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TABLES

1. INTRODUCTION

South Africa is a water scarce country; it receives about half the world's average rainfall annually. The demand for water remains on the increase while the supply is constrained. The Department of Water and Sanitation is committed to Water Conservation (WC) and Water Demand Management (WDM) initiatives that will promote the efficient use of water throughout the various sectors in the country.

Eskom, as a strategic user, is committed to continuous improvement of the water management tools and initiatives used within the organisation, as well as the introduction of new tools that minimise and optimise the use of water, in support of the national policy.

Accurate water use monitoring, accounting and reporting is considered an integral and fundamental water management tool available to power stations. The objective of this standard is to prescribe the minimum requirements for monitoring, accounting and reporting of water use at Eskom's power stations. This forms the basis for sound water and effluent management.

1.1 MINIMUM REQUIREMENTS FOR FLOW AND LEVEL MEASUREMENTS

All Eskom's power stations are required to comply with the minimum requirements stipulated in this standard in order to ensure that each power station has a credible water balance. These requirements are summarised below and detailed requirements have been provided in the document.

- The stations shall have flow metering devices on all major streams as identified in Appendix A.
- The stations shall have level measurement on all major storage facilities as identified in Appendix B.
- All stations shall conduct an operational risk assessment to identify flow meters that are required to enable a credible water balance, and shall ensure that all streams, that significantly impact the water balance, be metered or accounted for by calculation where metering is not possible.
- The risk assessment may identify the need for additional metering over and above the identified minimum requirements in Appendix A. The risk assessment will be approved by the Engineering Manager; supported by Asset Management – Process and Chemical Engineering Department (Water Management) and Sustainability (Water CoE). The risk assessment shall be authorised by the respective Power Station General Manager.
- All stations shall ensure that all major processes are balanced such as potable water, demineralised water, main cooling water, auxiliary cooling water, and effluent and ash systems where applicable.
- The stations shall ensure that, taking into account measurement errors, an accuracy of 90 % over the major process balances, listed above, is attained. The stations shall report on water use performance monthly (in L/USO on the raw water and demin water use). The format for reporting is specified in Appendix D.
- Flow meter selection and installation shall be in line with section 3.4.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document prescribes the minimum requirements for the monitoring, management, accounting and reporting of water use. It also provides guidelines on the types and accuracy of measurement devices that are recommended for use within the operations, in order to ensure a credible water balance. The scope does not include maintenance requirements of the measuring devices. All stations are expected to ensure that the maintenance strategies for all the specified instrumentation and water balancing systems are developed and implemented.

2.1.1 Purpose

The purpose of this document is to ensure that all power stations apply the fundamentals prescribed herein for accounting, monitoring and reporting of water use. This is achieved by prescribing:

- Minimum requirements for metering of water streams and the measurement of storage elements within the power station boundaries.
- A structured water monitoring, management, accounting and reporting framework that provides the necessary information that will assist in defining and driving WC/WDM strategies.

2.1.2 Applicability

This document shall apply to all Eskom's power stations, both existing (operational) and new builds.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] Eskom Water Management Policy 32-1163

[2] Eskom Water Strategy 240-91213207

[3] Water Schemes Supplying Eskom Coal Fired PS and Guideline for Water Stats Calculations 240-130899253

[4] ISO 9001 Quality Management Systems.

[5] Field Equipment Installation Standard 240-56355754

[6] Flow Measurement Systems Installation Standard 240-56355789

[7] Control & Instrumentation Field Enclosures and Cable Termination Standard 240-56355815

[8] Requirements for Control and Power Cables for Power Stations Standard 240-56227443

[9] Earthing and Lightning Protection Standard 240-56356396

[10] Process Calibration Equipment Standard 240-56355535

2.2.2 Informative

[11] DWS's Best Practice Guideline G2: Water and Salt Balances.

