systems. In coming up with a water audit report using the above mentioned code of practice, the water services authorities will have to use readings recorded from meters installed as the main part of their data, hence the need to correctly install the meters in order to get accurate readings. The current situation is that the installation of meters is being done by plumbers who are in some cases oblivious of the effect of haphazard installations and choice of fittings adjacent to the meter. As these meters are used for both domestic and industrial billing of consumers, the overregistration or underregistration due to their incorrect installation can result in false billing of consumers with resultant audit imbalances between the quantities of water actually supplied against water consumed. Water loss management as prescribed in the new draft National Water Supply Regulations can only be as accurate as the instruments used to measure the volumes of water. Unaccounted-for water brought by unacceptable errors in meter indications have to be eliminated if the objectives of preserving water are to be achieved. The unit cost of purified water is going to become expensive owing to escalating purification, storing and transportation costs as well as scarcity owing to erratic weather patterns in the southern hemisphere, and therefore every drop of water needs to be accounted for.

Thus, the objectives of this research were to investigate the effects of various fittings and installation practices being currently employed in practice and come up with recommendations on the correct choice of fittings to be used adjacent to water meters as well as guidelines on correct installation. The objectives of this project were attained by subjecting two main types of 15mm diameter domestic meters, namely volumetric and inferential meters, to some of the conditions in which they are installed

in practice and comparing the characteristics with standard meter performance characteristics. Tests were carried out in accordance with ISO 4064-3;1983 and SABS 1529-1:1994 standards on water meters. The meters were installed in a test bench in compatible groups, for example, inferential meters only. Readings were taken for the chosen flow rates and then compared with the actual volume of water through the meters as measured by a calibrated tank downstream of the meters. A constant head tank on the roof of the building ensured a steady flow of water through the meters. The percentage errors between the reading of the meter and the actual volume were then plotted against the corresponding flow rates and the resultant curves analysed.

By repeating the signature test twice, firstly at the beginning of the tests and again at the end, it was possible to determine whether the deviations in error versus flow-rate graphs were due to installation configurations being tested and not due to deterioration of the meter through wear and tear or change in environmental conditions. The first test involved inserting a 15mm ball valve at the inlet side of the meters and adjusting it so that it was fully open, 22,5° open and 45° open respectively. The second test involved rotating the meters 45° from the vertical and the third test had the meters installed with approved fittings (JASWIC;"R" Specifications, 1994) to simulate the above ground installation but without the inlet valve.

The following results emanated from the research:

- The 15mm ball valve in various positions of opening at the inlet of the meters as well as the above ground installation did not produce any consistent notable effect on the meter accuracies
- The accuracy of certain models of volumetric meters was affected by the 45° tilt configuration, and
- The accuracy of the inferential, multi-jet type meters was affected in the lower flow rates below q_t (transitional flowrate) when the meters were rotated 45° from the vertical.

This research also indicated that more tests on all existing installation practices have to be carried out on all sizes of both single-jet and multi-jet inferential meters in order to be able to make comprehensive conclusions. The unusual phenomena exhibited by some volumetric meters requires further investigation.

Based on the results and interpretation thereof, the following recommendations are made:

- An inferential meter designed to operate in the horizontal standard position should always be installed with its turbine shaft axis coaxial with the vertical axis. More so there is need to investigate the critical angles or angular tolerance to which different models of meters start to lose sensitivity.

- The above ground installation does not impart large inaccuracies on meter performances and its use in meter installations where ease of reading is required, can still remain a normal practice.

- That an inlet ball valve of the type used in this research does not impart large inaccuracies on domestic meter performances. Emphasis is put on the words "type used in this research" as different valves impart different flow disturbance characteristics and therefore more types of valves should be tested.

- Better training curricula should be formulated for all plumbers to avoid improper installation of meters and increase their understanding of the importance of the information derived from a water meter in local government water management systems.

- Regular checks on meter manufacturers should be continued long after type approval to ensure that they still produce their meters with accuracy and durability as key requirements. This recommendation emanates from the fact that some type approved meters used in the research, failed the initial selection criteria.

- All municipalities and water governing bodies, plumbers institutions and other interested organizations should make use of the "*Guidelines on Domestic Meter Installation Practices*" which emanated from this study.

Acknowledgements

This research has been made possible by the funding of a project by Water Research Commission, entitled "Water meters: the influence of fittings and various configurations on accuracy". The financing of the project by the Water Research Commission is gratefully acknowledged.

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The committee consisted of :

Water Research Commission .... J Bhagwan (Chairman)

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Cape Town Metropolitan Council .... HC Chapman

Greater Johannesburg Metropolitan Council .... C Botha

Pretoria City Council .... T Westman

Kent Metering (Pty) Ltd .... CJ Grant

Meinecke Meters (Pty) Ltd .... BEL Bold

Stewart Scott (Pty) Ltd. .... EH Johnson

Water System Measuring Technik .... FJM Draxl

South African Bureau of Standards .... C van Hoeve

Finally, the services and contribution of the SABS Water Meter Laboratory staff is gratefully appreciated.

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GLOSSARY

Definitions

Accuracy:The comparison of the actual meter reading to the true value.

Water meter: Self contained integrating measuring instrument that continuously determine the volume of water flowing through them.

Potable water: Water that complies with the requirements of SABS 241.

Minimum flowrate(q_{min}): The lowest flowrate at which the meter is required to give indications within the permissible tolerance.

Overload flowrate(q_s):The flowrate that is equal to $2q_p$ and that represents the highest flowrate at which the meter is required to operate in a satisfactory manner for a short period of time without deterioration.

Permanent flowrate(q_P): The flowrate for which the meter is designed and at which the meter is required to give indications within the permissible tolerance under normal conditions of use.

Transitional flowrate(q_t): A flowrate that occurs between the permanent flowrate and the minimum flowrate and at which the flow is divided into two zones, the upper zone and the lower zone , each characterised by a specific permissible tolerance.

Abbreviations

BS: British Standard

CSIR: Centre for Scientific and Industrial Research

GMS: Galvanised mild steel

ISO: International Organisation for Standardisation

JASWIC: Joint Acceptance Scheme for Water Installation Components

NB: Nominal bore

OIML: International Organisation for Legal Metrology

SABS: South African Bureau of Standards

KEY TO GRAPH LEGENDS

ag: *Above ground configuration*

above ground ave.: Above ground configuration average curve

BV manifold 45 open ave: Ball valve configuration average curve with the valve 45 degree open.

T1, T2, T3 : Accuracy curves produced by plotting the percentage errors of the three meter readings taken at the same test flowrate.

Test manifold ave.: The average of the curves T1, T2, and T3

45 deg. tilt ave.: 45 degree configuration average curve

Background

This research to establish the influence of various fittings and installation configurations on the accuracy of a meter was initiated by the South African Bureau of Standards with financial assistance from the Water Research Commission. The pending new Water Regulations will prescribe water auditing as a requirement and the code of practice for "*The management of potable water in distribution systems*" (SABS 0306, 1999) will require accurate measurement of water passing through a water meter installation. It is therefore essential to measure and know the effect and contribution of meter accessories, fittings and pipe configurations used in installing a meter on the meter accuracy and performance. This will help to better inform and advise municipalities and contractors on the importance of correct choice of fittings and installation procedures. Haphazard meter installations and poor choice of materials having become the norm owing to deteriorating plumbing practices, the study of their impact on the meter accuracy is hence necessary. The relevance is that this understanding will contribute towards reducing the ensuing problems such as incorrect consumer billing, water loss audit imbalances and increase in unaccounted-for water thus rendering the water management systems by water authorities ineffective. A few examples of some existing poor installations are shown on photographs in Annex A.

This research first had to establish a reference or control as the basis for comparing the results of all the tests. Thus all the meters were initially tested in accordance with the requirements of South African Bureau of Standards (SABS1529-1,1994), which is similar to International Standard (ISO4064, 1983) regarding most aspects. To be able to see the performance of the meter over its entire range, twenty two flow rates instead of only five were tested and results were plotted against the percentage error in the volume reading shown by the meter to the actual volume as measured by a calibrated tank. Although the purpose of this research was not to verify the accuracies of the meters in ordinary calibration rigs, it is worth mentioning that some of the initial efficiency results did not comply with South African Bureau of Standards (SABS1529-1,1994) tolerances of 5% for flowrates less than the transitional flowrate q_t and 2% for flowrates greater than q_t . This research focused more on the repeatability of the meter accuracy in various installation conditions.

The various configurations were then tested and the graphs obtained superimposed and compared against the initial efficiency curves or "signature" of the meter under test. The term signature symbolises the uniqueness of one meter curve when compared with another and is a true representation of performance of a meter over its entire operating range within those chosen conditions. A final "signature" test had to be done in order to be able to separate meter readings due to meter deterioration with those attributable to installation conditions. The following chapters describes the research programme and then gives an account of the tests undertaken and of their results.

2 Standards for installation and previous researches

Comprehensive standards have been developed and researches undertaken on measurement of flow in closed conduits, using pressure differential devices such as orifice plates, nozzles and Venturi tubes when they are inserted in conduits running full to determine the flowrate of the fluid. British Standard (BS1042, 1992), and International Standard (ISO5167, 1991) are a few reference examples which specify installation and operating conditions of these devices with a great degree of detail. For volume flowrate methods of measuring cold potable water using meters, International Standard (ISO4064,Part Two,1978) and International Organisation for Legal Metrology (OIML, Document 4, 1981) recognise the need for straight lengths of pipe before and after a meter. The length is given in multiples of the nominal diameter D of the pipe in which the water meter is installed. For both single jet and multijet meters, the upstream and downstream lengths should be 3D and 1D respectively, regardless of the size of the meter. On errors due to installation effects the International Organisation for Legal Metrology (OIML, Document 4, Section 6.3, 1981) admits that "the effect of installation conditions on the accuracy of a water meter has not been comprehensively investigated". A research programme (Harrison, 1990) financed by the European Community used a number of water meter test laboratories in investigating the effects of flow disturbances on the accuracy of inferential water meters. In this research they developed "standardised in-line flow disturbance devices" to create upstream and downstream velocity profile distortions and upstream and downstream swirls. The conclusion from this research was that flow disturbances change the accuracy of modern water meters , installed in a pipe as stipulated in the OIML document, by more than the permitted amount. This report also references an unpublished KIWA report of August 1976 which has a bibliography of about 12 references relating to the influence of installation conditions on the accuracy of water meters.

3 Domestic water meters

Most domestic water meters are mechanical meters that can conveniently be divided into two main types: (1)Displacement and (2) Inferential. Type 1 comprises meters which are volumetric in operation, the cyclic displacement of the detecting element,e.g. a piston, being directly proportional to the volume of fluid passing through the meter during each cycle. From an academic point of view, displacement meters should be subdivided into positive -displacement and semi-positive displacement types (Fig. 1), the former classification covering those meters which employ a packed piston. When a packed piston is used there is no leakage so that, for all practical purposes, the meter can register down to zero flow. However the modern trend on the design of the displacement meters is to rely on very close machining tolerances between the moving element and its working chamber. Inevitably this means that these meters have a certain minimum flow rate below which inaccurate flow registration results.

The cyclic movement of the piston can be followed from Fig. 2 (a, b, c and d). In position (a) both the inlet and outlet ports are in communication with the inside of the piston, the incoming liquid (shown hatched horizontally) starting the piston off in its semi-rotary movement, and expelling the outgoing liquid (shown hatched vertically) through the outlet port. The liquid on the outside of the piston (shown cross hatched) is in a neutral position, since it is cut off from both inlet and outlet ports, but as the

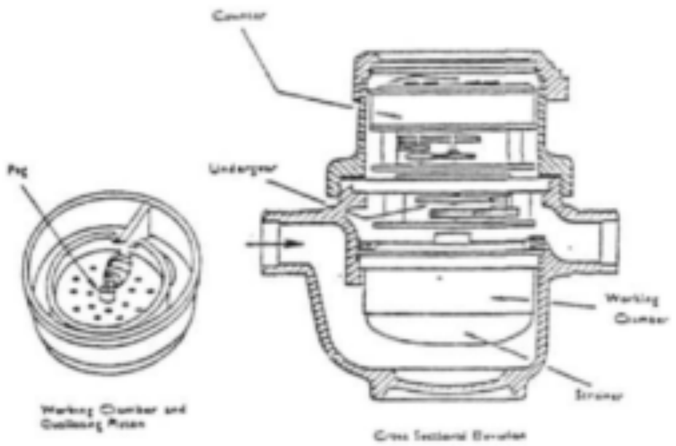


Fig. 1 Semi-positive dispacement meter

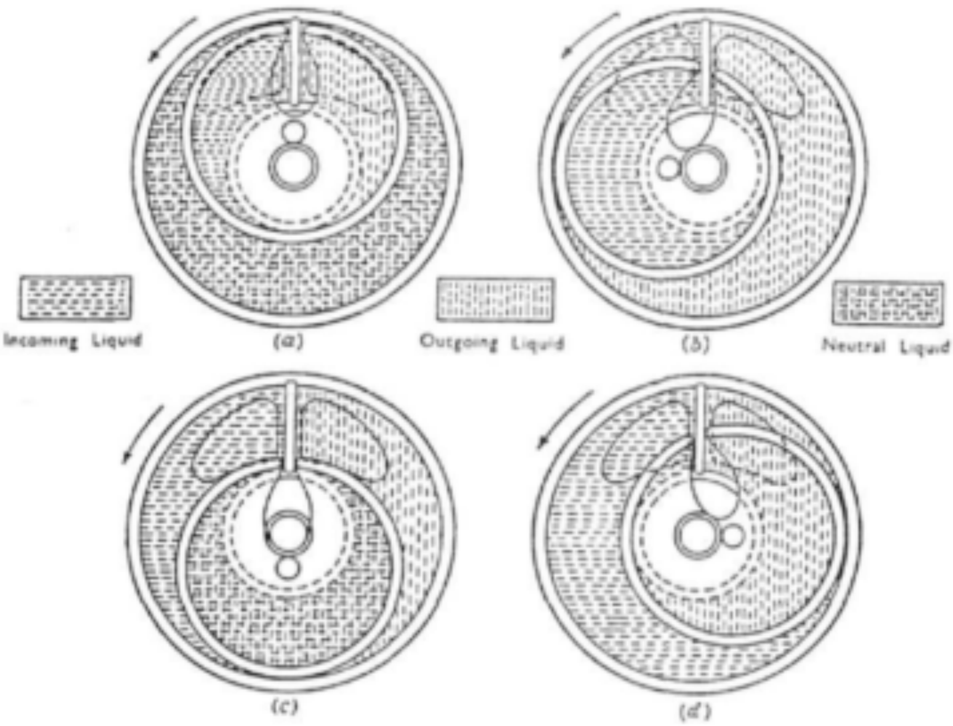


Fig. 2 Piston meter ; Sequence of operations

movement of the piston continues it becomes the outgoing liquid, and is discharged through the outlet port. In position (b) the incoming and outgoing liquid is on both sides of the piston, while in position (c) the incoming liquid is on the outside of the piston, the outgoing liquid on the outside of the piston to the other side of the radial partition being expelled through the outlet port. At this instant the liquid on the inside of the piston is neutral, since it is cut off from both ports, but it becomes the outgoing liquid as the movement of the piston proceeds. The final position (d) shows the piston 90° before position (a). It will be seen that the piston is always moving in the same direction, so no shock is experienced, and each semi-revolution permits a definite volume of liquid to pass through the meter

Type 2 embraces inferential meters; they measure the velocity of flow, and from this measurement infer the volume of flow hence the name inferential meters. In all mechanical meters of the inferential type the moving element consists of the rotor, and the basic principle is to design the meter in such a manner that, over the working range of the instrument, the speed of rotation of the rotor bears a constant linear relationship to the velocity of flow through the meter. The force acting on the rotor is the driving torque which is resisted by the torques due to damping, fluid friction (viscous drag) and mechanical friction. A single-jet (Fig.3) passes the total flow through one jet which strikes the rotor at one point on its periphery. A multi-jet meter (Fig. 4) embodies means for dividing the total flow into a number of jets spaced around the periphery of the rotor.

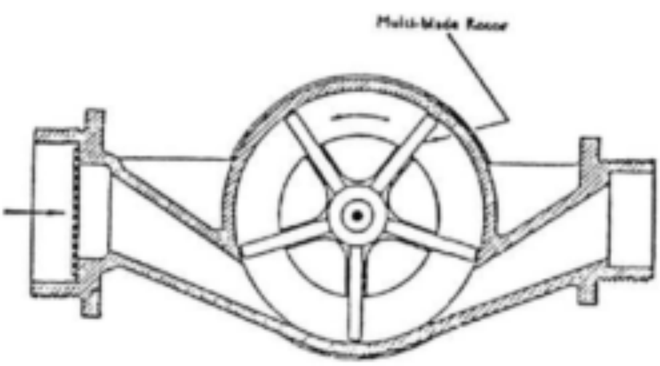


Fig. 3 Single-jet meter

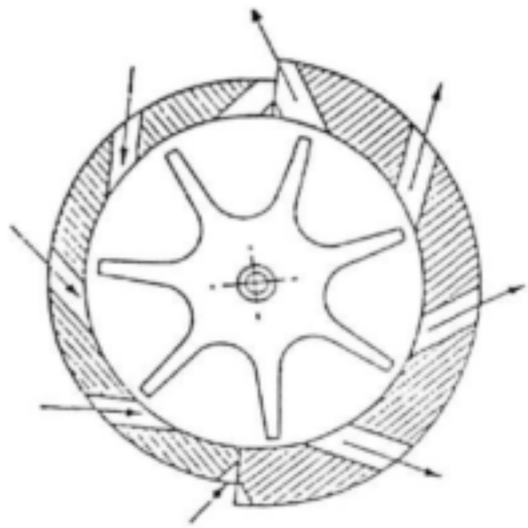


Fig. 4 Multi-jet meter

Domestic meters commonly used are the inferential (single-jet and multi-jet) and volumetric (piston) meters with the following nominal bores commonly used; 15 mm, 20 mm and 25 mm. This is because of the relatively low draw-offs at which water enters into consumer networks. For pipeline systems that have very high variances in flow rates such that none of the operating ranges of the flow rates of the above mentioned meters is adequate, larger meters and combination meters have been developed but these are mainly for industrial and zone water metering.

Most households have moderate flow rates and therefore the 15 mm, class B meter is the most common meter installed and hence it was used for the research. Whether a volumetric or inferential meter is installed is purely a matter of choice of the water authority or contractor, but can be restricted by whether the meter is to be installed horizontally or vertically. Most inferential meters are horizontal meters but most volumetric meters can be used in both the horizontal and vertical installations.

4 Calibration standards and terminology for water meters

All water meters with a nominal bore not exceeding 100 mm are calibrated for compliance with South African Bureau of Standards (SABS1529-1,1994), and are metrologically classified as A, B, C or D depending on the level of accuracy required from the meter. The least accurate is a class A meter which is not used for billing purposes .The most accurately calibrated meter is a class D meter which has also the largest range (see Table 1 below) although for purposes of billing the use of classes B and C have tended to dominate with the former being commonly used by both domestic and commercial users. Consequently the meters used in the research were class B meters as they are commonly used for domestic metering and consumer billing.

A calibrated water meter has a flow range in which it is designed to operate ranging from a minimum to a maximum flow rate. The minimum flow rate q_{min} is the lowest flow rate at which the meter is

Table 1-Metrological class of meters

1	2	3	4	5
Class of meter	For q_p not exceeding $10m^3/h$		For q_p exceeding $10m^3/h$	
	Minimum flow rate q_{min}	Transitional flow rate q_t	Minimum flow rate q_{min}	Transitional flow rate q_t
A	0,04 q_p	0,1 q_p	0,08 q_p	0,3 q_p
B	0,02 q_p	0,08 q_p	0,03 q_p	0,2 q_p
C	0,01 q_p	0,015 q_p	0,006 q_p	0,015 q_p
D	0,0075 q_p	0,0115 q_p	--	--

required to give indications within a permissible tolerance whereas the permanent flow rate q_p is the flow rate for which the meter is designed and at which the meter is required to give indications within the permissible tolerance under normal conditions of use. The transitional flow rate q_t occurs between the permanent flow rate and the minimum flow rate. This is divided into two zones, the upper zone and the lower zone, each characterised by a specific permissible tolerance. The overload flow rate q_s which is twice the permanent flow rate is the highest flow rate the meter is required to operate in a satisfactory manner for a short period of time without deterioration.

5 Flow parameters that affect a meter

For both inferential and volumetric meters , the diameter of the main pipe bears little relationship to the nominal size of the meter which should be used. Each nominal size of any particular make has a definite minimum flow, below which it will not register accurately, and a maximum flow rate, above which it will be overloaded. Hence the size of the meter selected will depend entirely on the anticipated flow range. The exception to the above statement, in so far as the low flows are concerned, is the positive type meter, which, as already explained, is accurate to what is, for all practical purposes, zero flow.

Both the volumetric and velocity meters derive their driving energies from the fluid which they are measuring, hence some flow parameters which affect this energy do influence the accuracy of these meters. It has been found that the following parameters affect the accuracy of a meter;

(a) the upstream velocity profile distortion,

(b) the temperature effect ,

(c) the viscosity effect , and

(d) the swirl effect.

It was also found that the meter characteristics is a function of the velocity profile just upstream of the rotor. The volumetric meters have indicated in previous researches (Harrison,1990), (OIML, Document 4, 1981) to be insensitive to upstream velocity profiles as well as the swirl effect. Temperatures and viscosities of potable water as tested in the laboratory can be strictly controlled, therefore their effects on the systematic errors of the meter readings are constant.

Fittings, bends and valves before a meter introduce either swirl or velocity profile distortions, as well as introducing more head losses. It is therefore worth investigating for each type of meter the effects of these on the accuracy of the meter. Caution is needed in separating the errors due to air pockets and general errors characteristic with each test rig from those inherent in the flow due to fittings. Air pockets are inherent in many actual ground installations although use of rising mains and air release valves can minimise these. Whereas test benches can be vacuumed (this is the ideal condition) but normally merely flushing the entire system by fully opening the downstream valve to the meter under test removes most of the air pockets. A much more recent practice on some test rigs without vacuum pumps on conventional meters is to invert them 80° from the normal horizontal position and flush water through, expecting all air to rise and be flushed out.