[12] ISO 17025 General requirements for the competence of testing and calibration laboratories

[13] RR Cook 2nd Edition 2002: The assessment of uncertainties of measurement for calibration and testing laboratories

2.3 DEFINITIONS

Definition	Description
Accounting	In terms of this standard, water accounting refers to the process of recording, analysing, verifying, validating and reporting on the usage of water within the boundaries of the power station's Water Management System
Approved by	The accountability of the Approver of the document is equivalent to the specified role of Functional Responsible/Owner as identified in 240-53114186 and 32-6 for Documents and Records Management.

Definition	Description
Authorised persons	A qualified metrologist with a MertCert Certificate from the National Laboratory Association (NLA) to calibrate process calibration equipment in an Eskom or national metrology laboratory.
Back-up meter	A back-up meter is a flow meter that is used for payment purposes when the designated payment meter is faulty or has been removed for repairs.
Best practical theoretical means	This refers to acceptable methods of calculation or estimation that includes practices such as pump running hours multiplied by capacity for flow rate, solids in raw water multiplied by volume of water treated as an estimate of solids in sludge, etc.
Calibration	Calibration relates to a set of operations that establishes, under specific conditions, the relationship between the quantities indicated by the flowmeter (with measurement uncertainties) and the corresponding values realized by a reference standard of higher metrological quality (with associated measurement uncertainties).
Competent person	A person who has at minimum attended and completed evaluation the National Laboratory Association of South Africa Courses : • Introduction to measurement, • Uncertainty of Measurement - GUM (Physical) • Method Validation (Calibration) These certificates provide assurance that the in-situ verification performed are done professionally and up to the standard of the Guide to Uncertainty of Measurement (Reference: Process Calibration Equipment Standard -240-56355535).
Effluent	Any process water of which the physical, biological or chemical composition have been altered during the operation of the process such that the water cannot be further used within the process.
Gross litres/USO	The total volume of water consumed by the power station and other third party users outside of the power station relative to the total number of units of electricity supplied by the power station to the national grid
HP range	Refers to the supply to the Unit High Pressure Cooling systems used in the Auxiliary Cooling Systems.
Information meters	All meters used for gathering information (small streams that are already accounted in the parent streams).
In-situ Verification	Verification means to determine the accuracy of a meter on site under normal operating and site conditions and provision of objective evidence that a given item fulfils specified requirements
License	The water use license issued by the Department of Water and Sanitation (DWS)
LP range	Refers to the total Supply to the Low Pressure make-up to the units. This includes supplies to the Condensers, De-aerators, Reserve Feed Tanks, Stator Cooling, etc.
Measured in-situ verification	Measured in-situ verification (MISV) is the process used at the site of the payment meter to verify the accuracy of the payment meter readings.
Metering	In the context of this document, refers to the measurement or quantification of bulk fluid within a pipe or channel expressed as volumetric flow rate.
Nett litres/USO	The total volume of raw water consumed by the power station only, relative to the total number of units of electricity supplied to the national grid.
Payment meter	A payment meter is a flow meter designated to be used for payment purposes measuring any water entering the Water Management System.

Definition	Description
	Also those through which water is passed on to the Third Parties for the purpose of full or partial cost recovery.
Primary Process meters	Main input and output flow meters into the major processes.
Raw water	The water which has been allocated to the power station, by DWS, for which a permit or license for abstraction and use has been granted. This definition excludes all waters brought into the station from any other sources (i.e. supplementary waters).
Reject water	Any high salinity liquid effluent that cannot be further re-used in any other means other than with ash. i.e. sludge, regeneration effluents and the rejected water from a desalination process.
Salt balance	A salt accounting process assessing incoming raw water quality (salt load), chemicals used for treatment and the quality (salt load) of effluent.
Secondary process meters	Meters used for process and efficiency monitoring and control.
Stage capacity curve calibration	Refers to the calibration of level transmitters using a curve (or graph) showing the relation between the surface area of the water in a reservoir/ dam and the corresponding volume of water in the reservoir/dam.
Straight pipe run requirements	Refers to the minimum length expressed in pipe diameters of straight unobstructed rigid pipe that must be available on the intake/inlet side of the flow meter and the minimum length expressed in diameters of straight unobstructed rigid pipe that must be available on the discharge of the flow meter.
Supplementary water	All waters introduced into the station water management system from sources other than the raw water supply system/s. For example, mine waste water, storm water, waste water final effluent recycled back into the station by way of recovery dams, etc.
Third party supply meter	A meter which is designated for use for payment purposes (external parties such as municipalities) or internal Eskom users (other Eskom power stations)
USO	Power sent out to the national grid in GWh, the official figures as published by GPSS.
Verification meter	A verification meter is a portable calibrated flow meter used to “verify” the accuracy performance of an installed flow meter.
Water balance	The equation that describes the amount of water in and out of a system or process.
Water Management Officer	A person appointed by the power station manager to be responsible for water management on site.
Wastewater	Wastewater is water containing waste, or water that has been in contact with waste material. Wastewater includes: - domestic wastewater - biodegradable industrial wastewater - Industrial wastewater. *Source: Registration guide: A guide to the registration of water use under the national water act (Act 36 of 1998), First Edition March 2000, DWS*
WUL streams	All streams to be metered as stipulated in each station’s IWULA.
Zero Liquid Effluent Discharge (ZLED)	This refers to taking all reasonable measures to prevent pollution of water resources by the establishment of a hierarchy of water uses based on quality. Cascading the water from higher quality to lower quality users / uses enables high rates of re-use. Where possible, water is lost only by evaporation, whilst the accompanying dissolved and suspended solids are retained. The net result is that no deliberate discharge of pollutants to a water resource under

Definition	Description
	normal operating conditions and average climatic conditions take place.

2.3.1 DISCLOSURE CLASSIFICATION

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
BMC	Best Measurement Capability
CoE	Centre of Excellence
C&I	Control and Instrumentation
CIP	Clean In Place
COE	Centre of Excellence
CPP	Condensate Polishing Plant
CW	Cooling Water
DWS	Department of Water and Sanitation
FGD	Flue Gas Desulphurisation
FIIS	Field Instrumentation Installation Standard
FM	Flow Meter
GPSS	Generation Production and Sample System
HP	High Pressure
IWULA/WUL	Integrated Water Use Licence/Water Use Licence
KPI	Key Performance Indicator
LP	Low Pressure
MB	Mixed Bed
MF	Microfiltration
OEM	Original Equipment Manufacturer
PED	Primary Energy Department
PS	Power Station
P&T	Performance and Testing
RO	Reverse Osmosis
STEP	Station Thermal Efficiency Program
UF	Ultrafiltration
USO	Unit Send Out
WAF	Water Accounting Framework
WC	Water Conservation
WDM	Water Demand Management
WTP	Water Treatment Plant
WUL	Water Use Licence
YTD	Year to Date

2.5 ROLES AND RESPONSIBILITIES

Chemical Services Managers at the stations are responsible for accounting and reporting as stipulated in this standard.

The Engineering Manager is responsible for the provision of equipment and implementation. His/her delegates shall ensure that the minimum requirements of this standard are met by making provision in the technical plan for the required engineering changes to be implemented.

Control and Instrumentation engineering is responsible for providing the technical specification criteria for selection of flow meters suitable for the intended application, correct installation in accordance with the FIIS and OEM requirements, compiling maintenance strategies and ensuring that the engineering change process is adhered to for any changes to the flow metering and level measurement design base.

Control and Instrumentation (C&I) Maintenance at each power station are responsible for ensuring that the calibration, verification and maintenance of the instrumentation is conducted at appropriate intervals to ensure adherence to this document.

Due to the differences in the roles and responsibilities of C&I maintenance and P&T personnel at the various power stations, the responsibility for verification and calibration of flow meters can be a local decision. The maintenance of flow meters is the responsibility of the Maintenance Department.

The responsibility of Sustainability is to review and report on the status of the flow meters, water use performance and compliance to the WUL.

Asset Management (Process and Chemical Engineering Department), as the custodian of the water balances, is responsible for ensuring that the minimum requirements, as stipulated in this standard, are sufficient to ensure sound and effective water accounting, and subsequently, water management at each of the power stations.