6 Research equipment

The details on models of inferential and volumetric meters used in the research are shown in Table 2 below.Three meters were disqualified after the initial signature test as they did not comply with South African Bureau of Standards (SABS1529-1, 1994) tolerances against which they were type approved and therefore could not be taken to be representative of other meters. There was no criteria used in selecting any particular brand of meters as these meters were donated by the respective meter manufacturers. The first column of the table identifies the meter model, the calibration class, the nominal operating pressure of the meter and the pressure loss across the meter at q_s. The second column identifies the nominal size of the meter in volume flowrate and the type (whether volumetric or inferential) and the way it is installed (horizontal or vertical). The fourth column describes whether the meter is type approved for trade use in South Africa and the thread size of end connections.

The SABS water meter laboratory used in the research handles all type approval, production verification and dispute testing of water meters. Copies of the calibration certificates of the 100 ℓ and 10 ℓ tanks used for measuring the actual volume of water are shown in annex B. Thus the volume measured from these tanks is the meter prover volume used in determining the error. Its calibration therefore can be traced to the national standard via the Weights and Measures Act , vis -a-vis, the Trade Metrology Act,(Act 77 of 1973), of South Africa.

7 Methodology

The meters were tested in three batches owing to test bench limitations and because meters of different types cannot be tested together. For example, volumetric meters cannot be tested together with inferential meters. The three batches were;

Batch 1 consisting of inferential meters from models C, D and E,

Batch 2 consisting of volumetric meters from models B and F, and

Batch 3 consisting of inferential meters from model A only.

Table 2 — Meters used in research

1	2	3	4
Meter Model	**Size and type**	**ID Number**	**Remarks**
Model A Class "B" PN16, P = 100 kPa	1,5 m^3/h inferential horizontal	AI1 AI2 AI3	Type approved.Connection size = G 20 B
Model B Class "B" PN16, P = 100 kPa	1,5 m^3/volumetric horizontal and vertical	BP1 BP2 BP3	Type approved.Connection size = G 20 B
Model C Class "B" PN16, P = 100 kPa	1,5 m^3/h inferential, horizontal	CI1 CI2 CI3*	Type approved. Connection size = G 20 B In plastic body
Model D Class "B" PN16, P = 100 kPa	1,5 m^3/h inferential, horizontal	DI1 DI2 DI3*	Type approved. Connection size = G 20 B In brass body
Model E Class "B" PN16, P = 60 kPa	1,5 m^3/h inferential horizontal	EI1 EI2 EI3*	Type approved. Connection size = G 20 B
Model F Class "B" PN16, P = 40 kPa	1,5 m^3/h volumetric horizontal	FP1 FP2 FP3	Not type approved. Connection size = G 20 B
*The three meters were disqualified after the initial signature tests.			

Tests were conducted within 10 % of the specified flow rates q_{min}, q_t, q_p and q_s, in accordance with International Standard (ISO4064, 1983) and South African Bureau of Standards (SABS1529-1,1994), for all the tests except for the initial and final signature tests, where intermediate and extreme low and high flow rates were chosen in addition to those mentioned above.

As mentioned earlier, the initial signature tests were carried out on all the meters with a total of twenty two flow rates over the full range of the meter. The meters were installed with standard connectors on the normal manifold used for type approval of meters. The configuration is shown in Photograph 1 in annex C. Long straight lengths of pipes greater than 3D on the inlet and greater than 1D on the outlet of each meter ensured fully developed flows entering and undisturbed flows leaving the meter. The identification numbers and the route, which is the relative identification of each meter on the test bench counting from the inlet of the test bench, were recorded on the test sheet. This ensured that a meter was always installed in the same position relative to other meters in every configuration under test. Once on the test bench, air was removed by flushing with water by opening the downstream valve until no more bubbles could be seen through the graduated sight glass of the variable area flowmeter. The initial reading after flushing was recorded for each meter and then by carefully adjusting the downstream ball valve to the required flow rate, the first test run could be started. By switching on the solenoid valve integral with the variable area flowmeter connected to a timer which automatically switched off when the volume of the measuring tank had been filled, a test run could be completed and the results recorded. The volumes were read from a scale on a transparent sight glass attached to the tank. The temperature and pressure of the water were read from dial gauges installed upstream of the meters. The water coming from a constant head tank on the roof of the eighth floor (about 325 kPa static head) of the building ensured that a constant pressure for each flow could be maintained. The readings on the meter were then recorded and by subtracting the initial reading taken before the test, the volume of water as recorded by each meter were noted down. Three readings were taken for each chosen flow rate. The percentage error was then calculated from the following formula:

$$\text{Percentage error of meter reading} = \frac{V_{meter} - V_{tank}}{V_{tank}} \times 100 \qquad (1)$$

where

V_{meter} is the volume of water as read by the meter;

V_{tank} is the volume measured from the tank (meter prover volume).

Thus the technique involved the determination of systematic and random errors and uncertainties for each stage in the measurement chain. Minimizing systematic errors was achieved by setting up the bench properly, for example, pipe alignments of the system ensuring stresses were not transferred from the pipework to the meter under test. Random errors were minimized by doing three tests at each chosen flow rate within short periods of time or consecutively to prevent the effect of wear and tear or environmental changes. This emphasized the significance of the final efficiency test as an indicator of the extent of the increase of error due to wear and tear.

The results were entered into a spreadsheet (see annex E) with formulas including (1) above, which calculated the average value of the error over the three readings taken for each flow. The spreadsheet also calculated the percentage variance of each reading from the average and this indication of the scatter of batch readings was used to separate significant random errors in meter reading caused by the technician from those attributable to the meter. Graphs of the percentage error versus the flow rate (see annex C) were then plotted for all the meters. Because of the periodic non-availability of the laboratory in order to accommodate other tests, the meters had to be stored for some days before tests could continue. In such cases all meters were fitted with plastic endcaps at their inlets and outlets to prevent the ingress of dirt. In addition plastic meters were filled with water to ensure that the plastics did not dry out which could result in additional errors.

7.1 Ball valve configuration

This test involved inserting a 15 mm PN25 ball valve which complied with South African Bureau of Standards (SABS1056-3,1985),before the inlet of each meter (Fig. 5 below and photograph 2 in annex C). The following adjustments to the valves were then made:

(a) fully open valve;

(b) 22,5° open valve; and

(c) 45° open valve.

The effect of these adjustments was to introduce a velocity profile disturbance which disrupted the steady flow. This is a common practice in meter box installations and is recommended in some guidelines shown in annex A on Some Common Installation Practices. Different valves are used by different meter manufacturers and produce different flow distortions , hence results obtained were for these types of ball valves only. Seven flow rates were chosen for each valve position and readings recorded three times for each flow rate. The results of these tests were entered in spreadsheets and the graphs obtained were superimposed on the initial signature curve of the respective meters.

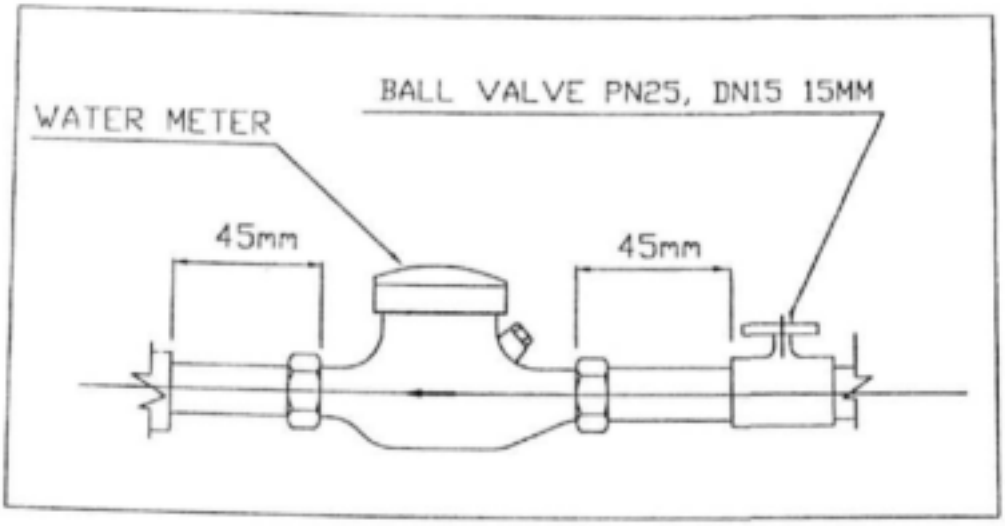


Fig. 5 Ball valve configuration

7.2. 45-degree tilt configuration

This test involved setting up the meters on the normal test manifold and then rotating the meters by 45° from the vertical (Fig. 6 below and photograph 3 in annex C). This is not a standard practice but due to its prevalence in the field, it was decided to investigate its influence on meter accuracy.

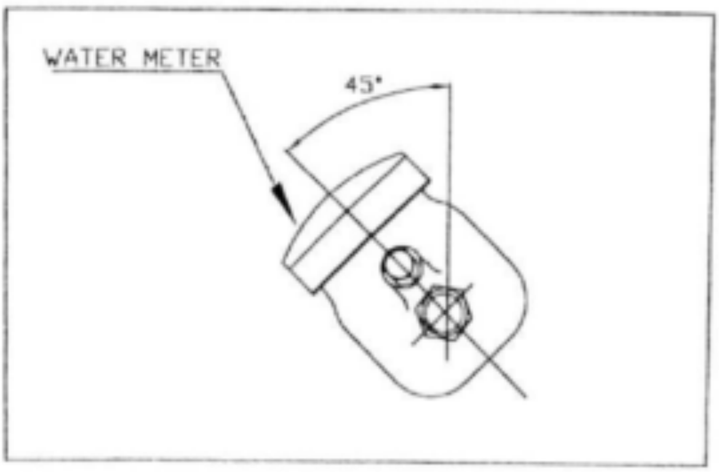


Fig. 6 45° degree tilt configuration.

The angle of inclination from the vertical could vary from 0° upwards, but due to the limited time and resources available, the worst case was investigated. Seven flow rate readings were taken for all the groups of meters and the results plotted against the initial signature curve of the respective meters

7.3 Above ground configuration

This test involved assembling galvanized fittings to form a typical above ground installation (Fig. 7 and photograph 4 in annex C) but without the inlet gate valve. The valve was omitted deliberately to ensure that the influence of the galvanised elbows and fittings could be investigated alone. This installation is quite commonly used and typical practical applications are depicted in Annex A in drawings by the Department of Water Affairs and Forestry and the City Council of Pretoria. Seven flow rates were chosen for each group of meters and the resultant curves superimposed on the initial signature curves of the respective meters.

Finally, the meters were set up again on the normal test manifold and the twenty flow rates repeated for the meters . A final signature test was done for all the batches of meters and again the resultant curves were superimposed on the initial signature curves of the respective meters.

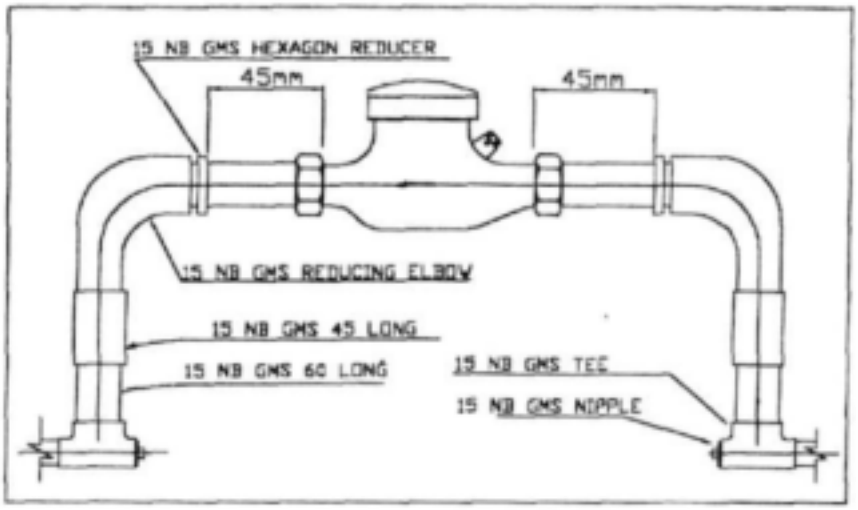


Fig. 7 Above ground configuration

8 Results of tests and discussion

Each meter had two graphs plotted consisting of:

(a) one graph with the test curves of the results obtained with a ball valve in various stages of opening superimposed on the initial signature, and

(b) a second graph with curves for the results obtained with the meter rotated 45° from the vertical and the above ground installation superimposed on the initial and final signature.

The two set of graphs for each meter are shown in Annex D.

8.1. Model A (AI1, AI2, AI3)

From the graphs of the three meters tested in the Model A group all the curves had peaks at a flow rate of 500 ℓ/h on the initial efficiency curves .Meter AI3 failed to meet the SABS tolerance at this point. However, as the repeatability of the meters was the same, no meter was disqualified. The curves with the valve in various positions of opening crept upwards by not more than 2 % from the initial curve except at flow rates greater than q_p where the reverse was true. There was very good correlation with the initial and final curves for all the test configurations except for the 45° orientation where all the meters severely underregistered increasingly from 200ℓ/h to q_{min}. Therefore, it was conclusive from the tests that the 45° orientation affected the performance of the meter.

8.2 Model B (BP1, BP2, BP3)

There was good correlation of all curves versus the initial and final curves at flow rates greater than 200 ℓ/h (all turning points of the curves appeared here), as expected for a volumetric meter. Below 200 ℓ/h variances from the initial efficiency curve were greatest for the 22,5° open configuration (about 1% underregistering), whereas the fully open configuration correlated well. The final signature shifted steeply below 100 ℓ/h resulting in failure to meet SABS tolerance. Hence the results were not conclusive and could not be attributed to the fittings or configurations.

8.3 Model C (CI1, CI2, CI3)

The initial signature curves showed the meter CI3 having two peaks; one of overregistration at 1,5 m^3/h and one of underregistration at 2 m^3/h. The peaks were outside the SABS tolerance band and not similar to the other curves from the other two meters, this meter was rejected. The 45° orientation produced the same effect as in the other inferential meters in that the curves steeped extremely giving severe underregistering at flow rates less than the transitional flow rate. The other configurations had small variances from the initial and final efficiency curves, although the fully open valve configuration on meter CI2 curve near q_{min} is uncharacteristic and cannot be easily explained. Hence the only notable effect was with the 45° orientation to the vertical as the erratic curves of the other configurations did not reveal conclusive trends.

8.4 Model D (DI1, DI2, DI3)

A similar initial signature curve characteristic to the one from meter CI3 above resulted in meter DI3 being rejected. The curves with valve configuration show very close correlation between the curves at all positions of opening and hence there was no considerable effect on the meter accuracies. Nothing could be concluded from the rest of the tests as the meters started showing what seemingly appeared to be counter problems. Hence no conclusion could be drawn from this model of meter. The counter is a mechanical part of the meter which counts the volume of water by way of converting the revolutions of the turbine or piston shaft , through a gear train transmission into cubic meters. Roller or drum counters are used for depicting tens, hundreds and larger volumes in cubic meters whereas circular graduated dials are used mostly for fractions of a cubic meter.

8.5 Model E (EI1, EI2, EI3)

The initial signature curve for EI3 was uncharacteristic when compared with the other two meters of the same model hence this meter was rejected. The 45° orientation produced the same trend as in other inferential meters but the pitching of the error curves began much earlier at around 750 ℓ/h. The rest of the configurations correlated well with the initial and final signature curves.

8.6 Model F (FP1, FP2, FP3)

All the curves of the various configurations of all the meters correlated satisfactorily with the initial and final efficiency curves at almost all flow rates except for small kinks at 200 ℓ/h for the fully open valve configurations for meters FP2 and FP3. It is with repeatable results of such meters that definite conclusions can be drawn about the performances of volumetric meters as there were no peculiar and inexplicable meter performances. Thus for these meters it can be safely concluded that they were not affected by any of the test configurations.

9 Conclusion

9.1 Conclusions of research

The investigation of the influence of various fittings on the accuracy of a meter produced various meter performances and results. The main finding of this research was that at an installation of 45° to the vertical an inferential meter severely underregisters the value of the water passing through it. All the inferential meters had large shifts from the signature curves at flow rates below the transition flow rate. Tests carried out on this configuration showed the curve of every inferential meter deviating towards errors greater than 10 % at flows near the minimum flow rate. The presence of a valve upstream of both inferential and volumetric meters shifted the error curve marginally from the signature curves and therefore did not affect their accuracy severely.

The above ground fittings did not displace the curves large enough for both types of meters tested to enable drawing of any conclusions. The piston meters proved that some models were sensitive to upstream flow conditions and orientation from the vertical and other types were not. The model F piston meters were hardly affected by any configuration tested whereas the model B meters had inexplicable large displacements from the initial signature at flow rates below q_t. The final signature curves for the latter model also shifted above the SABS 1529-1 tolerances of 5 % at the flow rates near q_{min}, hence it is premature to conclude whether the fittings affected the meter or that the meter accuracies had deteriorated due to wear and tear.

Other recommendations that emanated from this research are:

- An inferential meter designed to operate in the horizontal standard position should always be installed with its turbine shaft axis coaxial with the vertical axis. More so there is need to investigate the critical angles or angular tolerance to which different models of meters start to lose sensitivity.

- The above ground installation does not impart large inaccuracies on meter performances and its use in meter installations where ease of reading is required, can still remain a normal practice.

- That an inlet ball valve of the type used in this research does not impart large inaccuracies on domestic meter performances. Emphasis is put on the words "type used in this research" as different valves impart different flow disturbance characteristics and therefore more types of valves should be tested.

- Better training curricula should be formulated for all plumbers to avoid improper installation of meters and increase their understanding of the importance of the information derived from a water meter in local government water management systems.

- Regular checks on meter manufacturers should be continued long after type approval to ensure that they still produce their meters with accuracy and durability as key requirements. This recommendation emanates from the fact that some type approved meters used in the research, failed the initial selection criteria.

- All municipalities and water governing bodies, plumbers institutions and other interested organizations should make use of the "*Guidelines on Domestic Meter Installation Practices*" which emanated from this study.

9.2 General conclusions

The problems that arose due to the suitability of some of the meters chosen as standard comparison meters brought to the research another interesting observation on meters that are already type approved under the existing South African Bureau of Standards (SABS 1529-1,1994). The meters CI3, DI3 and EI3 were disqualified from the research as they failed to meet the tolerances specified in the above-mentioned standard. The meter AI3 failed throughout all the tests at 500 ℓ/h and the other two meters from this type had kinks of overregistration on the curves at this flow rate which resulted in meter AI2 exceeding the 2 % error stipulated by the specification.

The explanation for the severe underregistration at lower flowrates for inferential meters on the 45° orientation can be due to the increase of the mechanical friction between the rotor and the shaft bearings as the points of support of the rotor are no longer the bearing areas only as designed. As mentioned earlier the force acting on the rotor is the driving torque, which is resisted by the torques due to damping, fluid friction (viscous drag), and mechanical friction. For a fluid of constant density such as water, the driving torque is proportional to V^2, where V is the velocity of flow (relative to the rotor blades), the damping torque is proportional to N^2, where N is the speed of rotation of the rotor, the torque due to fluid friction is proportional to V^2 and the torque due to mechanical friction is proportional to the weight of the rotor normal to the point of support. If the damping and fluid friction torques are large in relation to the mechanical friction torque, the speed, N, of the rotor will be directly proportional to the velocity of flow, V, and accurate metering will result. Therefore, the torque due to mechanical friction must be kept low, and this can be done only by careful design of the rotor bearings and reducing to the lowest possible limit the transmission load to the presentation element. The coefficient of friction between the rotor and the shaft can increase due to improper seating of the rotor bearing on the shaft bearing. This will mean high mechanical friction and consequent underregistering at lower flowrates. As the velocity of flow increases above transition region the rotor is floating completely in water and there is minimal contact of its bearing surface with the bearing tip of the shaft. Therefore the reduced mechanical friction resulted in accurate metering at higher flowrates for all meters irrespective of the 45° tilt.

10 Recommendations for future research

The main recommendation for future research is that more tests should be done on most sizes of both single-jet and multi-jet inferential meters simulating most existing installation practices in order to be able to make comprehensive conclusions. As these researches would involve numerous tests, more laboratories can be drawn into these researches and intercomparisons done initially to be able to establish compatibility in the results of the same meters. A large enough statistically representative sample of meters is necessary for these kind of tests bearing in mind that some meters fail to perform and have to be removed from a research. As technology is moving towards electronic meters, most research is going to shift towards these meters. However, as the electronic meter can only be as accurate as the mechanical meter that transmits the source signal, it is recommended that these researches be continued and accelerated. The unusual phenomena exhibited by some volumetric meters should be investigated further as there was ambiguity in the results recorded for the piston meters tested. Lastly, most of the meters exhibited abnormal characteristics which might have been caused by entrained air, hence research into the effect of air on the accuracy of domestic meters is recommended.

References

CLAY, CAE, SPENCER, EA and GRIFFITHS, C (1980) *Improving the confidence in hydraulic laboratory calibrations.*

DEPARTMENT OF HOUSING , SOUTH AFRICA (1995) *Guidelines for the provision of engineering services and amenities in residential township development.* Rev. ed. Pretoria: CSIR, Division of Building Technology, 1995.

DEPARTMENT OF WATER AFFAIRS , SOUTH AFRICA *Draft National Water Supply Regulations*

HARRISON, P (1990) *The effects of flow disturbances on the accuracy of turbine type water meters..*

INTERNATIONAL STANDARD ORGANISATION ISO 4064-2(1978) *Measurement of water flow in closed conduits cold potable water meters. Installation requirements.*

INTERNATIONAL ORGANISATION FOR LEGAL METROLOGY OIML Document 4(1981) *Installation and Storage Conditions for cold water meters.*

INTERNATIONAL STANDARD ORGANISATION ISO 4064-3(1983) *Measurement of water flow in closed conduits cold potable water meters. Test methods and equipment.*

SOUTH AFRICAN BUREAU OF STANDARDS SABS 1529-1(1994)*Water meters for cold potable water - Part 1: Metrological characteristics of mechanical water meters of nominal bore not exceeding 100 mm.*

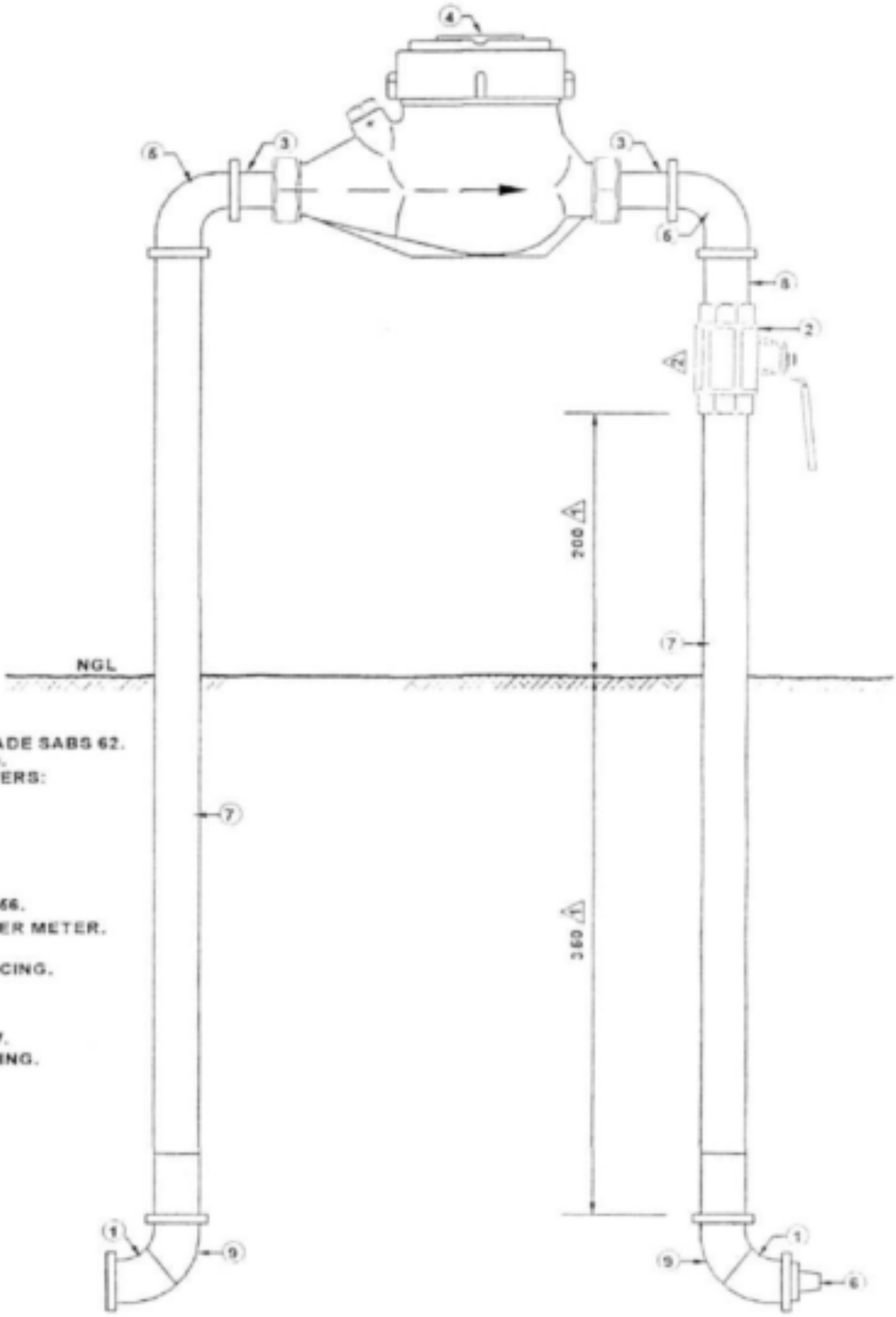
SOUTH AFRICAN BUREAU OF STANDARDS SABS 0306 (1999) *The management of potable water in distribution systems.*

SOUTH AFRICAN *Water Services Act (1997)Act 108.*

ANNEX A

Some common installation practices

A2



NOTES :
ALL GALV: MEDIUM GRADE SABS 62.
ALL DIMENSIONS IN mm.
* VARIABLE PIPE DIAMETERS:
15, 20, 25, 40 & 50 Ø.

NOTES :
(1) ELBOWS, GALV.
(2) VALVE, BALL SABS 1056.
(3) COUPLINGS FOR WATER METER.
(4) WATER METER .
(5) ELBOWS, GALV. REDUCING.
(6) PLUGS, GALV.
(7) PIPE, GALV.
(8) NIPPLE, BARREL GALV.
(9) "DENSOTAPE" WRAPPING.

WATER METER CONNECTION DETAIL

N.T.S.

No	AMENDMENTS - WYSIGINGS	DATE DATUM	DESIGNED ONTWERP	CITY COUNCIL OF PRETORIA WATER & THE ENVIROMENT DEPT.		STADSRAAD VAN PRETORIA DEPT. WATER & DIE OMGEWING	
1	DIMENTIONS REVISED (E.v.H & E.P)	8/99	DRAWN GETEKEN L. VILJOEN	WATER SUPPLY		MISCELLANEOUS	
2	VALVE POSITION CHANGED (P. DE KLERK)	9/99	TRACED NAGETREK 8858/W/2	TYPICAL STANDPIPE FOR 15ø, 20ø, 25ø, 40ø & 50ø WATER CONNECTION			
			CHECKED NAGESIEN T.F. WESTMAN	CHIEF WATER ENGINEER : HOOFWATERINGENIEUR :	CITY ENGINEER : STADSINGENIEUR :	CONTRACT No : KONTRAK Nr :	DRAWING No : TEKENING Nr :
			DATE DATUM OCTOBER 1995	PHS CRONJE Pr.Eng	NDe V LOUBSER Pr.Eng		8858/W/2 2

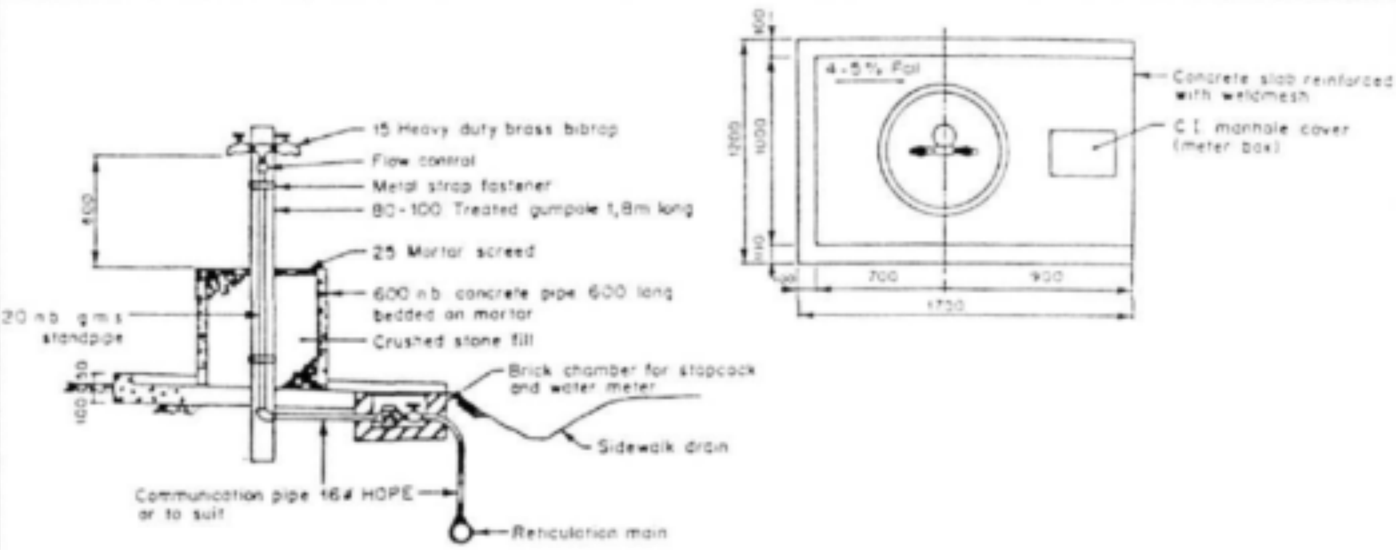


Figure 8.31: Typical standpipe detail

An acceptable discharge capacity from a standpipe is about 15 l/min per tap. For commonly used taps the calculated discharge range, at an assumed efficiency of 80 % is:

Tap diameter	Discharge	
	5 m head	60 m head
15 mm	8 l/min	75 l/min
20 mm	14 l/min	140 l/min

However, the high discharge rates for a 60 m head will normally be reduced by the limitations of the pipework. In practice, measured flow rates to single dwelling houses seldom exceed 40 l/min.

Water taps with high capacities may result in large water wastage when taps are left open, even for only a short time. Therefore tap capacity should be restricted to a maximum of 20 l/min. Figure 8.31 gives details of a typical standpipe installation.

Water kiosks are being used extensively in the semi-formal settlement areas where urbanisation has caused the rapid growth of settlements. The sale of water at kiosks provides an effective means of recovering costs; this is especially relevant where community management structures are not yet in place.

Due to their higher cost and the need for sufficient users to make individual units commercially viable, kiosks are usually spaced further apart than standpipes would be. For the system to be viable, individual kiosks should supply at least 50 dwellings.

Facilities for accurately measuring and dispensing the standard purchase volume (usually 20 or 25 litres) should be provided. The structures should be sturdily constructed, and have lockable facilities.

Water tanks with a tap may be the first level of supply improvement before any distribution piping is installed. Water may be supplied to the tank by a road tanker, by gravity flow from a spring, from a borehole equipped with an engine-driven pump, by rainwater, or from a small treatment works. People may need to walk long distances to the tank to collect this water. However, its quality is usually good, and it may often be the only source of water available to a community.

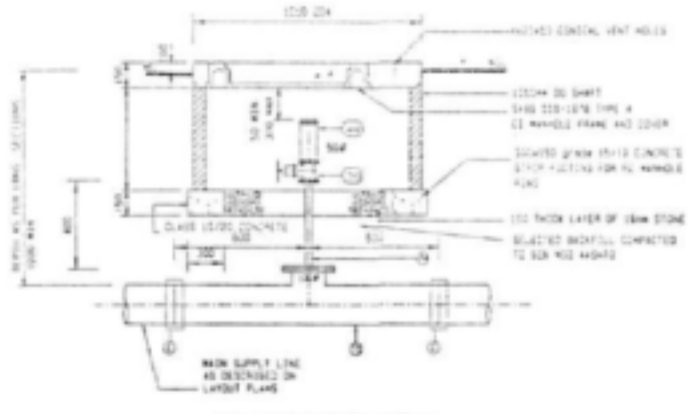
Where the tanks are filled by rainwater collection, it is possible for each home to own its own tank and maintain its own systems. It is important to set up a committee of local residents to manage any such system for public supply.

The size of the tank and its design should be in accordance with the design principals given elswhere in this document.

Water vendors are not generally considered in the planning stage, and may often resist the upgrading of a water supply. These entrepreneurs often operate with only a donkey cart and a number of 200 litre drums, or with motorised transport.

Table 8.19: Selection criteria for water supply terminals

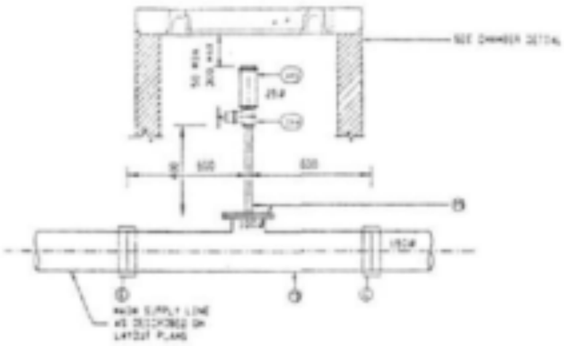
	Affordability (investment)	Cost recovery	Maintenance needs	Unit cost
Public standposts	medium	flat rate	medium	low
Water kiosks	medium	per amount used	low	high
Tanker supply to tank	medium	flat rate	medium/high	medium/high
Vendors	low	per amount used	low	medium/high
Metered yard tap	high	per amount used	low	low
Metered house connection	high	per amount used	low	low
Handpump	medium/low	flat rate	medium	medium
Spring supply to tank	low	flat rate	low	low



AIR VALVE CHAMBER TYPE A

50Ø AIR VALVE

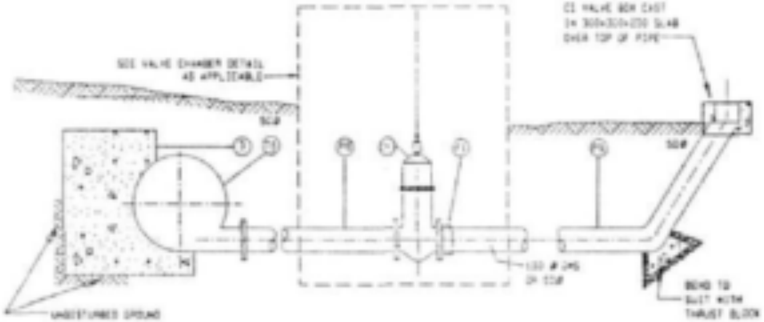
SCALE 1 : 50



CHAMBER TYPE A

25Ø AIR VALVE

SCALE 1 : 50

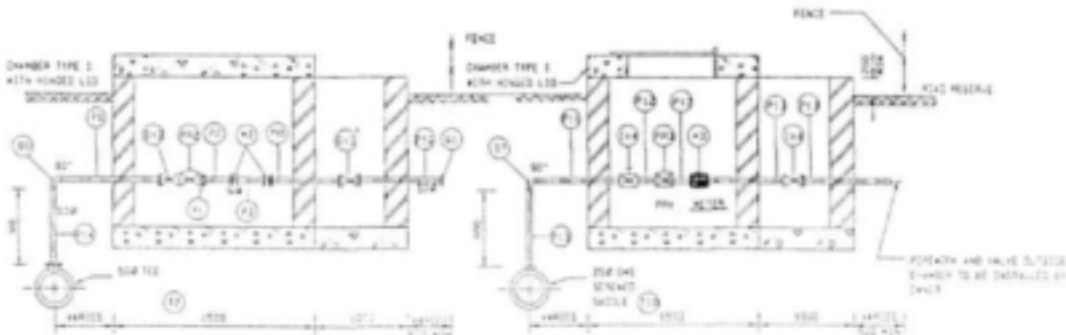


SECTION A-A

100 NB SCOUR DETAILS

SCALE 1 : 50

50 NB	SCOUR PIPE SCHEDULE OF FITTINGS	100 NB
[illegible]	NB GMS PIPE FLANGED LENGTH AS DETERMINED ON SITE	
[illegible]	SCOUR TEE WITH NB FLANGED BRANCH	
	[illegible] THRUST BLOCK (WHERE SPECIFIED) CLASS 15/19	
[illegible]	NB FLANGED GATE VALVE WITH CAP, AS SPECIFIED	[illegible]
[illegible]	NB FLANGED ADAPTOR	[illegible]
[illegible]	NB GMS DISCHARGE PIPE WITH BENDS IF NECESSARY TO SUITABLE OUTLET POSITION WITH CI VALVE BOX	



DETAIL OF 50 NB CONNECTION

DETAIL OF 25 NB CONNECTION

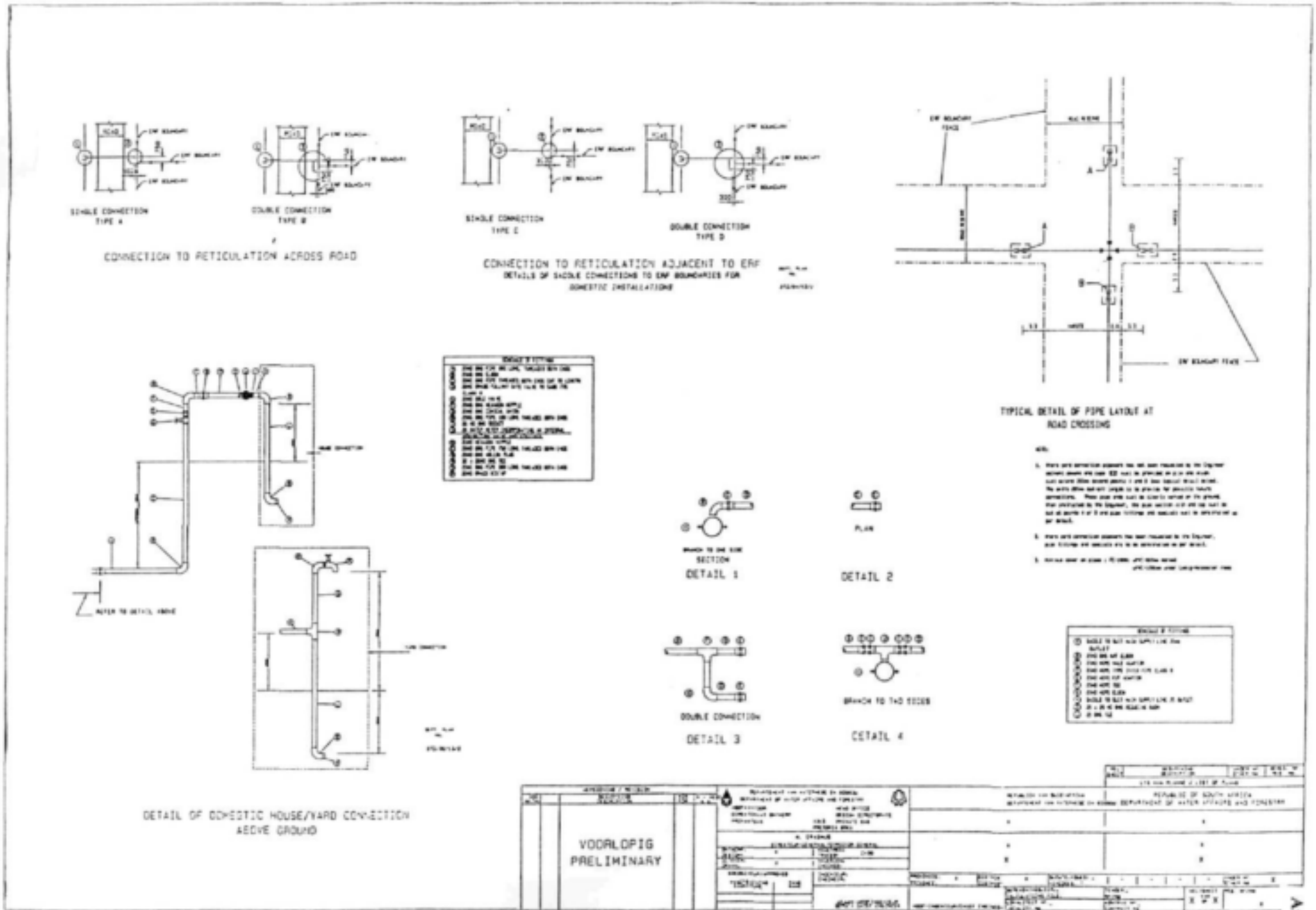
stewart scott CONSULTING ENGINEERS RAADGEWENDE INGENIEURS

TYPICAL VALVE DETAILS

NTS

73

A4



SINGLE CONNECTION TYPE A
DOUBLE CONNECTION TYPE B
CONNECTION TO RETICULATION ACROSS ROAD
SINGLE CONNECTION TYPE C
DOUBLE CONNECTION TYPE D
CONNECTION TO RETICULATION ADJACENT TO ERF
DETAILS OF SADDLE CONNECTIONS TO ERF BOUNDARIES FOR
DOMESTIC INSTALLATIONS
TYPICAL DETAIL OF PIPE LAYOUT AT
ROAD CROSSING
SECTION
DETAIL 1
PLAN
DETAIL 2
DOUBLE CONNECTION
DETAIL 3
BRANCH TO TWO SIDES
DETAIL 4
DETAIL OF DOMESTIC HOUSE/YARD CONNECTION
ABOVE GROUND
VOORLOPIG
PRELIMINARY
REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
A5

a) Pretoria – Meter installed with upstream bends

b) Pretoria – Meter installation tilted

c) Pretoria – Meter installed with upstream bends

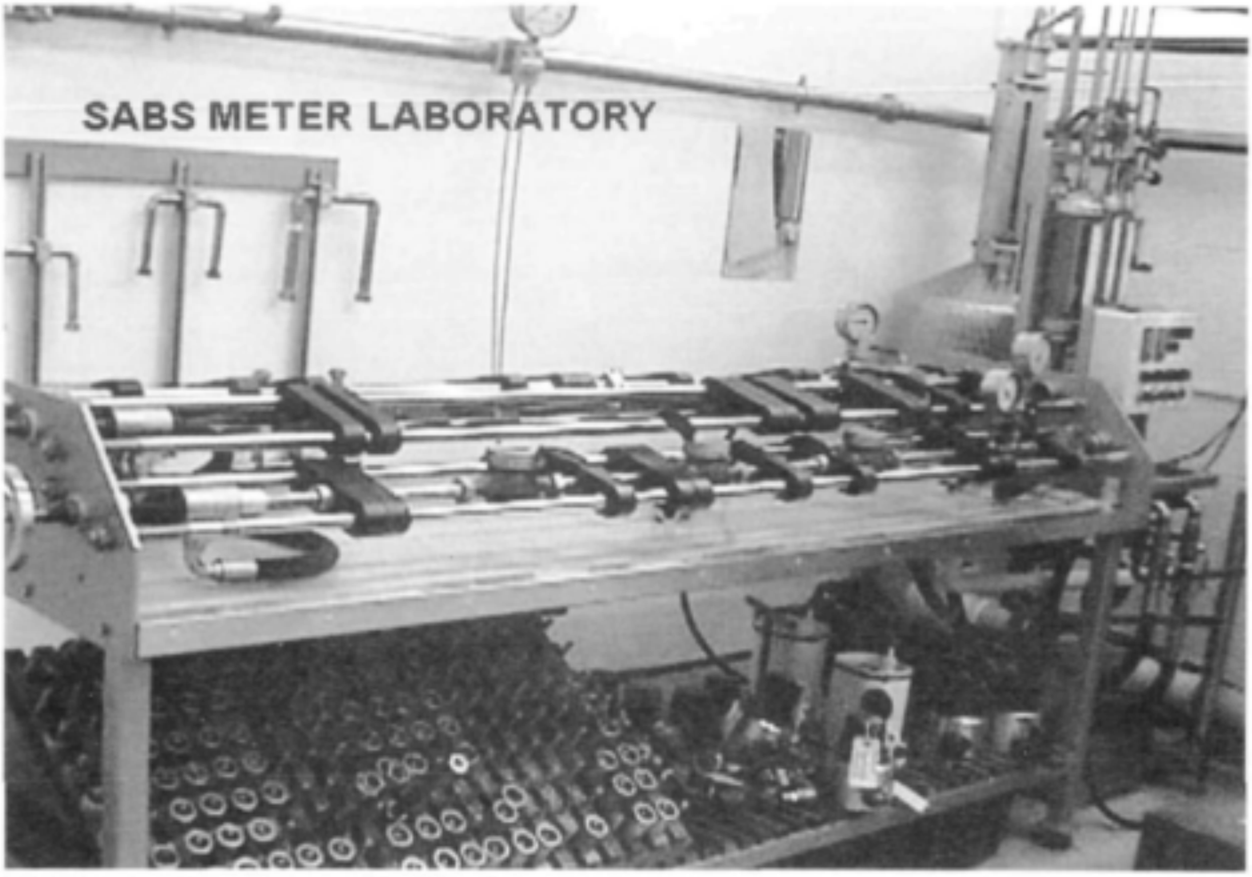
d) Pretoria – Meter installation tilted

e) Pretoria – Meter installed in a skew pipe arrangement

f) Pretoria – Meter installed with upstream bends

ANNEX B

SABS water meter laboratory and calibration certificates



SABS Water Meter Accuracy Test Bench

SABS

SANAS
ACCREDITED LABORATORY

South African Bureau of Standards, Private Bag X191, Pretoria, 0001
Tel: (012) 428-7911, Fax: (012) 344-1568