The Process and Chemical Engineering Senior Manager within Asset Management shall be responsible for the periodic review of this document.

2.5.1 RACI Matrix for Water accounting

In addition to the roles and responsibilities outlined above, each Power Station shall be responsible for further defining, in the form of a RACI matrix, the roles and responsibilities for major activities pertaining to water accounting, as outlined below:

2.5.1.1 Operations and Maintenance Activities

- Reporting (taking meter readings, reservoir levels, etc.)
- Accounting (preparing the excel spreadsheet, performing the stats, compilation of WAF report, etc.)
- First line reporting (defects –for example sump pump not working, noisy meter, faults on flow meter display, overgrown vegetation around the meter, etc.)
- Planned maintenance (including in situ verification, inspections, etc.)
- Design (flow meter replacements –mods)
- Corrective maintenance (including off site calibration)
- Portable equipment calibration

2.5.1.2 Governance Activities

- out of normal conditions (action plan to address non-compliance to WAF, meter reading procedure and the water stats guide)

2.6 PROCESS FOR MONITORING WATER USE

Water use shall be monitored on a continuous basis.

A monthly water use report, approved by the CSM shall be submitted to the Power Station General Manager, PED, Asset Management: Process and Chemical Engineering (Water Management) and Sustainability Water CoE. This report shall be in accordance with the reporting framework prescribed in Appendix D of this document. Each power station must develop its own reporting mechanisms for internal use.

2.7 RELATED/SUPPORTING DOCUMENTS

N/A

3. MINIMUM REQUIREMENTS FOR WATER ACCOUNTING AND MANAGEMENT

A Water/Salt balance is one of the tools that can be used at a power station to manage water on site. It is not possible however, to derive a water/salt balance without having the means to measure and account for the water. Each power station shall have a water balance that ensures that all incoming water to the power station is balanced through the various processes within the station. Therefore it is necessary to first establish the water streams that significantly impact on the stations overall water balance, as well as the streams that need to be measured, in order to be able to monitor each of the processes and perform a process balance. It is important to achieve a balance with an adequate resolution or degree of detail for each stream or flow. Further, for the purpose of water management and taking account of measurement errors, an accuracy of 90 % or better over major processes is considered adequate [11]. Thus all instrumentation (payment meters, primary process meters, etc.) used in the water accounting must meet the accuracy requirements as specified.

It is clear that the measuring devices form an integral part of this process and if the correct streams are not identified and measured, it would not be possible to achieve the consistently required accuracy of these water balances.

3.1 MEASUREMENT AND MONITORING REQUIREMENTS FOR STREAMS AND STORAGE ELEMENTS

A number of streams and storage elements have been identified which need to be measured and monitored. These streams and storage elements are listed in Appendix A and B, respectively. The tables listed on these appendices stipulate the minimum requirements with respect to flow and level measurements for major streams and storage elements that have been identified as impacting on the water balance. Each power station is responsible to conduct a risk assessment in accordance to the prescribed format in Appendix C, Table 1. The risk assessment shall identify any other additional flow meter requirements that may not be listed in Appendix A, but significantly affect the water balance of the station (this will vary from site to site, depending on the different technologies/processes employed within the power station). This risk assessment shall be reviewed annually to ensure that changes to plant or process operations have not impacted on the water metering or water balance requirements.

3.1.1 Payment meters

All raw water payment meters shall be of the electromagnetic type. The designed accuracy shall be better than plus or minus 0,5% of the actual flow rate, down to a flow velocity of 1 mm/s, in both forward and reverse directions, for both the displayed reading and the transmitted signal. The accuracy of the meter is maintained between fluid velocities of 10 mm/s to 15 000 mm/s (i.e. 1500:1 turn-down ratio/range-ability of the minimum to maximum velocity). Where the installed payment meter is not of the electromagnetic type, it shall still meet the accuracy requirements as stated.