TRADE METROLOGY DIVISION
South African National Accreditation System
Accredited Laboratory No. 1405

Tel No: (012) 428-7014
Fax No: (012) 428-6552

Certificate of Calibration

No. 198/98

ON SITE CALIBRATION

Calibration of	:	Volumetric measures.
Description of item/s	:	1 x 100 ℓ volumetric measure/s. 1 x 10 ℓ volumetric measure/s.
Calibrated for	:	Fluid Technology Division Attention: Mr J Wantenaar Room M025 SABS
Calibration procedure	:	See page 2 par. 2
Date of calibration	:	1998-06-26
Validity of calibration	:	The value/s in this certificate is/are correct at the time of calibration. Subsequently the accuracy will depend on such factors as the care exercised in handling and use of the instrument/s and the frequency of use. Recalibration should be performed after a period which has been chosen to ensure that the instrument's accuracy remain/s within the desired limit/s.
Calibrated by	:	SG Mahalngu
Checked by	:	BF vd Merwe

SOUTH AFRICAN BUREAU OF STANDARDS

CALIBRATION CERTIFICATE NO. **198/98**

1. Laboratory Standards and Equipment

Laboratory Standards and Equipment	SABS No.	Cert. No.
5 ℓ strike measure	NCS 5	231/NCS 5/97
50 ℓ volumetric measure	23529	231/23529/97

2. Procedure

The volumetric standard was calibrated using the volumetric method (direct volume to volume). Corrections to the apparent volume of water were made for the differential water temperature and thermal expansion of the material of the volumetric standard. Quality Procedure/s QP/231/14.

3. Results

Serial No.	Graduation calibrated in ℓ	Actual volume at 20 °C in ℓ	Uncertainty of calibration in ℓ
WSM 963610	10	10,00	± 0,02
WSM 963609	100	99,99	± 0,07

4. Remarks

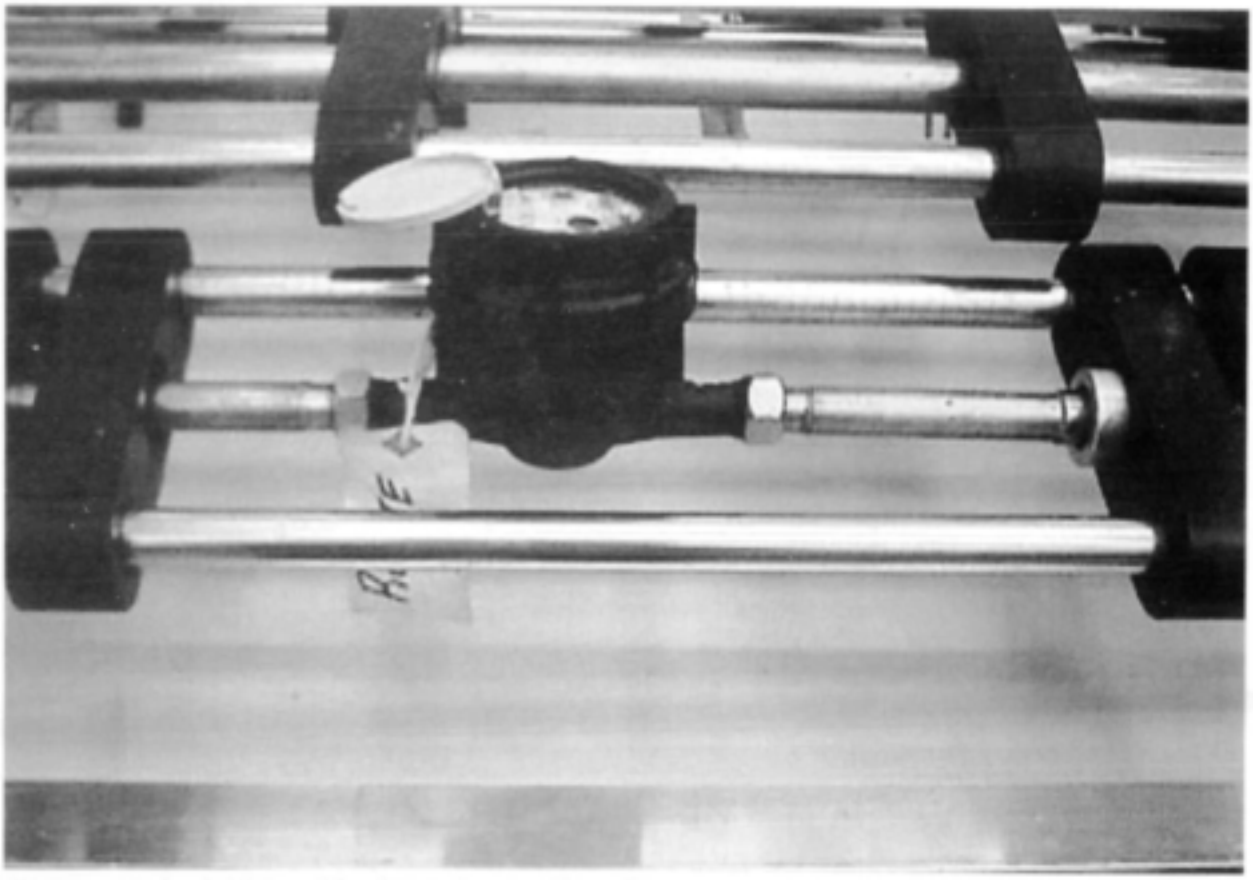
A drainage time of 15 seconds was used during the calibration. The coefficient of cubical expansion of the volumetric standard calibrated was assumed to be: 0,0000507 ℓ/°C.
Measurements were made at a 95 % confidence level.

Calibrated by : SG Mahlangu

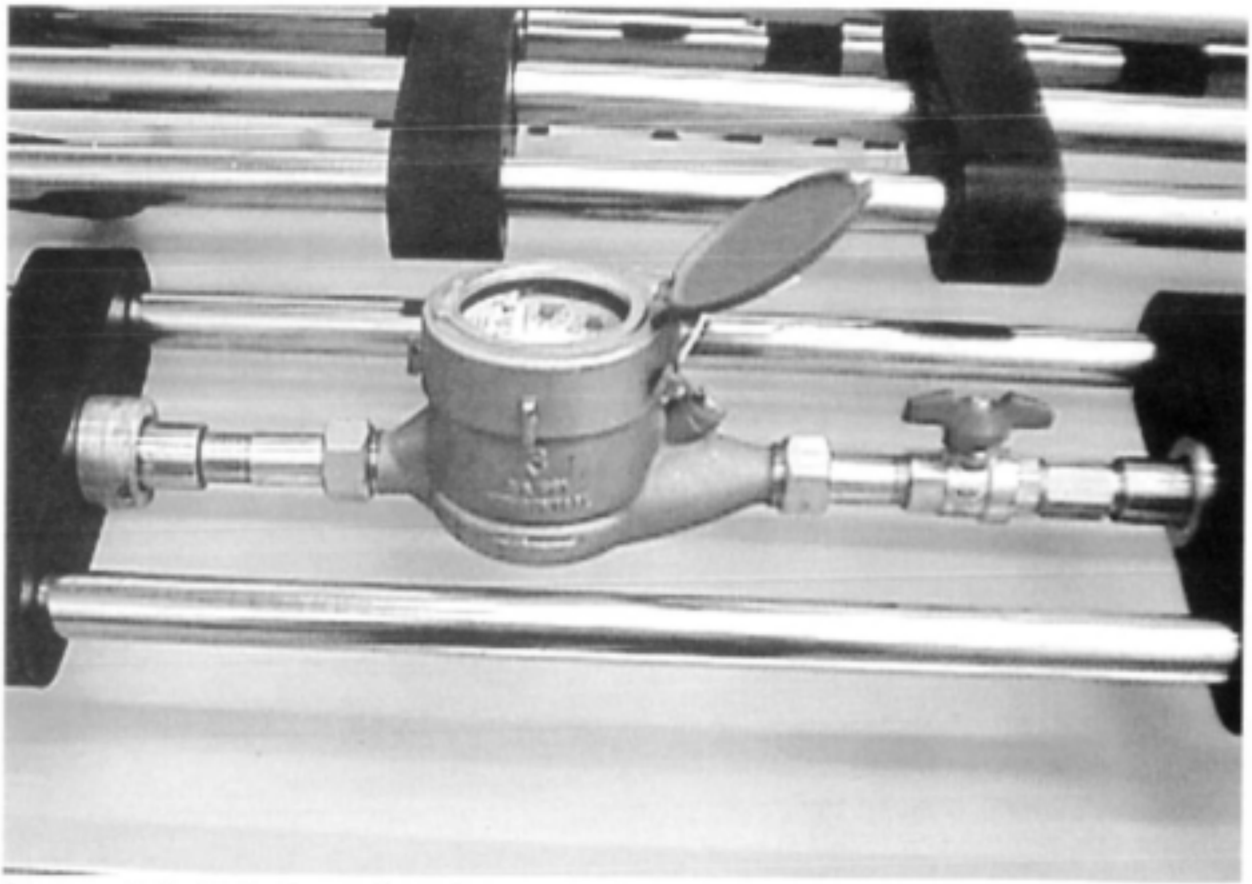
Checked by : BF vd Merwe

ANNEX C

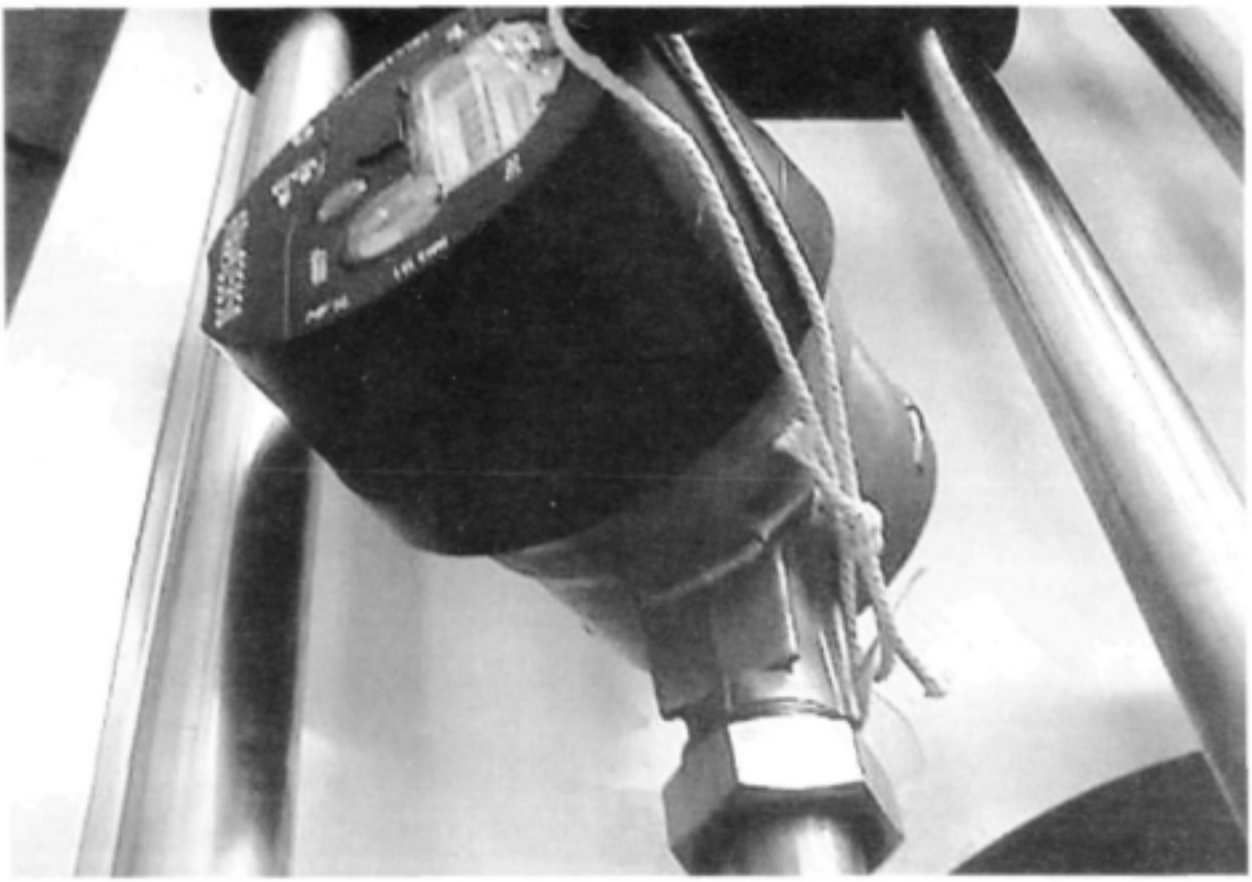
Photographs of test configurations



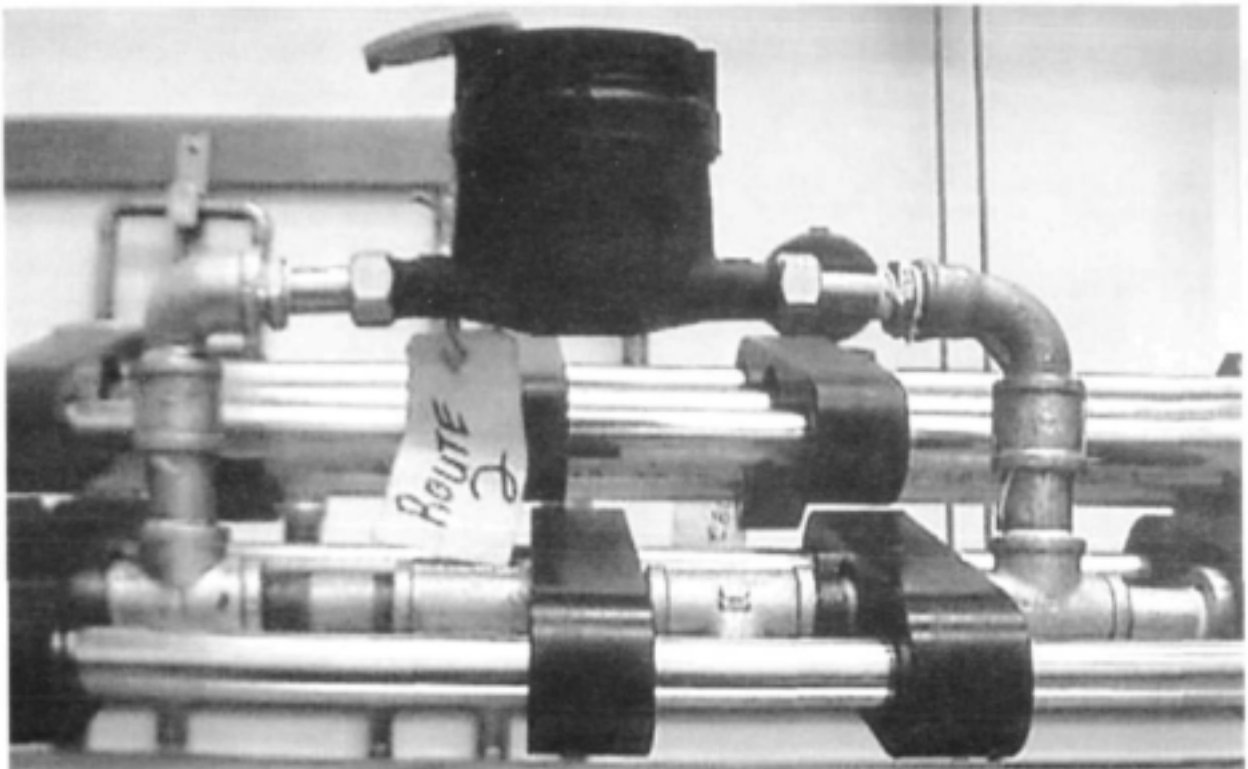
Photograph 1 – Initial and final signature configuration



Photograph 2 – Ball valve configuration



Photograph 3 – 45-degree configuration



Photograph 4 – Above ground configuration

ANNEXURE D

Examples of graphs generated for different types of meters:

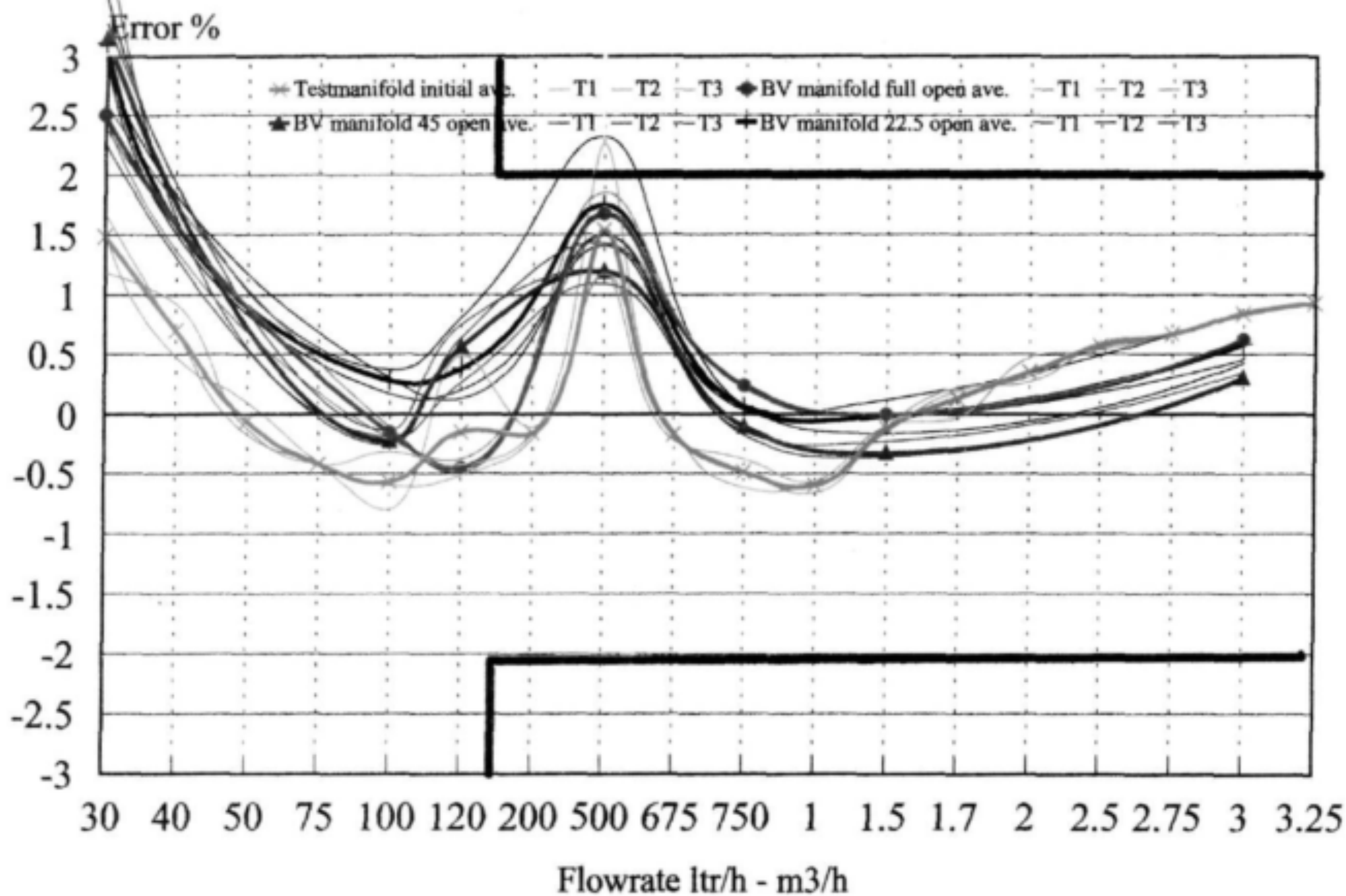
D_2 & D_3 = Inferential meter with readings reflecting all the tests and positions.

D_7 & D_9 = Piston meter with readings reflecting all the tests and positions.

(Please note that a large number of graphs had been generated by the study. Should the reader require a full set, then kindly contact WRC in this regard.)

Domestic Water Meter Model AI 1 Qp = 1.5 m3/h WRC Project

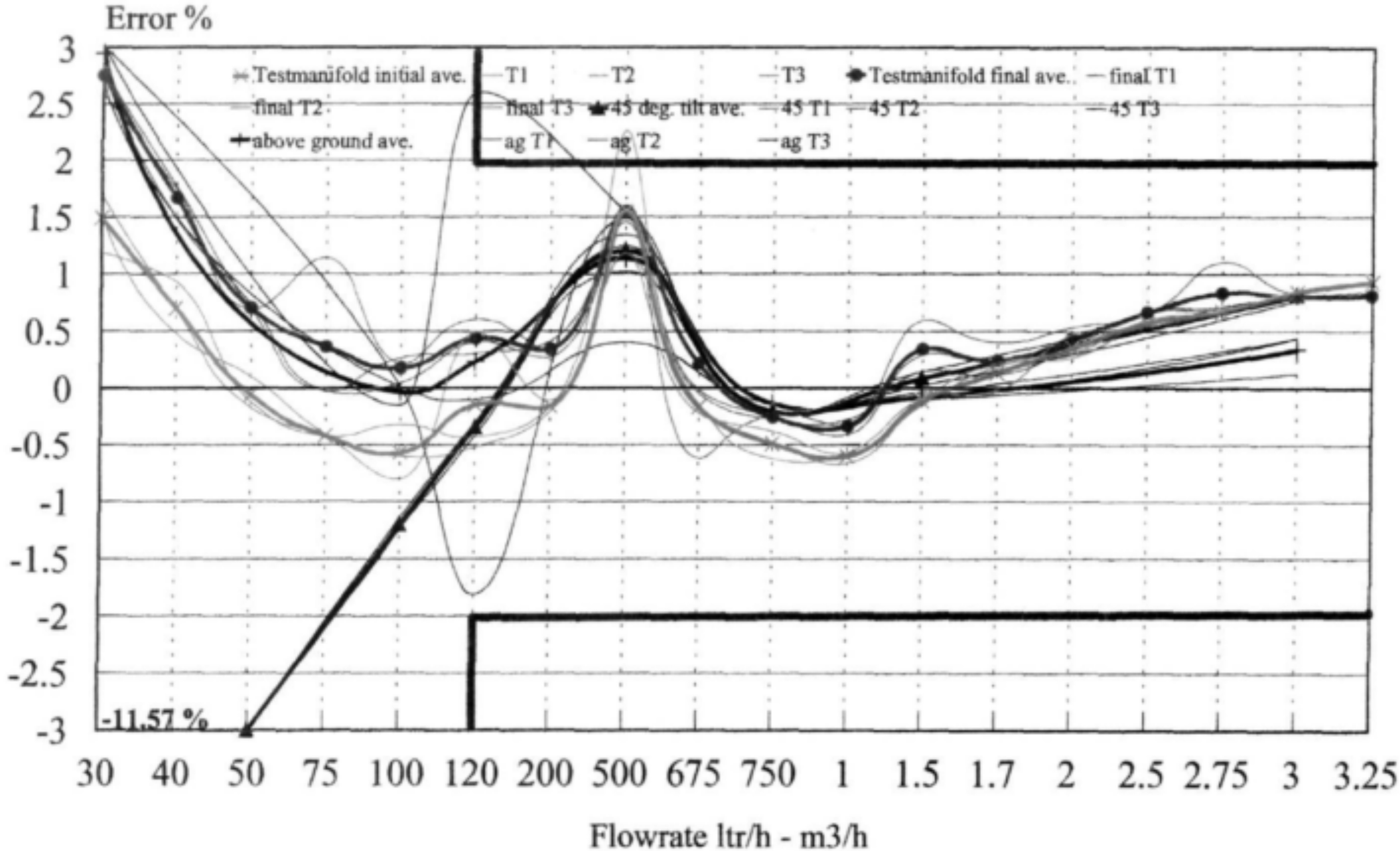
Efficiency Curve SABS 1529 - 1 1994 full & partial flow range & various manifolds/positions



SABS Water Meter Laboratory   19th, June 1999   WRC99252.prx

Domestic Water Meter Model AI 1 Qp = 1.5 m3/h WRC Project

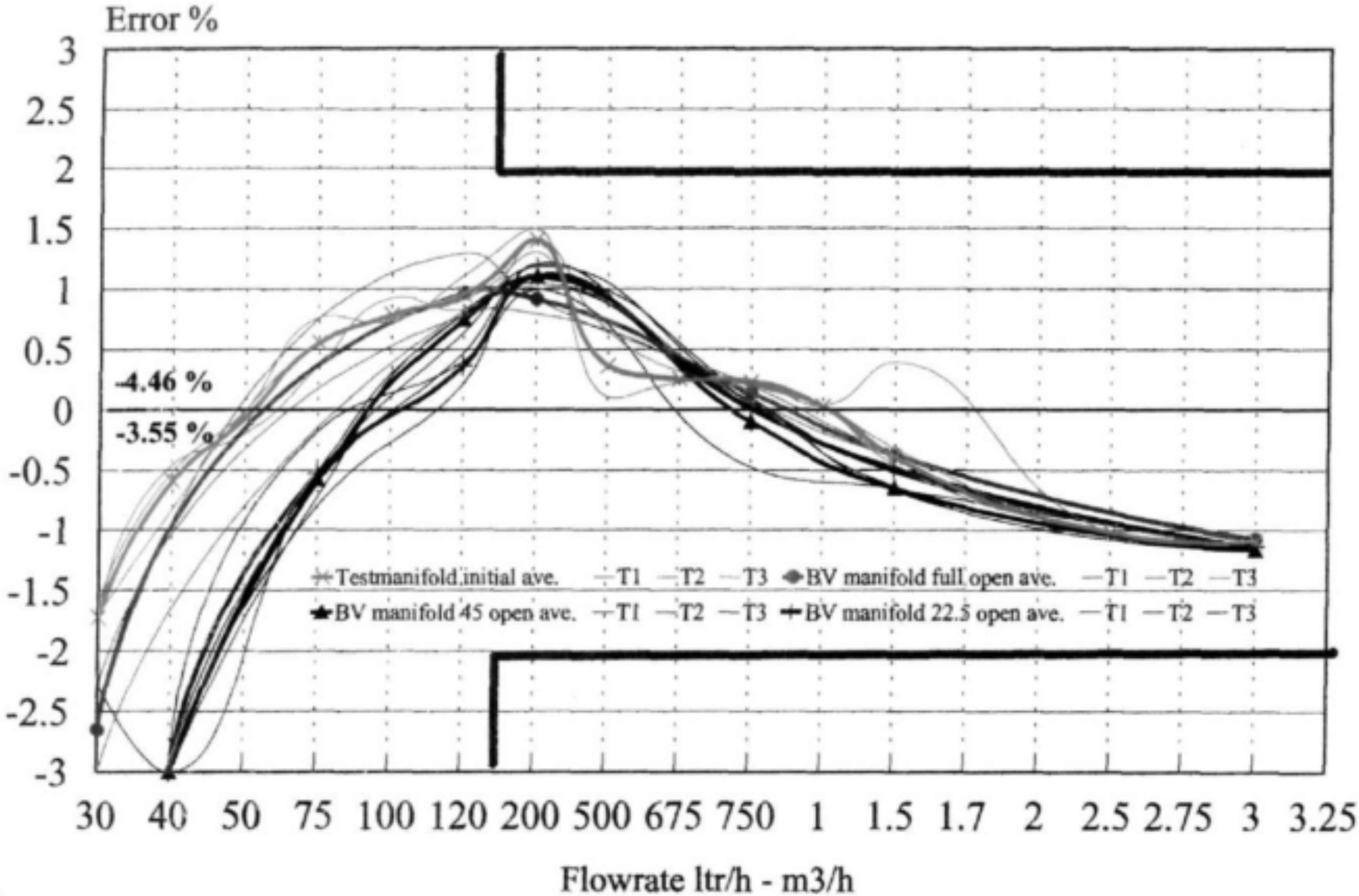
Efficiency Curve SABS 1529 - 1 1994 full & partial flow range & various manifolds/positions



SABS Water Meter Laboratory 19th, June 1999 WRC99253.prx

Domestic Water Meter Model BP 1 Qp = 1.5 m3/h WRC Project

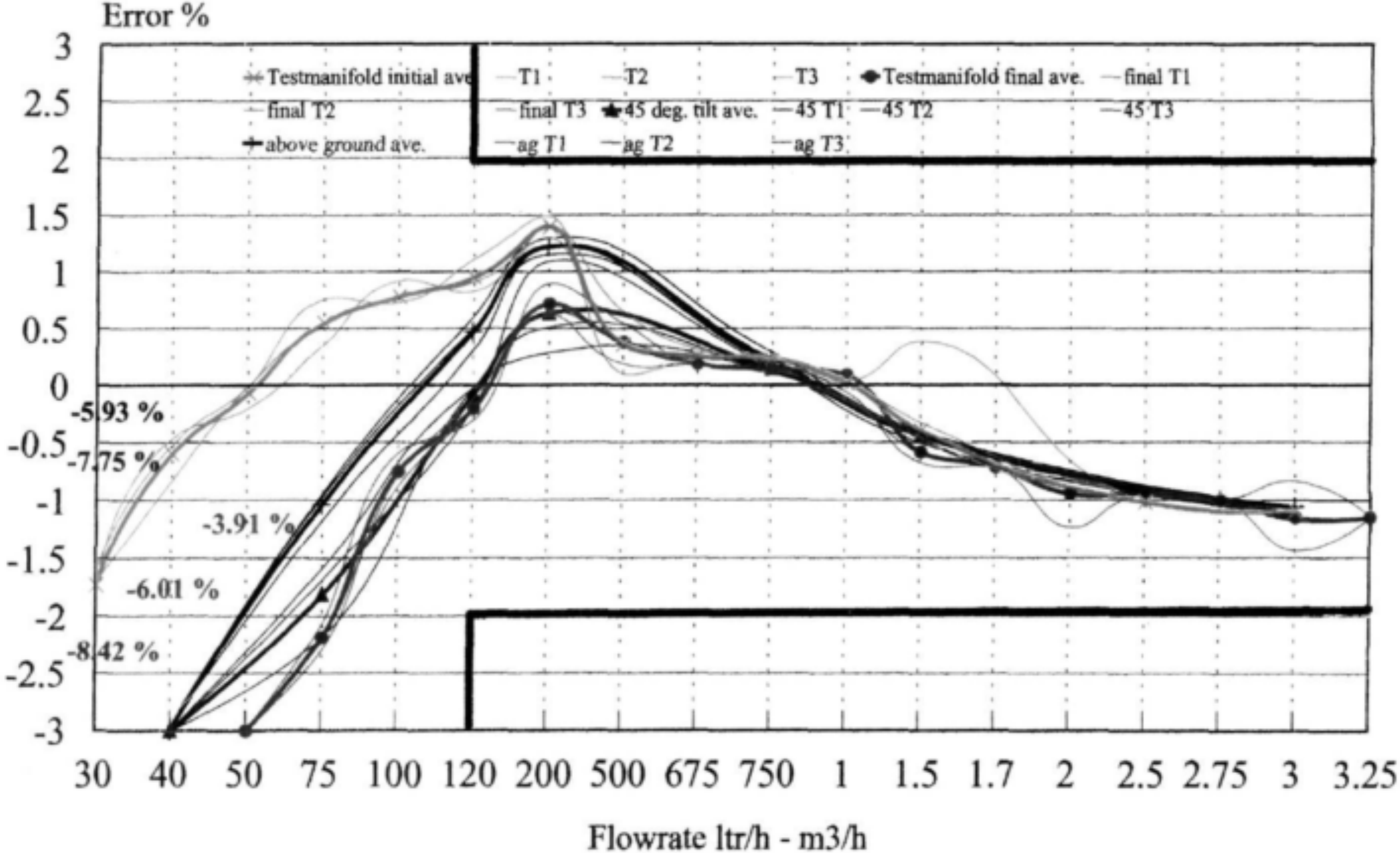
Efficiency Curve SABS 1529 - 1 1994 full & partial flow range & various manifolds/positions



SABS Water Meter Laboratory 19th, June 1999 WRC99266.prx

Domestic Water Meter Model BP 1 Qp = 1.5 m3/h WRC Project

Efficiency Curve SABS 1529 - 1 1994 full & partial flow range & various manifolds/positions



SABS Water Meter Laboratory 19th, June 1999 WRC99267.prx

ANNEX E

Spreadsheets analysis of results

3

Water Meter - Test Report

Applicable Regulation		**Test type:**	**WRC Project**	**Print date:**	**24 March 2000**
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	**WRC**	**Print time:**	**02:34:41 PM**
Meter Size:	**"3", Qp = 1,5 m3/h**	**Manufacturer:**		**Revised**	**16/06/99**
Meter Class:	**"B"**			**File No.:**	**WRCsig-4.rex**
Magnetic drive	**No**	**Meter Type:**		**Report No.:**	**3571/930507/R29**
Route No:	**3**	**Flow orientation:**		**Test No:**	**992102**
Receipt reading:		**P Group:**			
Model:		**Working Pressure:**			

Meter Serial #	Model AI 1	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	330	330	330	330
	Water temperature oC	19.0	18.5	18.5	18.7
	Test duration sec	3059	3235	3373	3222
	Volume displacement ltr	10.022	10.022	10.018	10.021
10 l/h	Start reading m3	16.43381	16.44411	16.45439	
	End reading m3	16.44411	16.45439	16.46459	
	Difference ltr	10.30	10.28	10.20	10.26
	Difference %	**2.77%**	**2.57%**	**1.82%**	**2.39%**
	Actual flow rate ltr/hour	11.79	11.15	10.69	11.20
ideal <+- 0.5 %	**Variance to average**	**-0.39%**	**-0.19%**	**0.57%**	**Pass**
	Flow pressure kPa	330	330	330	330
	Water temperature oC	19.0	19.0	19.0	19.0
	Test duration sec	2273	2158	2316	2249
	Volume displacement ltr	10.024	10.025	10.024	10.024
15 l/h	Start reading m3	16.40239	16.41286	16.42334	
	End reading m3	16.41286	16.42334	16.43381	
	Difference ltr	10.47	10.48	10.47	10.47
	Difference %	**4.45%**	**4.54%**	**4.45%**	**4.48%**
	Actual flow rate ltr/hour	15.88	16.72	15.58	16.05
ideal <+- 0.5 %	**Variance to average**	**0.33%**	**-0.06%**	**0.03%**	**Pass**
	Flow pressure kPa	335	330	330	332
	Water temperature oC	19.5	19.5	19.5	19.5
	Test duration sec	1892	1960	1784	1879
	Volume displacement ltr	10.029	10.029	10.028	10.029
20 l/h	Start reading m3	16.37098	16.38145	16.39193	
	End reading m3	16.38145	16.39193	16.40239	
	Difference ltr	10.47	10.48	10.46	10.47
	Difference %	**4.40%**	**4.50%**	**4.31%**	**4.40%**
	Actual flow rate ltr/hour	19.08	18.42	20.24	19.22
ideal <+- 0.5 %	**Variance to average**	**0.30%**	**-0.10%**	**0.09%**	**Pass**
	Flow pressure kPa	335	335	335	335
	Water temperature oC	19.5	19.5	19.5	19.5
	Test duration sec	1693	1653	1618	1655
	Volume displacement ltr	10.028	10.028	10.028	10.028
	Start reading m3	16.33977	16.35017	16.36058	
22.5 l/h	End reading m3	16.35017	16.36058	16.37098	
	Difference ltr	10.40	10.41	10.40	10.40
	Difference %	**3.71%**	**3.81%**	**3.71%**	**3.74%**
	Actual flow rate ltr/hour	21.32	21.84	22.31	21.82
ideal <+- 0.5 %	**Variance to average**	**0.93%**	**-0.07%**	**0.03%**	**Pass**
	Flow pressure kPa	335	335	335	335
	Water temperature oC	19.0	19.0	19.0	19.0
	Test duration sec	1248	1213	1207	1223
	Volume displacement ltr	10.029	10.030	10.030	10.030
30 l/h	Start reading m3	16.30885	16.31914	16.32945	
	End reading m3	16.31914	16.32945	16.33977	
	Difference ltr	10.29	10.31	10.32	10.31
	Difference %	**2.50%**	**2.79%**	**2.89%**	**2.76%**
	Actual flow rate ltr/hour	28.93	29.77	29.92	29.53
ideal <+- 0.5 %	**Variance to average**	**0.16%**	**-0.03%**	**-0.13%**	**Pass**

REMARKS:

Final signature test

Tested in series with 2 x 3 other meters of same type but different makes

Water Meter - Test Report

Applicable Regulation		**Test type:**	**WRC Project**	**Print date:**	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	WRC	**Print time:**	02:34:41 PM
Meter Size:	"3", Qp = 1.5 m3/h	**Manufacturer:**		**Revised**	16/06/99
Meter Class:	"B"			**File No.:**	WRCsig-4.rex
Magnetic drive	No	**Meter Type:**		**Report No.:**	3571/930507/R29
Route No:	3	**Flow orientation:**		**Test No:**	992102
Receipt reading:		**P Group:**			
Model:		**Working Pressure:**			

Meter Serial #	Model AI 1		Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	335	335	335	335
	Water temperature	oC	18.5	18.5	18.5	18.5
	Test duration	sec	868	870	879	872
	Volume displacement	ltr	10.026	10.032	10.031	10.030
40 l/h	Start reading	m3	16.27826	16.28846	16.29867	
	End reading	m3	16.28846	16.29867	16.30885	
	Difference	ltr	10.20	10.21	10.18	10.20
	Difference	**%**	**1.74%**	**1.77%**	**1.49%**	**1.67%**
	Actual flow rate	ltr/hour	41.58	41.51	41.08	41.39
ideal <+- 0.5 %	**Variance to average**		**-0.07%**	**-0.11%**	**0.18%**	**Pass**
	Flow pressure	kPa	335	335	335	335
	Water temperature	oC	19.0	19.0	19.0	19.0
	Test duration	sec	732	713	714	720
	Volume displacement	ltr	10.030	10.030	10.025	10.028
50 l/h	Start reading	m3	16.24796	16.25806	16.26816	
	End reading	m3	16.25806	16.26816	16.27826	
	Difference	ltr	10.10	10.10	10.10	10.10
	Difference	**%**	**0.70%**	**0.70%**	**0.75%**	**0.71%**
	Actual flow rate	ltr/hour	49.33	50.64	50.55	50.16
ideal <+- 0.5 %	**Variance to average**		**0.02%**	**0.02%**	**-0.03%**	**Pass**
	Flow pressure	kPa	335	335	335	335
	Water temperature	oC	19.5	19.5	19.5	19.5
	Test duration	sec	497	497	491	495
	Volume displacement	ltr	10.005	10.012	10.002	10.006
75 l/h	Start reading	m3	16.21783	16.22795	16.23796	
	End reading	m3	16.22795	16.23796	16.24796	
	Difference	ltr	10.12	10.01	10.00	10.04
	Difference	**%**	**1.15%**	**-0.02%**	**-0.02%**	**0.37%**
	Actual flow rate	ltr/hour	72.47	72.52	73.33	72.77
ideal <+- 0.5 %	**Variance to average**		**-0.78%**	**0.39%**	**0.39%**	**Pass**
	Flow pressure	kPa	335	335	335	335
	Water temperature	oC	19.5	19.5	19.5	19.5
	Test duration	sec	369	336	365	357
	Volume displacement	ltr	10.018	10.013	10.005	10.012
100 l/h	Start reading	m3	16.18774	16.19778	16.20782	
	End reading	m3	16.19778	16.20782	16.21783	
	Difference	ltr	10.04	10.04	10.01	10.03
	Difference	**%**	**0.22%**	**0.27%**	**0.05%**	**0.18%**
	Actual flow rate	ltr/hour	97.74	107.28	98.68	101.06
ideal <+- 0.5 %	**Variance to average**		**-0.04%**	**-0.09%**	**0.13%**	**Pass**
	Flow pressure	kPa	330	330	330	330
	Water temperature	oC	19.5	19.5	19.5	19.5
	Test duration	sec	289	299	299	296
	Volume displacement	ltr	10.009	10.009	10.009	10.009
120 l/h	Start reading	m3	16.15758	16.16765	16.17769	
	End reading	m3	16.16765	16.17769	16.18774	
	Difference	ltr	10.07	10.04	10.05	10.05
	Difference	**%**	**0.61%**	**0.31%**	**0.41%**	**0.44%**
	Actual flow rate	ltr/hour	124.68	120.51	120.51	121.87
ideal <+- 0.5 %	**Variance to average**		**-0.17%**	**0.13%**	**0.03%**	**Pass**

Test Place **SABS Pretoria**

Test Date 28/05/99

Testing Officer Date: ___/___/___ Manager Date: ___/___/___

Signed ________________ Signed ________________

Water Meter - Test Report

Applicable Regulation		**Test type:**	WRC Project	**Print date:**	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	WRC	**Print time:**	02:34:41 PM
Meter Size:	"3", Qp = 1.5 m3/h	**Manufacturer:**		**Revised**	16/06/99
Meter Class:	"B"			**File No.:**	WRCsig-4.rex
Magnetic drive	No	**Meter Type:**		**Report No.:**	3571/930507/R29
Route No:	3	**Flow orientation:**		**Test No:**	992102
Receipt reading:		**P Group:**			
Model:		**Working Pressure:**			