Raw and potable water to third party supplies shall be evaluated against the incoming raw water volumes. Where the volume supplied to a third party exceeds 5% of the incoming raw water, the designed accuracy of the installed flow meter shall meet the requirements specified in the preceding paragraph.

Each meter shall have an accredited assessment of the uncertainty of measurement of both the displayed reading and the transmitted signal, i.e. the sum of all the uncertainties of measurement of each of the components comprising the complete flowmeter installation. This uncertainty shall not exceed 4% on site (Best measurement capability of test equipment used to obtain measurement dependant on site conditions.

All payment meters shall be equipped with a local display that is readily accessible to allow operating personnel to easily take readings. The meters shall have both local and remote reading capability and all signals shall be transmitted to a control room for monitoring and trending.

3.1.2 Raw water back-up meters

All flow meters shall have a capability to be read locally and remotely. All local displays shall be accessible for operating and maintenance. All signals shall be transmitted to the station's Water Treatment Plant (WTP) control room for monitoring and trending. The flow meters shall provide both an instantaneous flow as well as a totalised flow measurement.

The designed accuracy of these meters has to be better than plus or minus 2% of the actual flow rate, down to a flow velocity of 5 mm/s, for both the displayed reading and the transmitted signal. The basic accuracy of the meter is maintained between fluid velocities of 30 mm/s to 12 000 mm/s (i.e. 400:1).

Each meter shall have an accredited assessment of the uncertainty factors regarding both the displayed reading and the transmitted signal. This uncertainty shall not exceed 4%.

With dual meter installations, i.e. where both a payment meter and a back-up meter are installed, upon verification the field calibration factor of the ultrasonic back-up meter is adjusted to give a measurement within ± 0,5% of the electromagnetic payment meter, provided the payment meter is verified within the 4% uncertainty mentioned above.

The difference between the readings of the payment meter and the back-up meter shall be no more than 5%. Should it increase above 5%, action shall be taken by the relevant power station personnel to resolve the problem. In the case where the flow meter does not belong to the power station (for example Camden Power Station) it is accepted that the station will not be able to comply with this requirement however, it is the duty of the power station to report it to PED and the supplier and this reporting must be done in writing and a record kept. In the event that both payment and back-up flow meters are not available, the agreed method of accounting should be established as per the "Water Schemes Supplying Eskom Coal Fired PS and Guideline for Water Stats Calculations - 240-130899253". Each station is responsible for developing a station specific work instruction for the agreed method of accounting and this work instruction must be signed off.

3.1.3 Other meters on main/process pipelines

All local displays shall be accessible for operating and maintenance. The flow meters shall provide both an instantaneous flow and a totalised flow measurement. Flow meter readings shall be transmitted to the WTP control room where they shall allow the capability for trending.

The designed accuracy of these meters must be better than plus or minus 2% of the actual flow rate. The basic accuracy of the meter is maintained between operational fluid velocities. Each meter shall have an accredited assessment of the uncertainty factors regarding both the displayed reading and the transmitted signal. This uncertainty shall not exceed 4%.

In the event that a flow meter is not available, an alternative accurate method of accounting shall be utilised until the flow meter becomes available. This method shall be documented. The format in which this is documented can be a local decision (for example, a procedure, flow meter register, etc.)

3.1.4 Calibration requirements for installed flow meters

The meter used for verification of installed flow meters shall be calibrated by an ISO 17025 accredited facility annually.

The sum total of the uncertainty of measurement for any of the following: the displayed flow rate, the totalised value or the transmitted current signal of the meter under test shall not exceed 0,25% of the true accredited value. The repeatability of the evaluated errors of three separate readings shall be within 0,15%. This is applicable to all meters (payment and non-payment meters for water accounting).

All new major meters (payment meters; payment back-up meters and process flow meters) shall have valid calibration certificates prior to installation. Existing/already installed meters that cannot be removed for calibration after repairs to the primary instrument or flow sensors, due to size or lack of redundancy, shall be subjected to be measured in-situ verification.