Meter Serial #	Model AI 1	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	335	325	330	330
	Water temperature oC	20.0	19.5	20.0	19.8
	Test duration sec	186	185	179	183
	Volume displacement ltr	10.045	10.008	10.032	10
200 l/h	Start reading m3	16.12739	16.13747	16.14752	
	End reading m3	16.13747	16.14752	16.15758	
	Difference ltr	10.08	10.05	10.06	10.06
	Difference %	**0.35%**	**0.42%**	**0.28%**	**0.35%**
	Actual flow rate ltr/hour	194.42	194.75	201.76	196.92
ideal <+- 0.2 %	**Variance to average**	**0.00%**	**-0.07%**	**0.07%**	Pass
	Flow pressure kPa	330	330	330	330
	Water temperature oC	20.0	19.5	19.5	19.7
	Test duration sec	73	72	72	72
	Volume displacement ltr	10.068	10.073	10.073	10.071
500 l/h	Start reading m3	16.09671	16.10694	16.11716	
	End reading m3	16.10694	16.11716	16.12739	
	Difference ltr	10.23	10.22	10.23	10.23
	Difference %	**1.61%**	**1.46%**	**1.56%**	**1.54%**
	Actual flow rate ltr/hour	496.50	503.65	503.65	501.25
ideal <+- 0.2 %	**Variance to average**	**-0.07%**	**0.08%**	**-0.02%**	Pass
	Flow pressure kPa	320	320	325	322
	Water temperature oC	19.5	19.5	19.5	19.5
	Test duration sec	539	535	533	536
	Volume displacement ltr	100.200	100.150	100.110	100.153
675 l/h	Start reading m3	15.79637	15.89656	15.99667	
	End reading m3	15.89656	15.99667	16.09617	
	Difference ltr	100.19	100.11	99.50	99.93
	Difference %	**-0.01%**	**-0.04%**	**-0.61%**	**-0.22%**
	Actual flow rate ltr/hour	669.24	673.91	676.17	673.09
ideal <+- 0.2 %	**Variance to average**	**-0.21%**	**-0.18%**	**0.39%**	Pass
	Flow pressure kPa	320	320	320	320
	Water temperature oC	19.5	19.5	19.5	19.5
	Test duration sec	487	484	483	485
	Volume displacement ltr	100.340	100.170	100.160	100.223
750 l/h	Start reading m3	15.49645	15.59654	15.69644	
	End reading m3	15.59654	15.69644	15.79637	
	Difference ltr	100.09	99.90	99.93	99.97
	Difference %	**-0.25%**	**-0.27%**	**-0.23%**	**-0.25%**
	Actual flow rate ltr/hour	741.73	745.07	746.53	744.44
ideal <+- 0.2 %	**Variance to average**	**-0.00%**	**0.02%**	**-0.02%**	Pass
	Flow pressure kPa	315	315	310	313
	Water temperature oC	18.0	19.0	19.5	18.8
	Test duration sec	362	356	363	360
	Volume displacement ltr	100.130	100.140	100.100	100.123
1000 l/h	Start reading m3	15.19706	15.29679	15.39666	
	End reading m3	15.29679	15.39666	15.49645	
	Difference ltr	99.73	99.87	99.79	99.80
	Difference %	**-0.40%**	**-0.27%**	**-0.31%**	**-0.33%**
	Actual flow rate ltr/hour	995.77	1012.65	992.73	1000.31
ideal <+- 0.2 %	**Variance to average**	**0.07%**	**-0.06%**	**-0.02%**	Pass

Differential flow ltr/h	**500**	**750**	**1500**	**3000**
Differential pressure kPa				
Manifold pressure kPa	ERR	ERR	ERR	ERR
Pressure test kPa				
Pressure test minutes		**See final test sheet**		

Water Meter - Test Report

Applicable Regulation
SABS 1529-1 1994, section 6.4 and A 4.2h

Meter Size:	"3", Qp = 1.5 m3/h	**Test type:**	WRC Project	**Print date:**	24 March 2000
Meter Class:	"B"	**Customer :**	WRC	**Print time:**	02:34:41 PM
Magnetic drive	No	**Manufacturer:**		**Revised**	16.06.99
Route No:	3			**File No.:**	WRCsig-4.rex
Receipt reading:		**Meter Type:**		**Report No.:**	3571/930507/R29
Model:		**Flow orientation:**		**Test No:**	992102
		P Group:			
		Working Pressure:			

Meter Serial #	Model AI 1		Test # 1	Test # 2	Test # 3	aver. 1-3
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	300	290	300	297
	Water temperature	oC	21.0	230.0	21.0	90.7
	Test duration	sec	245	235	241	240
	Volume displacement	ltr	100.000	100.050	102.000	100.683
1500 l/h	Start reading	m3	14.79366	14.89396	14.99416	
	End reading	m3	14.89396	14.99416	15.09677	
	Difference	ltr	100.30	100.20	102.61	101.04
	Difference	%	**0.30%**	**0.15%**	**0.60%**	**0.35%**
	Actual flow rate	ltr/hour	1469.39	1532.68	1523.65	1508.16
ideal <+- 0.2 %	**Variance to average**		**0.95%**	**0.20%**	**0.25%**	Pass

	Flow pressure	kPa	300	300	285	295
	Water temperature	oC	19.5	19.5	22.0	20.3
	Test duration	sec	210	204	205	206
	Volume displacement	ltr	100.200	100.140	100.030	100.123
1750 l/h	Start reading	m3	14.39227	14.49272	14.59294	
	End reading	m3	14.49272	14.59294	14.69338	
	Difference	ltr	100.45	100.22	100.44	100.37
	Difference	%	**0.25%**	**0.08%**	**0.41%**	**0.25%**
	Actual flow rate	ltr/hour	1717.71	1767.18	1756.62	1746.90
ideal <+- 0.2 %	**Variance to average**		**-0.90%**	**0.17%**	**-0.16%**	Pass

	Flow pressure	kPa	945	940	940	942
	Water temperature	oC	23.0	22.5	22.5	22.7
	Test duration	sec	176	177	178	177
	Volume displacement	ltr	100.180	100.230	100.240	100.217
2000 l/h	Start reading	m3	13.99012	14.09071	14.19131	
	End reading	m3	14.09071	14.19131	14.29209	
	Difference	ltr	100.59	100.60	100.78	100.66
	Difference	%	**0.41%**	**0.37%**	**0.54%**	**0.44%**
	Actual flow rate	ltr/hour	2049.14	2038.58	2027.33	2038.31
ideal <+- 0.2 %	Variance to average		**0.33%**	**0.07%**	**-0.10%**	Pass

	Flow pressure	kPa	920	925	925	923
	Water temperature	oC	22.5	23.0	23.0	22.8
	Test duration	sec	144	144	144	144
	Volume displacement	ltr	100.280	100.310	100.250	100.280
2500 l/h	Start reading	m3	13.63727	13.78822	13.88921	
	End reading	m3	13.73822	13.88921	13.99012	
	Difference	ltr	100.95	100.99	100.91	100.95
	Difference	%	**0.57%**	**0.68%**	**0.66%**	**0.67%**
	Actual flow rate	ltr/hour	2507.00	2507.75	2506.25	2507.00
ideal <+- 0.2 %	Variance to average		**-0.30%**	**-0.01%**	**0.01%**	Pass

	Flow pressure	kPa	920	920	900	913
	Water temperature	oC	22.0	22.0	23.0	22.3
	Test duration	sec	132	133	131	132
	Volume displacement	ltr	100.330	100.360	100.420	100.370
2750 l/h	Start reading	m3	13.33363	13.48466	13.58574	
	End reading	m3	13.43466	13.58574	13.68727	
	Difference	ltr	101.03	101.08	101.53	101.21
	Difference	%	**0.70%**	**0.72%**	**1.11%**	**0.84%**
	Actual flow rate	ltr/hour	2726.27	2716.51	2759.63	2737.36
ideal <+- 0.2 %	**Variance to average**		**0.14%**	**0.12%**	**-0.27%**	Pass

Test Place **SABS Pretoria**
Test Date 28/05/99

Testing Officer Date: ___/___/___ Manager Date: ___/___/___

Signed _______________ Signed _______________

Water Meter - Test Report

Applicable Regulation
SABS 1529-1 1994, section 6.4 and A 4.2h
Meter Size: "3", Qp = 1,5 m3/h
Meter Class: "B"
Magnetic drive No
Route No: 3
Receipt reading:
Model:

Test type: WRC Project
Customer : WRC
Manufacturer:
Meter Type:
Flow orientation:
P Group:
Working Pressure:

Print date: 24 March 2000
Print time: 02:34:41 PM
Revised 16-06-99
File No.: WRCsig-4.rex
Report No.: 3571/930507/R29
Test No: 992102

Meter Serial #	Model AI 1	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	890	880	890	887
	Water temperature oC	20.5	20.5	21.0	20.7
	Test duration sec	119	120	119	119
	Volume displacement ltr	100.460	100.470	100.480	100.470
3000 l/h	Start reading m3	13.07977	13.18104	13.28232	
	End reading m3	13.18104	13.28232	13.38363	
	Difference ltr	101.27	101.28	101.31	101.29
	Difference %	**0.81%**	**0.81%**	**0.83%**	**0.81%**
	Actual flow rate ltr/hour	3039.13	3014.10	3039.73	3030.94
ideal <+- 0.2 %	**Variance to average**	**0.31%**	**0.01%**	**-0.01%**	Pass

	Flow pressure kPa	890	890	880	887
	Water temperature oC	20.5	19.0	19.5	19.7
	Test duration sec	111	110	110	110
	Volume displacement ltr	100.500	100.520	100.530	100.517
3250 l/h	Start reading m3	12.77574	12.87709	12.97842	
	End reading m3	12.87709	12.97842	13.07977	
	Difference ltr	101.35	101.33	101.35	101.34
	Difference %	**0.35%**	**0.81%**	**0.82%**	**0.82%**
	Actual flow rate ltr/hour	3259.46	3289.75	3290.07	3279.70
ideal <+- 0.2 %	**Variance to average**	**-0.32%**	**0.02%**	**0.01%**	Pass

	Flow pressure kPa				
	Water temperature oC				
	Test duration sec				
	Volume displacement ltr				
	Start reading m3				
	End reading m3				
	Difference ltr				
	Difference %				
	Actual flow rate ltr/hour				
	Variance to average				

	Flow pressure kPa				
	Water temperature oC				
	Test duration sec				
	Volume displacement ltr				
	Start reading m3				
	End reading m3				
	Difference ltr				
	Difference %				
	Actual flow rate ltr/hour				
	Variance to average				

	Flow pressure kPa				
	Water temperature oC				
	Test duration sec				
	Volume displacement ltr				
	Start reading m3				
	End reading m3				
	Difference ltr				
	Difference %				
	Actual flow rate ltr/hour				
ideal <+- 0.2 %	**Variance to average**				

REMARKS:
Final signature test
Tested in series with 2 x 3 other meters of same type but different makes.

Water Meter - Test Report

Applicable Regulation		Test type:	WRC Project	Print date:	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		Customer :	WRC	Print time:	02:43:32 PM
Meter Size:	"3", Qp = 1.5 m3/h	Manufacturer:		Revised	15/06/99
Meter Class:	"B"			File No.:	WRC22.5 rex
Magnetic drive	No	Meter Type:		Report No.:	3571/930507/R29
Route No:	3	Flow orientation:		Test No:	9828-02
Receipt reading:		P Group:			
Model:		Working Pressure:			

Meter Serial #	Model AI 1	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	310	310	310	310
TEST FLOW RATES	Water temperature oC	20.5	20.5	20.5	20.5
	Test duration sec	1191	1176	1180	1182
	Volume displacement ltr	10.030	10.031	10.030	10.030
"B"	Start reading m3	9.12023	9.13061	9.14094	
30 ltr/h	End reading m3	9.13061	9.14094	9.15126	
	Difference ltr	10.38	10.33	10.32	10.34
	Difference %	**3.49%**	**2.98%**	**2.89%**	**3.12%**
	Actual flow rate ltr/hour	30.32	30.71	30.60	30.54
ideal <+- 0.5 %	**Variance to average**	-0.37%	**0.14%**	**0.23%**	Pass
	Flow pressure kPa	320	320	320	320
	Water temperature oC	21.0	21.0	21.0	21.0
	Test duration sec	290	279	278	282
	Volume displacement ltr	9.999	10.000	9.997	9.999
"B"	Start reading m3	9.16128	9.17136	9.18138	
120 ltr/h	End reading m3	9.17136	9.18138	9.19139	
	Difference ltr	10.08	10.02	10.01	10.04
	Difference %	**0.81%**	**0.20%**	**0.13%**	**0.38%**
	Actual flow rate ltr/hour	124.13	129.03	129.46	127.49
ideal <+- 0.5 %	**Variance to average**	**-0.43%**	**0.18%**	**0.25%**	Pass
	Flow pressure kPa	320	320	320	320
0.5 Qp	Water temperature oC	19.0	19.0	19.0	19.0
	Test duration sec	525	530	534	530
	Volume displacement ltr	100.160	100.130	100.200	100.163
"A" to "D"	Start reading m3	9.19139	9.29162	9.39178	
750 ltr/hour	End reading m3	9.29162	9.39178	9.49205	
	Difference ltr	100.23	100.16	100.27	100.22
	Difference %	**0.07%**	**0.03%**	**0.07%**	**0.06%**
	Actual flow rate ltr/hour	686.81	680.13	675.51	680.78
ideal <+- 0.2 %	Variance to average	-0.01%	**0.03%**	**-0.01%**	Pass
	Flow pressure kPa	300	300	300	300
1.00 Qp	Water temperature oC	19.0	19.0	19.0	19.0
	Test duration sec	252	234	227	238
	Volume displacement ltr	100.050	100.200	100.100	100.117
"A" to "D"	Start reading m3	9.49205	9.59194	9.69211	
1500 ltr/hour	End reading m3	9.59194	9.69211	9.79233	
	Difference ltr	99.89	100.17	100.22	100.09
	Difference %	-0.16%	-0.03%	0.12%	-0.02%
	Actual flow rate ltr/hour	1429.29	1541.54	1587.49	1516.49
ideal <+- 0.2 %	Variance to average	0.14%	**0.01%**	-0.14%	Pass
	Flow pressure kPa	915	915	915	915
1.00 Qs	Water temperature oC	18.0	18.5	18.5	18.3
	Test duration sec	119	119	120	119
	Volume displacement ltr	100.350	100.330	100.360	100.347
"A" to "D"	Start reading m3	9.90560	10.00638	10.10717	
3000 ltr/hour	End reading m3	10.00638	10.10717	10.20841	
	Difference ltr	100.78	100.79	101.24	100.94
	Difference %	0.43%	**0.46%**	**0.88%**	0.59%
	Actual flow rate ltr/hour	3035.80	3035.19	3010.80	3027.22
ideal <+- 0.2 %	Variance to average	999.25%	**1009.45%**	-0.29%	Pass

REMARKS

Box configureation with ball valve upstream from meter. Valve opening "22.5 degree OPEN" Meter in series with two others of same make. Tested at 5 flows to SABS 1529-1 and two others as per selection of SIGNATURE GRAPH.

Water Meter - Test Report

Applicable Regulation		**Test type:**	WRC Project	**Print date:**	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	WRC	**Print time:**	02:43:32 PM
Meter Size:	"3", Qp = 1,5 m3/h	**Manufacturer:**		**Revised**	15/06/99
Meter Class:	"B"			**File No.:**	WRC22.5.rex
Magnetic drive	No	**Meter Type:**		**Report No.:**	3571/930507/R29
Route No:	3	**Flow orientation:**		**Test No:**	9828-02
Receipt reading:		**P Group:**			
Model:		**Working Pressure:**			

Meter Serial #	**Model AI 1**		**Test # 1**	**Test # 2**	**Test # 3**	**aver. 1 -3**
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	330	330	300	320
FLOW RATE	Water temperature	oC	21.5	21.5	21.5	21.5
(Meter curve)	Test duration	sec	362	354	356	357
	Volume displacement	ltr	10.013	10.013	10.010	10.012
100 lt/hour	Start reading	m3	10.43416	10.44421	10.45424	
	End reading	m3	10.44421	10.45424	10.46428	
	Difference	ltr	10.05	10.03	10.04	10.04
	Difference	**%**	**0.37%**	**0.17%**	**0.30%**	**0.28%**
	Actual flow rate	ltr/hour	99.58	101.83	101.22	100.87
	Variance to average		**-0.09%**	**0.11%**	**-0.02%**	Pass

	Flow pressure	kPa	335	335	335	335
FLOW RATE	Water temperature	oC	21.5	21.5	21.5	21.5
(Meter curve)	Test duration	sec	73	71	71	72
	Volume displacement	**ltr**	10.047	10.048	10.039	10.045
500 lt/hour	Start reading	m3	10.46428	10.47456	10.48475	
	End reading	m3	10.47456	10.48475	10.49494	
	Difference	ltr	10.28	10.19	10.19	10.22
	Difference	**%**	**2.32%**	**1.41%**	**1.50%**	**1.75%**
	Actual flow rate	ltr/hour	495.47	509.48	509.02	504.57
	Variance to average		**-0.57%**	**0.33%**	**0.24%**	Pass

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	**%**				
	Actual flow rate	ltr/hour				
	Variance to average					

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	**%**				
	Actual flow rate	ltr/hour				
	Variance to average					

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	**%**				
	Actual flow rate	ltr/hour				
	Variance to average					

Test Place **SABS Pretoria**
Test Date 09/07/98

Testing Officer Date: ____/___/___ Manager Date: ___/___/___

Signed ________________ Signed ________________

E8

Water Meter - Test Report

Applicable Regulation
SABS 1529-1 1994, section 6.4 and A 4.2h

Meter Size:	"3", Qp = 1,5 m3/h	**Test type:**	WRC Project	**Print date:**	28 March 2000
Meter Class:	"B"	**Customer :**	WRC	**Print time:**	09:47:35 AM
Magnetic drive	No	**Manufacturer:**		**Revised**	15/06/99
Route No:	3			**File No.:**	wrctst-1.rex
Receipt reading:	6.23739	**Meter Type:**		**Report No.:**	3571/930507/R29
Model:		**Flow orientation:**		**Test No:**	9827-01
		P Group:			
		Working Pressure:			

Meter Serial #	Model AI 1	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 1	# 1	# 1	
	Flow pressure kPa	335	335	335	335
TEST FLOW RATES	Water temperature oC	19.5	19.5	19.5	19.5
	Test duration sec	1157	1174	1176	1169
	Volume displacement ltr	10.030	10.019	10.027	10.025
"B"	Start reading m3	6.43867	6.44895	6.45921	
30 ltr/h	End reading m3	6.44895	6.45921	6.46950	
	Difference ltr	10.28	10.26	10.29	10.28
	Difference %	**2.49%**	**2.41%**	**2.62%**	**2.51%**
	Actual flow rate ltr/hour	31.21	30.72	30.69	30.87
ideal <+- 0.5 %	**Variance to average**	**0.01%**	**0.10%**	**-0.12%**	**Pass**

	Flow pressure kPa	335	335	335	335
	Water temperature oC	19.5	19.5	19.5	19.5
	Test duration sec	284	282	283	283
	Volume displacement ltr	9.997	9.999	9.999	9.998
"B"	Start reading m3	6.47027	6.48023	6.50021	
120 ltr/h	End reading m3	6.48023	6.49018	6.51016	
	Difference ltr	9.96	9.95	9.95	9.95
	Difference %	**-0.37%**	**-0.49%**	**-0.49%**	**-0.45%**
	Actual flow rate ltr/hour	126.72	127.65	127.20	127.19
ideal <+- 0.5 %	**Variance to average**	**-0.08%**	**0.04%**	**0.04%**	**Pass**

	Flow pressure kPa	325	330	330	328
0.5 Qp	Water temperature oC	17.0	17.5	19.5	18.0
	Test duration sec	524	520	525	523
	Volume displacement ltr	100.230	100.150	100.290	100.223
"A" to "D"	Start reading m3	6.51016	6.61065	6.71103	
750 ltr/hour	End reading m3	6.61065	6.71103	6.81154	
	Difference ltr	100.49	100.38	100.51	100.46
	Difference %	**0.26%**	**0.23%**	**0.22%**	**0.24%**
	Actual flow rate ltr/hour	688.60	693.35	687.70	689.87
ideal <+- 0.2 %	**Variance to average**	**-0.02%**	**0.01%**	**0.02%**	**Pass**

	Flow pressure kPa	310	310	310	310
1.00 Qp	Water temperature oC	19.0	19.0	19.0	19.0
	Test duration sec	250	250	251	250
	Volume displacement ltr	100.140	100.140	100.090	100.123
"A" to "D"	Start reading m3	6.81154	6.91169	7.01182	
1500 ltr/hour	End reading m3	6.91169	7.01182	7.11190	
	Difference ltr	100.15	100.13	100.08	100.12
	Difference %	**0.01%**	**-0.01%**	**-0.01%**	**-0.00%**
	Actual flow rate ltr/hour	1442.02	1442.02	1435.55	1439.86
ideal <+- 0.2 %	**Variance to average**	**-0.01%**	**0.01%**	**0.01%**	**Pass**

	Flow pressure kPa	820	820	820	820
1.00 Qs	Water temperature oC	19.5	19.5	19.5	19.5
	Test duration sec	126	125	125	125
	Volume displacement ltr	100.420	100.400	100.380	100.400
"A" to "D"	Start reading m3	7.11206	7.21311	7.31416	
3000 ltr/hour	End reading m3	7.21311	7.31416	7.41516	
	Difference ltr	101.05	101.05	101.00	101.03
	Difference %	**0.63%**	**0.65%**	**0.62%**	**0.63%**
	Actual flow rate ltr/hour	2869.14	2891.52	2890.94	2883.83
ideal <+- 0.2 %	**Variance to average**	**0.00%**	**-0.02%**	**0.01%**	**Pass**

REMARKS

Box configureation with ball valve upstream from meter. Valve opening "FULL OPEN" Meter in series with two others of same make.
Tested at 5 flows to SABS 1529-1 and two others as per selection of SIGNATURE GRAPH.

Water Meter - Test Report

Applicable Regulation		**Test type:**	**WRC Project**	**Print date:**	28 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	WRC	**Print time:**	09:52:07 AM
Meter Size:	"3", Qp = 1,5 m3/h	**Manufacturer:**		**Revised**	15/06/99
Meter Class:	"B"			**File No.:**	wrctst-1.rex
Magnetic drive	No	**Meter Type:**		**Report No.:**	3571/930507/R29
Route No:	3	**Flow orientation:**		**Test No:**	9827-01
Receipt reading:	6.23739	**P Group:**			
Model:		**Working Pressure:**			

Meter Serial #	Model AI 1		Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position			# 1	# 1	# 1	
	Flow pressure	kPa	325	325	325	325
FLOW RATE	Water temperature	oC	19.5	19.5	19.5	19.5
(Meter curve)	Test duration	sec	357	358	358	358
	Volume displacement	ltr	10.020	10.015	10.020	10.018
100 lt/hour	Start reading	m3	9.05873	9.06873	9.07873	
	End reading	m3	9.06873	9.07873	9.08874	
	Difference	ltr	10.00	10.00	10.01	10.00
	Difference	**%**	**-0.20%**	**-0.15%**	**-0.10%**	**-0.15%**
	Actual flow rate	ltr/hour	101.04	100.71	100.76	100.84
	Variance to average		**0.05%**	**0.00%**	**-0.05%**	Pass
	Flow pressure	kPa	330	330	330	330
FLOW RATE	Water temperature	oC	20.0	20.0	20.0	20.0
(Meter curve)	Test duration	sec	72	72	72	72
	Volume displacement	ltr	10.049	10.043	10.043	10.045
500 lt/hour	Start reading	m3	9.08874	9.09894	9.10915	
	End reading	m3	9.09894	9.10915	9.11938	
	Difference	ltr	10.20	10.21	10.23	10.21
	Difference	**%**	**1.50%**	**1.66%**	**1.86%**	**1.68%**
	Actual flow rate	ltr/hour	502.45	502.15	502.15	502.25
	Variance to average		**0.17%**	**0.01%**	**-0.19%**	**Pass**
	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	**%**				
	Actual flow rate	ltr/hour				
	Variance to average					
	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	**%**				
	Actual flow rate	ltr/hour				
	Variance to average					
	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	**%**				
	Actual flow rate	ltr/hour				
	Variance to average					

Test Place **SABS Pretoria**
Test Date 02/07/98

Testing Officer Date: ____/____/____ Manager Date: ___/___/___

Signed ________________ Signed ________________

Water Meter - Test Report

Applicable Regulation		**Test type:**	**WRC Project**	**Print date:**	**24 March 2000**
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	**WRC**	**Print time:**	**02:45:49 PM**
Meter Size:	**"3", Qp = 1,5 m3/h**	**Manufacturer:**		**Revised**	**16/06/99**
Meter Class:	**"B"**			**File No.:**	**WRC45T.rex**
Magnetic drive	**No**	**Meter Type:**		**Report No.:**	**5421/930507/R29**
Route No:	**3**	**Flow orientation:**		**Test No:**	**991901**
Receipt reading:		**P Group:**			
Model:		**Working Pressure:**			

Meter Serial #	Model AI 1		Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	335	335	335	335
TEST FLOW RATES	Water temperature	oC	21.0	21.0	21.0	21.0
	Test duration	sec	1134	1108	1110	1117
	Volume displacement	ltr	10.022	10.035	10.024	10.027
"B"	Start reading	m3	11.61038	11.61927	11.62811	
30 ltr/h	End reading	m3	11.61927	11.62811	11.63698	
	Difference	ltr	8.89	8.84	8.87	8.87
	Difference	**%**	**-11.30%**	**-11.91%**	**-11.51%**	-11.57%
	Actual flow rate	ltr/hour	31.82	32.60	32.51	32.31
ideal <+- 0.5 %	**Variance to average**		**-0.28%**	**0.34%**	**-0.06%**	**Fail**
	Flow pressure	kPa	325	325	325	325
	Water temperature	oC	21.0	21.0	21.0	21.0
	Test duration	sec	286	277	277	280
	Volume displacement	ltr	10.009	10.011	10.011	10.010
"B"	Start reading	m3	11.55077	11.56075	11.57072	
120 ltr/h	End reading	m3	11.56075	11.57072	11.58070	
	Difference	ltr	9.98	9.97	9.98	9.98
	Difference	**%**	**-0.29%**	**-0.41%**	**-0.31%**	-0.34%
	Actual flow rate	ltr/hour	125.99	130.11	130.11	128.70
ideal <+- 0.5 %	**Variance to average**		**-0.05%**	**0.07%**	**-0.03%**	**Pass**
	Flow pressure	kPa	320	320	320	320
0.5 Qp	Water temperature	oC	20.5	20.5	20.5	20.5
	Test duration	sec	483	485	485	484
	Volume displacement	ltr	100.160	100.240	100.200	100.200
"A" to "D"	Start reading	m3	11.20457	11.30454	11.40457	
750 ltr/hour	End reading	m3	11.30454	11.40457	11.50458	
	Difference	ltr	99.97	100.03	100.01	100.00
	Difference	**%**	**-0.19%**	**-0.21%**	**-0.19%**	-0.20%
	Actual flow rate	ltr/hour	746.53	744.05	743.75	744.78
ideal <+- 0.2 %	**Variance to average**		**-0.01%**	**0.01%**	**-0.01%**	**Pass**
	Flow pressure	kPa	310	310	310	310
1.00 Qp	Water temperature	oC	20.0	20.0	20.0	20.0
	Test duration	sec	249	248	250	249
	Volume displacement	ltr	100.090	100.140	100.180	100.137
"A" to "D"	Start reading	m3	10.90390	11.00414	11.10436	
1500 ltr/hour	End reading	m3	11.00414	11.10436	11.20457	
	Difference	ltr	100.24	100.22	100.21	100.22
	Difference	**%**	**0.15%**	**0.08%**	**0.03%**	0.09%
	Actual flow rate	ltr/hour	1447.08	1453.65	1442.59	1447.76
ideal <+- 0.2 %	**Variance to average**		**-0.06%**	**0.01%**	**0.06%**	**Pass**
	Flow pressure	kPa	910	915	915	913
1.00 Qs	Water temperature	oC	19.5	19.5	19.5	19.5
	Test duration	sec	118	119	119	119
	Volume displacement	ltr	100.450	100.450	100.440	100.447
"A" to "D"	Start reading	m3	10.60009	10.70138	10.80268	
3000 ltr/hour	End reading	m3	10.70138	10.80268	10.90390	
	Difference	ltr	101.29	101.30	101.22	101.27
	Difference	**%**	**0.84%**	**0.85%**	**0.78%**	0.82%
	Actual flow rate	ltr/hour	3054.58	3038.82	3038.52	3047.26
ideal <+- 0.2 %	**Variance to average**		**-0.02%**	**-0.03%**	**0.04%**	**Pass**

REMARKS

Normal manifold installation with meter rotated 45 degrees from the vertical.
Tested at 5 flows to SABS 1529-1 and two others as per selection of SIGNATURE GRAPH.

Water Meter - Test Report

Applicable Regulation		Test type:	WRC Project	Print date:	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		Customer :	WRC	Print time:	02:45:49 PM
Meter Size:	"3", Qp = 1,5 m3/h	Manufacturer:		Revised	16/06/99
Meter Class:	"B"			File No.:	WRC45T.rex
Magnetic drive	No	Meter Type:		Report No.:	5421/930507/R29
Route No:	3	Flow orientation:		Test No:	991901
Receipt reading:		P Group:			
Model:		Working Pressure:			

Meter Serial #	Model AI 1		Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	325	325	325	325
FLOW RATE	Water temperature	oC	21.5	21.5	21.5	21.5
(Meter curve)	Test duration	sec	364	362	362	363
	Volume displacement	ltr	10.014	10.014	10.014	10.014
100 ltr/hour	Start reading	m3	11.58070	11.59060	11.60049	
	End reading	m3	11.59060	11.60049	11.61038	
	Difference	ltr	9.90	9.89	9.89	9.89
	Difference	%	-1.14%	-1.24%	-1.24%	-1.20%
	Actual flow rate	ltr/hour	99.04	99.59	99.59	99.40
	Variance to average		-0.07%	0.03%	0.03%	Pass

	Flow pressure	kPa	320	320	320	320
FLOW RATE	Water temperature	oC	20.5	20.5	20.5	20.5
(Meter curve)	Test duration	sec	73	73	73	73
	Volume displacement	ltr	10.074	10.064	10.066	10.068
500 ltr/hour	Start reading	m3	11.52020	11.53041	11.54060	
	End reading	m3	11.53041	11.54060	11.55077	
	Difference	ltr	10.21	10.19	10.17	10.19
	Difference	%	1.35%	1.25%	1.03%	1.21%
	Actual flow rate	ltr/hour	496.40	496.31	496.41	496.50
	Variance to average		-0.14%	-0.04%	0.18%	Pass

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

Test Place SABS Pretoria
Test Date 15/05/99

Testing Officer Date: ___/___/___ Manager Date: ___/___/___

Signed ________________ Signed ________________

E12

Water Meter - Test Report

Applicable Regulation		Test type:	WRC Project
SABS 1529-1 1994, section 6.4 and A 4.2h		Customer :	WRC
Meter Size:	"3", Qp = 1,5 m3/h	Manufacturer:	
Meter Class:	"B"		
Magnetic drive	No	Meter Type:	
Route No:	3	Flow orientation:	
Receipt reading:	6.23739	P Group:	
Model:		Working Pressure:	

Print date:	24 March 2000
Print time:	02:50:28 PM
Revised	15/06/99
File No.:	WRC45.rex
Report No.:	3571/930507/R29
Test No:	9827-01

Meter Serial #	Model AI 1	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	330	330	330	330
TEST FLOW RATES	Water temperature oC	21.0	20.5	20.0	20.5
	Test duration sec	1169	1140	1145	1151
	Volume displacement ltr	10.020	10.030	10.032	10.027
"B"	Start reading m3	7.79484	7.80519	7.81562	
30 ltr/h	End reading m3	7.80519	7.81562	7.82588	
	Difference ltr	10.35	10.43	10.26	10.35
	Difference %	**3.29%**	**3.99%**	**2.27%**	**3.18%**
	Actual flow rate ltr/hour	30.86	31.67	31.54	31.35
ideal <+-0.5 %	**Variance to average**	**-0.11%**	**-0.80%**	**0.91%**	Pass
	Flow pressure kPa	330	330	330	330
	Water temperature oC	20.0	20.0	20.0	20.0
	Test duration sec	301	301	302	301
	Volume displacement ltr	9.994	9.993	9.995	9.994
"B"	Start reading m3	7.83573	7.84580	7.85582	
120 ltr/h	End reading m3	7.84580	7.85582	7.86588	
	Difference ltr	10.07	10.02	10.06	10.05
	Difference %	**0.76%**	**0.27%**	**0.65%**	**0.56%**
	Actual flow rate ltr/hour	119.53	119.52	119.15	119.40
ideal <+-0.5 %	**Variance to average**	**-0.20%**	**0.29%**	**-0.09%**	Pass
	Flow pressure kPa	325	325	325	325
0.5 Qp	Water temperature oC	17.5	17.5	17.5	17.5
	Test duration sec	529	534	535	533
	Volume displacement ltr	100.200	100.150	100.200	100.183
"A" to "D"	Start reading m3	7.86588	7.96594	8.06599	
750 ltr/hour	End reading m3	7.96594	8.06599	8.16602	
	Difference ltr	100.06	100.05	100.03	100.05
	Difference %	**-0.14%**	**-0.10%**	**-0.17%**	**-0.14%**
	Actual flow rate ltr/hour	681.89	675.17	674.24	677.08
ideal <+-0.2 %	**Variance to average**	**0.10%**	**-0.04%**	**0.03%**	Pass
	Flow pressure kPa	335	330	330	332
1.00 Qp	Water temperature oC	19.0	18.5	18.5	18.7
	Test duration sec	253	254	254	254
	Volume displacement ltr	100.100	100.150	100.140	100.130
"A" to "D"	Start reading m3	8.16602	8.26590	8.36571	
1500 ltr/hour	End reading m3	8.26590	8.36571	8.46550	
	Difference ltr	99.88	99.81	99.79	99.83
	Difference %	**-0.22%**	**-0.34%**	**-0.35%**	**-0.30%**
	Actual flow rate ltr/hour	1424.35	1419.45	1419.31	1421.03
ideal <+-0.2 %	**Variance to average**	**-0.08%**	**0.04%**	**0.05%**	Pass
	Flow pressure kPa	910	915	915	913
1.00 Qs	Water temperature oC	19.5	19.5	19.5	19.5
	Test duration sec	118	119	119	119
	Volume displacement ltr	100.450	100.400	100.430	100.427
"A" to "D"	Start reading m3	8.55742	8.65823	8.75896	
3000 ltr/hour	End reading m3	8.65823	8.75896	8.85971	
	Difference ltr	100.81	100.73	100.75	100.76
	Difference %	**0.26%**	**0.33%**	**0.32%**	**0.34%**
	Actual flow rate ltr/hour	3064.58	3037.31	3038.22	3046.65
ideal <+-0.2 %	**Variance to average**	**-0.12%**	**0.01%**	**0.02%**	Pass

REMARKS

Box configureation with ball valve upstream from meter. Valve opening "45 degree OPEN" Meter in series with two others of same make. Tested at 5 flows to SABS 1529-1 and two others as per selection of SIGNATURE GRAPH

Water Meter - Test Report

Applicable Regulation		Test type:	WRC Project	Print date:	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		Customer :	WRC	Print time:	02:50:28 PM
Meter Size:	"3", Qp = 1.5 m3/h	Manufacturer:		Revised	15/06/99
Meter Class:	"B"			File No.:	WRC45.rex
Magnetic drive	No	Meter Type:		Report No.:	3571/930507/R29
Route No:	3	Flow orientation:		Test No:	9827-01
Receipt reading:	6.23739	P Group:			
Model:		Working Pressure:			

Meter Serial #	Model AI 1		Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	335	335	335	335
FLOW RATE	Water temperature	oC	19.5	19.5	19.5	19.5
(Meter curve)	Test duration	sec	359	359	359	359
	Volume displacement	ltr	10.013	10.019	10.015	10.016
100 ltr/hour	Start reading	m3	8.46799	8.47799	8.48799	
	End reading	m3	8.47799	8.48799	8.49798	
	Difference	ltr	10.00	10.00	9.99	10.00
	Difference	%	-0.13%	-0.19%	-0.25%	-0.19%
	Actual flow rate	ltr/hour	100.41	100.47	100.43	100.44
	Variance to average		-0.06%	-0.00%	0.06%	Pass

	Flow pressure	kPa	335	335	335	335
FLOW RATE	Water temperature	oC	19.5	19.5	19.5	19.5
(Meter curve)	Test duration	sec	71	72	72	72
	Volume displacement	ltr	10.040	10.040	10.045	10.042
500 ltr/hour	Start reading	m3	8.49798	8.50714	8.51729	
	End reading	m3	8.50714	8.51729	8.52748	
	Difference	ltr	9.16	10.15	10.19	9.83
	Difference	%	-8.76%	1.10%	1.44%	-2.07%
	Actual flow rate	ltr/hour	509.07	502.00	502.25	504.42
	Variance to average		6.69%	-3.17%	-3.52%	Pass

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

Test Place SABS Pretoria
Test Date 03/07/98

Testing Officer Date: ___/___/___ Manager Date: ___/___/___

Signed ____________ Signed ____________

Water Meter - *Test Report*

Applicable Regulation		**Test type:**	**WRC Project**	**Print date:**	**24 March 2000**
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	**WRC**	**Print time:**	**02:23:23 PM**
Meter Size:	**"3", Qp = 1,5 m3/h**	**Manufacturer:**		**Revised**	**16/06/99**
Meter Class:	**"B"**			**File No.:**	**WRCfit.rex**
Magnetic drive	**No**	**Meter Type:**		**Report No.:**	**5421/930507/R29**
Route No:	**3**	**Flow orientation:**		**Test No:**	**991901**
Receipt reading:		**P Group:**			
Model:		**Working Pressure:**			

Meter Serial #	Model AI 1		Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	335	335	335	335
TEST FLOW RATES	Water temperature	oC	19.5	19.5	19.5	19.5
	Test duration	sec	1117	1117	1119	1118
	Volume displacement	ltr	10.024	10.019	10.039	10.027
"B"	Start reading	m3	12.70319	12.71353	12.72385	
30 ltr/h	End reading	m3	12.71353	12.72385	12.73416	
	Difference	ltr	10.34	10.32	10.31	10.32
	Difference	%	**3.15%**	**3.00%**	**2.70%**	**2.95%**
	Actual flow rate	ltr/hour	32.31	32.29	32.30	32.30
ideal <+- 0.5 %	**Variance to average**		**-0.20%**	**-0.05%**	**0.25%**	**Fail**

	Flow pressure	kPa	320	320	320	320
	Water temperature	oC	19.5	19.5	19.5	19.5
	Test duration	sec	280	281	282	281
	Volume displacement	ltr	10.010	10.011	10.010	10.010
"B"	Start reading	m3	12.64304	12.65331	12.66314	
120 ltr/h	End reading	m3	12.65331	12.66314	12.67314	
	Difference	ltr	10.27	9.83	10.00	10.03
	Difference	%	**2.60%**	**-1.81%**	**-0.10%**	**0.23%**
	Actual flow rate	ltr/hour	128.70	128.25	127.79	128.25
ideal <+- 0.5 %	**Variance to average**		**-2.37%**	**2.04%**	**0.33%**	**Pass**

	Flow pressure	kPa	320	320	320	320
0.5 Qp	Water temperature	oC	20.0	20.0	20.0	20.0
	Test duration	sec	483	483	483	483
	Volume displacement	ltr	100.220	100.140	100.240	100.200
"A" to "D"	Start reading	m3	12.31232	12.41239	12.51239	
750 ltr/hour	End reading	m3	12.41239	12.51239	12.61249	
	Difference	ltr	100.07	100.00	100.10	100.06
	Difference	%	**-0.15%**	**-0.14%**	**-0.14%**	**-0.14%**
	Actual flow rate	ltr/hour	746.98	746.39	747.13	746.83
ideal <+- 0.2 %	**Variance to average**		**0.01%**	**-0.00%**	**-0.00%**	**Pass**

	Flow pressure	kPa	290	290	290	290
1.00 Qp	Water temperature	oC	20.0	20.0	20.0	20.0
	Test duration	sec	246	242	242	243
	Volume displacement	ltr	100.090	100.120	100.050	100.087
"A" to "D"	Start reading	m3	12.01229	12.11228	12.21236	
1500 ltr/hour	End reading	m3	12.11228	12.21236	12.31232	
	Difference	ltr	99.99	100.08	99.96	100.01
	Difference	%	**-0.10%**	**-0.04%**	**-0.09%**	**-0.08%**
	Actual flow rate	ltr/hour	1464.73	1489.39	1488.35	1480.73
ideal [illegible]- 0.2 %	**Variance to average**		**0.02%**	**-0.04%**	**0.01%**	**Pass**

	Flow pressure	kPa	860	860	860	860
1.00 Qs	Water temperature	oC	19.5	19.5	19.5	19.5
	Test duration	sec	121	119	120	120
	Volume displacement	ltr	100.430	100.420	100.450	100.433
"A" to "D"	Start reading	m3	11.70998	11.81054	11.91140	
3000 ltr/hour	End reading	m3	11.81054	11.91140	12.01229	
	Difference	ltr	100.56	100.86	100.89	100.77
	Difference	%	**0.13%**	**0.44%**	**0.44%**	**0.34%**
	Actual flow rate	ltr/hour	2988.00	3037.92	3013.50	3013.00
ideal <+- 0.2 %	**Variance to average**		**0.21%**	**-0.10%**	**-0.10%**	**Pass**

REMARKS

Typical above the ground meter installation.
Tested at 5 flows to SABS 1529-1 and two others as per selection of SIGNATURE GRAPH.

Water Meter - Test Report

Applicable Regulation		**Test type:**	WRC Project	**Print date:**	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	WRC	**Print time:**	02:23:23 PM
Meter Size:	"3", Qp = 1,5 m3/h	**Manufacturer:**		**Revised**	16/06/99
Meter Class:	"B"			**File No.:**	WRCflt.rex
Magnetic drive	No	**Meter Type:**		**Report No.:**	5421/930507/R29
Route No:	3	**Flow orientation:**		**Test No:**	991901
Receipt reading:		**P Group:**			
Model:		**Working Pressure:**			

Meter Serial #	**Model AI 1**		**Test # 1**	**Test # 2**	**Test # 3**	**aver. 1 -3**
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	320	320	325	322
FLOW RATE	Water temperature	oC	19.5	19.5	21.5	20.2
(Meter curve)	Test duration	sec	360	363	362	362
	Volume displacement	ltr	10.025	10.019	10.019	10.021
100 ltr/hour	Start reading	m3	12.67314	12.68315	12.69317	
	End reading	m3	12.68315	12.69317	12.70319	
	Difference	ltr	10.01	10.02	10.02	10.02
	Difference	%	**-0.15%**	**0.01%**	**0.01%**	-0.04%
	Actual flow rate	ltr/hour	100.25	99.36	99.64	99.75
	Variance to average		**0.11%**	**-0.05%**	**-0.05%**	Pass

	Flow pressure	kPa	320	320	320	320
FLOW RATE	Water temperature	oC	19.0	19.0	19.0	19.0
(Meter curve)	Test duration	sec	73	73	73	73
	Volume displacement	ltr	10.066	10.070	10.070	10.069
500 ltr/hour	Start reading	m3	12.61249	12.62271	12.63293	
	End reading	m3	12.62271	12.63293	12.64304	
	Difference	ltr	10.22	10.22	10.11	10.18
	Difference	%	**1.53%**	**1.49%**	**0.40%**	**1.14%**
	Actual flow rate	ltr/hour	496.41	496.60	496.60	496.54
	Variance to average		**-0.39%**	**-0.35%**	**0.74%**	Pass

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

	Flow pressure	kPa				
	Water temperature	oC				
	Test duration	sec				
	Volume displacement	ltr				
	Start reading	m3				
	End reading	m3				
	Difference	ltr				
	Difference	%				
	Actual flow rate	ltr/hour				
	Variance to average					

Test Place **SABS Pretoria**
Test Date 20/05/99

Testing Officer Date: ___/___/___ Manager Date: ___/___/___

Water Meter - Test Report

Applicable Regulation		Test type:	WRC Project	Print date:	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		Customer :	WRC	Print time:	02:30:01 PM
Meter Size:	"3", Qp = 1.5 m3/h	Manufacturer:		Revised	15/06/99
Meter Class:	"B"			File No.:	WRC-sig.rex
Magnetic drive	No	Meter Type:		Report No.:	3571/123456/R000/a
Route No:	3	Flow orientation:		Test No:	981502
Receipt reading:	0.83699	P Group:			
Model:		Working Pressure:			