3.1.5 Measured in-situ verification requirements

Verification of the meters shall be performed annually for payment meters, 3rd party meters, WUL streams and primary process meters used for water accounting. Secondary process meters and information meters shall be verified at a frequency that shall be decided locally by each power station, based on their operational risk assessment. The minimum requirements for the in-situ verification of flow meters are those stipulated in the reference, *RR Cook 2nd Edition 2002: The assessment of uncertainties of measurement for calibration and testing laboratories*.

All verification equipment shall be calibrated annually according to ISO 17025 and shall have a valid calibration certificate at the time of use. Contractors providing the verification services need to provide copies of their equipment calibration certificate which will be valid at the time of providing the service, for audit and compliance purposes. Verification shall be done by accredited suppliers only, and proof of accreditation must be submitted by the supplier.

While performing the in-situ verification if it is found that the difference is larger than 4% it is required that the in-situ flowmeter be adjusted to match the flow of the verification meter within 2% of the actual flow. Appendix E shows an example of an in-situ verification certificate with all relevant information that needs to be captured in the certificate. The calibration information before and after the calibration should be captured on an appropriate calibration template and be archived for future reference [10].

3.1.6 Level measurement

All storage elements listed in Appendix B shall be equipped with level measurement. The level meters shall have both a local indication and a remote indication at the WTP control room.

As a minimum all stations shall have a rain gauge installed at strategic locations to monitor and record rainfall around the power station and volumes will be recorded daily the same time. This will allow consistency in 24 hour reporting periods.

3.2 MANAGEMENT OF FLOW AND LEVEL METERS

The plant custodian (C&I Engineering) shall keep a level and flow meter Master Document for all water accounting flow meters and storage elements (dams, reservoirs, etc.). The Master Document shall include the status of the meters (availability), date of last calibration, date of last verification and results thereof. It shall be updated quarterly and shall be submitted to PED, Sustainability (Water CoE) and Asset Management (Process and Chemical Engineering CoE - water management). The flow meter and dam level list and risk assessment template in Appendix C can be used for this purpose.

3.3 DATA MONITORING, RECORDING AND REPORTING

All major flow meter and level meter signals, as per Appendix A and B, shall be routed to the WTP control room. The measurements shall be trended and archived for record keeping purposes. Where the capability for transmitting of signals does not exist, all flow meter readings shall be recorded manually at set time intervals (not less than twice a month), until C&I upgrades are done for all stations that do not currently have this capability. Where there is no planned C&I upgrade project, each station shall make provision for water accounting flow meter C&I interface project in the Generation Technical Plan (GenTLC). Where readings are logged/obtained from the control system, readings shall also be recorded manually at a set time interval at least once a month. This affords an opportunity to confirm that there is correlation between the field reading and the transmitted reading and that the instrument is in a good working condition.

Faulty or defective flow meters shall be reported and the defects shall be tracked and reported as indicated in Appendix D. Similarly, measurements that are out of range or deviate from nominal flows shall be tracked and reported as indicated in Appendix D.

For raw water, the raw water supplier and the power station representative shall sign off on the meter reading in accordance with the local agreed work instruction [3].

The readings shall be utilised to draw up internal and monthly water use reports, the station overall balance and major process balances for raw water, potable water, demineralised water, sewage, effluent/station drains, cooling water, auxiliary cooling water and ash water (where applicable), as outlined in Appendix D. The monthly water use report shall be signed off by the Chemical Services Manager, and shall be submitted to PED, Asset Management (Process and Chemical Engineering) and Sustainability (Water CoE) for review. Each station is responsible to ensure the validity of the data reported. The data reported must be the same in all reports utilising the same data, such as the STEP, WAF and PED water use reports. There should not be any discrepancies in data reported. The water management officer/section chemist must ensure that the data he/she reports in all the WAF and PED reports is the same. She/he will cross check the data with the STEP data and ensure that there are no discrepancies. If any picked up, he/she is expected to address with the relevant party and coordinate efforts to resolve the discrepancy.

The water use reports must be used internally by each water management section chemist to monitor usage and to address deficiencies and abnormalities identified in the systems, in order to improve operations and optimise on the use of water.

The rainfall data will be reported to Primary Energy Department (PED) every Friday and Monday morning by 09:00 and to Sustainability Department (SD:EM) monthly by latest every 3rd working day of the new month.

3.4 FLOW METER SELECTION AND INSTALLATION

Each flow meter shall be suitable for the application as determined by various factors such as the water quality, volume of water, space available, access for operating and maintenance etc. Each flow meter shall be installed correctly to ensure that the accuracy of the flow meter is not compromised. The flow meter installation shall be in accordance with the following standards:

- Field Equipment Installation Standard 240-56355754 [5]
- Flow Measurement Systems Installation Standard 240-56355789 [6]
- Control & Instrumentation Field Enclosures and Cable Termination Standard 240-56355815 [7]

- Requirements for Control and Power Cables for Power Stations Standard 240-56227443 [8]
- Earthing and Lightning Protection Standard 240-56356396 [9]
- Process Calibration Equipment Standard 240-56355535 [10]
- Original Equipment Manufacturer (OEM) installation guidelines.

4. AUTHORISATION

This document has been seen and accepted by:

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5. REVISIONS

Date	Rev.	Compiler	Remarks
October 2015	0.1	Z Dladla	Review of document (32-1110) was required.
November 2015	0.2	Z Dladla	Conversion of the directive to a standard
January 2016	0.3	Z Dladla	Draft Document for Comments Review
May 2016	1	Z Dladla	Final Document for Authorisation and Publication
March 2020	1.1	Z Dladla	Document due for review. Draft document (WG compilation)
March 2021	1.2	Z Dladla	Final Draft after Comments Review Process
March 2021	2	Z Dladla	Final Rev 2 Document for Authorisation and Publication

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7. ACKNOWLEDGEMENTS

- N/A

APPENDIX A: MINIMUM REQUIREMENTS FOR MEASUREMENT OF SIGNIFICANT STREAMS (ANY NON-APPLICABLE OR ADDITIONAL FLOW METER MUST BE STIPULATED IN APPENDIX C)

NOTE: Unless otherwise stated all streams listed in appendix A are essential to measure with a flow meter.

A.1 Raw water
1.1 Raw water received (can be reservoir inlet or reservoir outlet – site specific) 1.2 Raw water to 3rd parties 1.3 Raw water to WTP i.e. demineralised water & potable water (can be metered separately- site specific) 1.4 Raw water to Fire range (site specific) 1.5 Raw water to service water range (site specific) 1.6 Raw to CW 1.7 Raw water to FGD (site specific)
A.2 Potable water
2.1 Potable water produced 2.2 Potable water to head tank (could be same as potable water produced where there are no unmetered supplies/tap offs before the head tank). 2.3 Potable water to third parties 2.4 Potable water to consumers 2.5 Potable water to fire range (site specific) 2.6 Potable Water to cooling water treatment plant –calculate/account/estimate for, not essential to measure (site specific) 2.7 Potable Water production effluent (sandfilter or MF or UF backwash water) 2.8 Clarifier Sludge discharged (account/estimate for) 2.9 Filtered water to 3rd party (Matla/Kriel) 2.10 Potable water to irrigation (site specific)
A.3 Demin Water
3.1 Demineralised water plant inlet (cation inlet) 3.2 Demineralised water plant outlet (MB outlet)/ Demineralised water produced 3.3 Demineralised water to LP and/or HP range (site specific) 3.4 Total demineralised water to station 3.5 Demineralised water to each unit i.e. total make up to each unit (normal and emergency make-ups) 3.6 Demineralised water to CPP (i.e. backwashes, regens & transfers) 3.7 Clarifier sludge discharged - account/estimate 3.8 Demineralised water (including semi-treated/filtered water) used for regeneration of IX plant and spent regenerants 3.9 Demineralised water for CIPs (site specific) 3.10 Demineralised water for flushing of membranes – account/estimate
A.4 Supplementary Water