Meter Serial #	Model AI 1	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	325	325	325	339
	Water temperature oC	20.5	20.0	20.0	22.0
	Test duration sec	3256	3280	3301	3473
	Volume displacement ltr	10.011	10.011	10.011	10.011
10 l/h	Start reading m3	2.59117	2.60104	2.61093	
	End reading m3	2.60104	2.61093	2.62081	
	Difference ltr	9.87	9.89	9.88	9.88
	Difference %	-1.41%	-1.21%	-1.31%	-1.31%
	Actual flow rate ltr/hour	11.07	10.99	10.92	10.38
ideal <+- 0.5 %	**Variance to average**	**0.10%**	**-0.10%**	**0.00%**	Pass
	Flow pressure kPa	325	325	325	325
	Water temperature oC	20.0	20.0	21.0	20.3
	Test duration sec	2303	2311	2305	2306
	Volume displacement ltr	10.013	10.013	10.013	10.013
15 l/h	Start reading m3	2.62081	2.63102	2.64126	
	End reading m3	2.63102	2.64126	2.65155	
	Difference ltr	10.21	10.24	10.29	10.25
	Difference %	**1.97%**	**2.27%**	**2.77%**	**2.33%**
	Actual flow rate ltr/hour	15.65	15.60	15.64	15.63
ideal <+- 0.5 %	**Variance to average**	**0.37%**	**0.07%**	**-0.43%**	Pass
	Flow pressure kPa	325	325	325	325
	Water temperature oC	20.5	20.5	20.5	20.5
	Test duration sec	1799	1802	1810	1804
	Volume displacement ltr	10.018	10.013	10.015	10.015
20 l/h	Start reading m3	2.65155	2.66185	2.67213	
	End reading m3	2.66185	2.67213	2.68245	
	Difference ltr	10.30	10.28	10.32	10.30
	Difference %	**2.81%**	**2.67%**	**3.05%**	**2.84%**
	Actual flow rate ltr/hour	20.05	20.00	19.92	19.99
ideal <+- 0.5 %	**Variance to average**	**0.03%**	**0.18%**	**-0.20%**	Pass
	Flow pressure kPa	325	325	325	325
	Water temperature oC	20.5	20.5	20.5	20.5
	Test duration sec	1676	1625	1626	1642
	Volume displacement ltr	10.015	10.018	10.018	10.017
22.5 l/h	Start reading m3	2.68245	2.69271	2.70299	
	End reading m3	2.69271	2.70299	2.71323	
	Difference ltr	10.26	10.28	10.24	10.26
	Difference %	**2.45%**	**2.62%**	**2.22%**	**2.43%**
	Actual flow rate ltr/hour	21.51	22.19	22.18	21.96
ideal <+- 0.5 %	Variance to average	**-0.02%**	**-0.19%**	**0.21%**	Pass
	Flow pressure kPa	325	325	325	325
	Water temperature oC	20.0	21.0	21.0	20.7
	Test duration sec	1154	1186	1189	1190
	Volume displacement ltr	10.020	10.020	10.020	10.020
30 l/h	Start reading m3	2.71323	2.72351	2.73360	
	End reading m3	2.72351	2.73360	2.74374	
	Difference ltr	10.28	10.09	10.14	10.17
	Difference %	**2.59%**	**0.70%**	**1.20%**	**1.50%**
	Actual flow rate ltr/hour	30.21	30.41	30.34	30.32
ideal <+- 0.5 %	Variance to average	**-1.10%**	**0.80%**	**0.30%**	Pass

Differential flow ltr/h	**500**	**750**	**1500**	**3000**
Differential pressure kPa				
Manifold pressure kPa				
Pressure test kPa				
Pressure test minutes		**See final test sheet**		

Water Meter - Test Report

Applicable Regulation		Test type:	WRC Project	Print date:	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		Customer :	WRC	Print time:	02:30:01 PM
Meter Size:	"3", Qp = 1,5 m3/h	Manufacturer:		Revised	15/06/99
Meter Class:	"B"			File No.:	WRC-sig.rex
Magnetic drive	No	Meter Type:		Report No.:	3571/123456/R000/a
Route No:	3	Flow orientation:		Test No:	981502
Receipt reading:	0.83699	P Group:			
Model:		Working Pressure:			

Meter Serial #	Model AI 1	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	325	325	325	325
	Water temperature oC	21.0	21.0	21.0	21.0
	Test duration sec	844	856	872	857
	Volume displacement ltr	10.021	10.020	10.016	10.019
40 l/h	Start reading m3	2.74374	2.75381	2.76390	
	End reading m3	2.75381	2.76390	2.77401	
	Difference ltr	10.07	10.09	10.11	10.09
	Difference %	0.49%	0.70%	0.94%	0.71%
	Actual flow rate ltr/hour	42.74	42.14	41.35	42.07
ideal <+- 0.5 %	Variance to average	0.22%	0.01%	-0.23%	Pass
	Flow pressure kPa	325	325	325	325
	Water temperature oC	20.5	20.0	20.0	20.2
	Test duration sec	728	714	720	721
	Volume displacement ltr	10.019	10.016	10.011	10.015
50 l/h	Start reading m3	2.77401	2.78404	2.79404	
	End reading m3	2.78404	2.79404	2.80404	
	Difference ltr	10.03	10.00	10.00	10.01
	Difference %	0.11%	-0.16%	-0.11%	-0.05%
	Actual flow rate ltr/hour	49.54	50.50	50.05	50.03
ideal <+- 0.5 %	Variance to average	-0.16%	0.11%	0.06%	Pass
	Flow pressure kPa	325	325	325	325
	Water temperature oC	20.5	20.0	20.0	20.2
	Test duration sec	479	489	475	481
	Volume displacement ltr	10.020	10.021	10.021	10.021
75 l/h	Start reading m3	2.80404	2.81402	2.82400	
	End reading m3	2.81402	2.82400	2.83398	
	Difference ltr	9.98	9.98	9.98	9.98
	Difference %	-0.40%	-0.41%	-0.41%	-0.41%
	Actual flow rate ltr/hour	75.31	73.77	75.95	75.00
ideal <+- 0.5 %	Variance to average	-0.01%	0.00%	0.00%	
	Flow pressure kPa	325	325	325	325
	Water temperature oC	20.5	20.5	21.0	20.7
	Test duration sec	358	358	358	358
	Volume displacement ltr	10.009	10.009	10.021	10.013
100 l/h	Start reading m3	2.83398	2.84391	2.85386	
	End reading m3	2.84391	2.85386	2.86385	
	Difference ltr	9.93	9.95	9.99	9.96
	Difference %	-0.79%	-0.59%	-0.31%	-0.56%
	Actual flow rate ltr/hour	100.65	100.65	100.77	100.69
ideal <+- 0.5 %	Variance to average	0.23%	0.03%	-0.25%	
	Flow pressure kPa	325	325	325	325
	Water temperature oC	20.5	20.5	20.5	20.5
	Test duration sec	289	301	300	297
	Volume displacement ltr	10.010	10.011	10.012	10.011
120 l/h	Start reading m3	2.86385	2.87391	2.88387	
	End reading m3	2.87391	2.88387	2.89384	
	Difference ltr	10.06	9.96	9.97	10.00
	Difference %	0.50%	-0.51%	-0.42%	-0.14%
	Actual flow rate ltr/hour	124.69	119.73	120.14	121.48
ideal <+- 0.2 %	Variance to average	-0.64%	0.37%	0.28%	pass / fail

Test Place SABS Pretoria

Test Date 17/04/98

Testing Officer Date: ___/___/___ Manager Date: ___/___/___

Signed ____________________ Signed ____________________

Water Meter - Test Report
Applicable Regulation
SABS 1529-1 1994, section 6.4 and A 4.2h

Meter Size:	"3", Qp = 1,5 m3/h	Test type:		Print date:	24 March 2000
Meter Class:	"B"	Customer :	WRC	Print time:	02:30:01 PM
Magnetic drive	No	Manufacturer:		Revised	15/06/99
Route No:	3			File No.:	WRC-sig.rex
Receipt reading:	0.83699	Meter Type:		Report No.:	3571/123456/R000/a
Model:		Flow orientation:		Test No:	
		P Group:			
		Working Pressure:			

Meter Serial #	**Model AI 1**	Test # 1	Test # 2	Test # 3	aver. 1-3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	325	325	325	325
	Water temperature oC	21.0	21.0	21.0	21.0
	Test duration sec	185	180	181	182
	Volume displacement ltr	10.010	10.010	10.006	10
200 l/h	Start reading m3	2.89384	2.90384	2.91383	
	End reading m3	2.90384	2.91383	2.92382	
	Difference ltr	10.00	9.99	9.99	9.99
	Difference %	-0.10%	-0.20%	-0.16%	-0.15%
	Actual flow rate ltr/hour	194.79	200.20	199.01	197.97
ideal <+- 0.2 %	Variance to average	-0.05%	0.05%	0.01%	Pass
	Flow pressure kPa	325	325	325	325
	Water temperature oC	21.5	21.5	21.5	21.5
	Test duration sec	71	72	72	72
	Volume displacement ltr	10.061	10.070	10.062	10.064
500 l/h	Start reading m3	2.92382	2.93400	2.94419	
	End reading m3	2.93400	2.94419	2.95448	
	Difference ltr	10.18	10.19	10.29	10.22
	Difference %	1.18%	1.19%	2.27%	1.55%
	Actual flow rate ltr/hour	510.14	503.50	503.10	505.56
ideal <+- 0.2 %	Variance to average	0.36%	0.36%	-0.72%	Pass
	Flow pressure kPa	320	320	320	320
	Water temperature oC	21.5	21.5	21.5	21.5
	Test duration sec	538	532	533	534
	Volume displacement ltr	100.080	100.140	100.150	100.123
675 l/h	Start reading m3	2.95448	3.05435	3.15436	
	End reading m3	3.05435	3.15436	3.25436	
	Difference ltr	99.87	100.01	100.00	99.96
	Difference %	-0.21%	-0.13%	-0.15%	-0.16%
	Actual flow rate ltr/hour	669.68	677.64	676.44	674.57
ideal <+- 0.2 %	Variance to average	0.05%	-0.03%	-0.01%	Pass
	Flow pressure kPa	330	330	330	330
	Water temperature oC	23.0	23.0	23.0	23.0
	Test duration sec	468	465	468	467
	Volume displacement ltr	100.240	100.150	100.100	100.163
750 l/h	Start reading m3	3.36375	3.46362	3.56316	
	End reading m3	3.46362	3.56316	3.66279	
	Difference ltr	99.87	99.54	99.63	99.68
	Difference %	-0.37%	-0.61%	-0.47%	-0.48%
	Actual flow rate ltr/hour	771.08	775.35	770.00	772.14
ideal <+- 0.2 %	Variance to average	-0.11%	0.13%	-0.01%	Pass
	Flow pressure kPa	315	315	315	315
	Water temperature oC	22.0	22.0	22.0	22.0
	Test duration sec	358	352	357	356
	Volume displacement ltr	100.050	100.100	100.100	100.083
1000 l/h	Start reading m3	3.66820	3.76779	3.86733	
	End reading m3	3.76779	3.86733	3.96678	
	Difference ltr	99.49	99.54	99.45	99.49
	Difference %	-0.56%	-0.56%	-0.65%	-0.59%
	Actual flow rate ltr/hour	1006.09	1023.75	1009.41	1013.03
ideal <+- 0.2 %	Variance to average	-0.03%	-0.03%	0.06%	Pass

Differential flow ltr/h	500	750	1500	3000
Differential pressure kPa				
Manifold pressure kPa	0	0	0	0
Pressure test kPa				
Pressure test minutes		See final test sheet		

Water Meter - Test Report

Applicable Regulation		**Test type:**		**Print date:**	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		**Customer :**	WRC	**Print time:**	02:30:01 PM
Meter Size:	"3", Qp = 1,5 m3/h	**Manufacturer:**		**Revised**	15/06/99
Meter Class:	"B"			File No.:	WRC-sig.rex
Magnetic drive	No	**Meter Type:**		**Report No.:**	3571/123456/R000/a
Route No:	3	**Flow orientation:**		Test No:	981502
Receipt reading:	0.83699	P Group:			
Model:		Working Pressure:			

Meter Serial #	Model AI 1		Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position			# 3	# 3	# 3	
	Flow pressure	kPa	300	300	300	300
	Water temperature	oC	23.0	23.0	230.0	92.0
	Test duration	sec	235	237	236	236
	Volume displacement	ltr	100.110	100.150	100.090	100.117
1500 l/h	Start reading	m3	3.96678	4.06675	4.16691	
	End reading	m3	4.06675	4.16691	4.26709	
	Difference	ltr	99.97	100.16	100.18	100.10
	Difference	%	**-0.14%**	**0.01%**	**0.09%**	-0.01%
	Actual flow rate	ltr/hour	1533.60	1521.27	1526.80	1527.20
ideal <+- 0.2 %	**Variance to average**		**0.13%**	**-0.02%**	**-0.10%**	Pass
	Flow pressure	kPa	250	290	290	290
	Water temperature	oC	23.0	23.0	23.0	23.0
	Test duration	sec	207	203	206	205
	Volume displacement	ltr	100.030	100.100	100.060	100.063
1700 l/h	**Start reading**	**m3**	**4.26709**	**4.36732**	**4.46740**	
	End reading	**m3**	**4.36732**	**4.46740**	4.56769	
	Difference	ltr	100.23	100.08	100.29	100.20
	Difference	**%**	**0.20%**	-0.02%	**0.23%**	**0.14%**
	Actual flow rate	ltr/hour	1739.65	1775.17	1748.62	1754.36
ideal <+- 0.2 %	**Variance to average**		**-0.06%**	**0.16%**	-0.09%	Pass
	Flow pressure	kPa	270	270	270	270
	Water temperature	oC	23.0	23.0	22.5	22.8
	Test duration	sec	177	174	174	175
	Volume displacement	ltr	100.200	100.070	100.120	100.130
2000 l/h	Start reading	m3	4.56769	4.66821	4.76876	
	End reading	m3	4.66821	4.76876	4.86916	
	Difference	ltr	100.52	100.55	100.40	100.49
	Difference	%	**0.32%**	**0.48%**	**0.28%**	**0.36%**
	Actual flow rate	ltr/hour	2037.97	2070.41	2071.45	2059.82
ideal <+- 0.2 %	Variance to average		**0.04%**	**-0.12%**	**0.08%**	Pass
	Flow pressure	kPa	840	840	880	853
	Water temperature	oC	23.0	23.0	23.5	23.2
	Test duration	sec	138	142	141	140
	Volume displacement	ltr	100.200	100.240	100.190	100.210
2500 l/h	Start reading	m3	4.86916	4.96997	5.07076	
	End reading	m3	4.96997	5.07076	5.17154	
	Difference	ltr	100.81	100.79	100.78	100.79
	Difference	%	**0.61%**	**0.55%**	**0.59%**	**0.58%**
	Actual flow rate	ltr/hour	2613.91	2541.30	2558.04	2570.71
ideal <+- 0.2 %	Variance to average		**-0.03%**	**0.03%**	**-0.01%**	**pass / fail**
	Flow pressure	kPa	880	880	880	880
	Water temperature	oC	23.5	23.5	23.5	23.5
	Test duration	sec	130	131	132	131
	Volume displacement	ltr	100.330	100.300	100.240	100.290
2750 l/h	Start reading	m3	5.17154	5.27256	5.37354	
	End reading	m3	5.27256	5.37354	5.47445	
	Difference	ltr	101.02	100.98	100.91	100.97
	Difference	**%**	**0.69%**	**0.68%**	**0.67%**	0.68%
	Actual flow rate	ltr/hour	2778.37	2756.34	2733.82	2756.06
ideal <+- 0.2 %	**Variance to average**		**-0.01%**	**0.00%**	**0.01%**	pass / fail

Test Place **SABS Pretoria**

Test Date 22/08/97

Testing Officer Date: ____/____/____ Manager Date: ___/____/___

Signed ________________ Signed ________________

Water Meter - Test Report

Applicable Regulation		Test type:		Print date:	24 March 2000
SABS 1529-1 1994, section 6.4 and A 4.2h		Customer :	W.R.C.	Print time:	02:30:01 PM
Meter Size:	"3", Qp = 1,5 m3/h	Manufacturer:		Revised	15/06/99
Meter Class:	"B"			File No.:	WRC-sig.rex
Magnetic drive	No	Meter Type:		Report No.:	3571/123456/R000/a
Route No:	3	Flow orientation:		Test No:	981502
Receipt reading:	0.83699	P Group:			
Model:		Working Pressure:			

Meter Serial #	**Model AI 1**	Test # 1	Test # 2	Test # 3	aver. 1 -3
Test bench position		# 3	# 3	# 3	
	Flow pressure kPa	880	880	880	880
	Water temperature oC	23.0	23.5	23.5	23.3
	Test duration sec	117	117	118	117
	Volume displacement ltr	100.440	100.390	100.390	100.407
3000 l/h	Start reading m3	5.62762	5.72890	5.83013	
	End reading m3	5.72890	5.83013	5.93139	
	Difference ltr	101.28	101.23	101.26	101.26
	Difference %	**0.84%**	**0.84%**	**0.87%**	**0.85%**
	Actual flow rate ltr/hour	3090.46	3088.92	3062.75	3080.66
ideal <+- 0.2 %	**Variance to average**	**0.01%**	**0.01%**	**-0.02%**	Pass

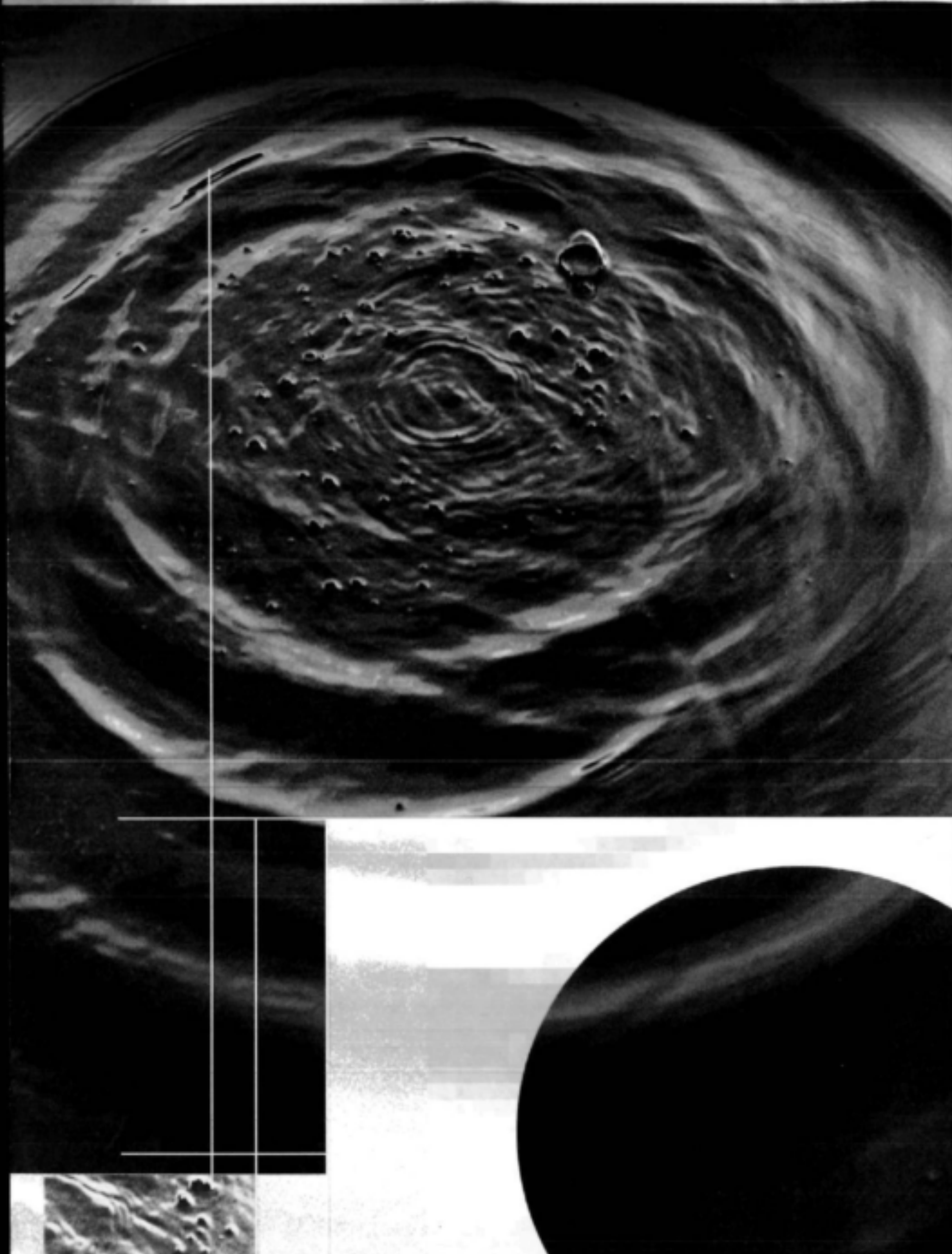
	Flow pressure kPa	860	850	840	850
	Water temperature oC	23.5	23.0	23.0	23.2
	Test duration sec	109	109	110	109
	Volume displacement ltr	100.410	100.400	100.430	100.413
3250 l/h	Start reading m3	5.93139	6.03274	6.13409	
	End reading m3	6.03274	6.13409	6.23547	
	Difference ltr	101.35	101.35	101.38	101.36
	Difference %	**0.94%**	**0.95%**	**0.95%**	**0.94%**
	Actual flow rate ltr/hour	3316.29	3315.96	3286.80	3306.29
ideal <+- 0.2 %	**Variance to average**	**0.01%**	**-0.00%**	**-0.00%**	Pass

	Flow pressure kPa				
	Water temperature oC				
	Test duration sec				
	Volume displacement ltr				
	Start reading m3				
	End reading m3				
	Difference ltr				
	Difference %				
	Actual flow rate ltr/hour				
	Variance to average				

	Flow pressure kPa				
	Water temperature oC				
	Test duration sec				
	Volume displacement ltr				
	Start reading m3				
	End reading m3				
	Difference ltr				
	Difference %				
	Actual flow rate ltr/hour				
	Variance to average				

	Flow pressure kPa				
	Water temperature oC				
	Test duration sec				
	Volume displacement ltr				
	Start reading m3				
	End reading m3				
	Difference ltr				
	Difference %				
	Actual flow rate ltr/hour				
	Variance to average				

Differential flow ltr/h	**500**	**750**	**1500**	**3000**
Differential pressure kPa				
Manifold pressure kPa				
Pressure test kPa				
Pressure test minutes		**See final test sheet**		



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