4.1 Polluted mine water recovered to the treatment plant (site specific) 4.2 Treated mine water recovered to treatment plant (site specific) 4.3 Treated sewage recovered from own sources to treatment plant 4.4 Treated sewage recovered from third parties (site specific) 4.5 Storm water harvested in Raw water reservoirs, Station drains dam and Ash dam/dump system – account/estimate 4.6 Water recovered from station drains 4.7 Water recovered from other dams
A.5 Cooling water
5.1 CW blowdowns to ashing system (specific to wet ashing stations) 5.2 CW clarifier sludge – to be accounted for/estimated 5.3 Ash water recovered to CW – required for specific sites recovering the water 5.4 Seepage recovered to CW - required for specific sites recovering the water 5.5 CW blowdowns to a desalination plant (East and West or North and South, as may be applicable) 5.6 CW transfer from one side to the other (site specific) 5.7 Service water return to CW – site specific
A.6 Sewage
6.1 Raw sewage to SWTP – legal requirement 6.2 Sewage from 3rd parties to SWTP (legal requirement, site specific) 6.3 Final effluent discharge – legal requirement 6.4 Treated sewage for internal use (irrigation, ash dams, ash dumps, etc.) – site specific (depending on WUL conditions)
A.7 Waste water
7.1 Reject water to ash dams/dust suppression/evaporation ponds – legal requirement (WUL) 7.2 Permeate produced (to CW, to Demineralized water plant, etc.) Site specific 7.3 Waste water licensed for water use (such as dust suppression) – site specific (WUL) 7.4 Station drains inflow (Includes station drains common inflow, inflows into each station drains dam for both clean, dirty and mixed Drains)
A.8 Auxiliary cooling
Open circuit: 8.1 Potable water make-up to aux cooling 8.2 Filtered water make-up to aux cooling 8.2 Blowdown to station drains **Closed circuit:** 8.3 Demineralised water make-up to aux cooling 8.4 Unitised demineralized water make-up to aux cooling
A.9 Rainfall Rainfall must be measured within the power station boundaries and recorded daily.

APPENDIX B: MINIMUM REQUIREMENTS FOR LEVEL AND VOLUME MEASUREMENT OF STORAGE ELEMENTS

B.1 Raw water
Raw water reservoirs
B.2 Potable water
Potable water storage tanks
B.3 Demineralised Water
Demineralised water storage tanks
B.4 Station Dams
All station dams
B.6 Auxiliary cooling
Water head tanks Pond levels

APPENDIX C: POWER STATION WAF FLOW METER LIST AND DAM LEVEL TRANSMITTER RISK ASSESSMENT

Each power station shall have as a minimum, the following documentation in place:

- Station specific water balance diagram
- Station process diagrams in place referring to streams and storage elements identified in appendix A and B.
- Power Station WAF Flow Meter List and Dam Level Transmitter Risk Assessment Template

This documentation shall be utilised to carry out a comprehensive assessment of the station specific water accounting and process meters. Chemical Services shall be the custodian of this assessment. The assessment of the station water balance shall be conducted with respect to streams that have a significant impact on the water balance in order to identify any additional requirement that has not been stipulated in this document. This assessment can also be used to justify deviation from the requirements of this standard where certain flow meters may not be required due to the measured stream having a low impact on the water balance or on water management. The station must be able to achieve and maintain 90 % or better accuracy on the overall station balance as well as the process balances (raw water, potable, demineralised water, cooling water, etc.).

C.1 Guideline for Completion of the meter list and risk assessment template

This excel document is seen as a flow meter and level transmitter [1]master sheet per station that will be compiled and signed off by each station's Chemical Services representative to list and identify the equipment and risk level associated with each measurement. This document is approved by the Engineering Manager, supported by Asset Management – Process and Chemical Engineering Department (Water Management) and Sustainability (Water CoE). This risk assessment shall be authorised by the respective Power Station General Manager.

The document needs to be kept on a common drive on the station IT server e.g. G-drive and maintained and updated as and when required by an agreed and appointed person e.g. C&I engineer

The document must also be accessible for information to other users for e.g. maintenance personnel and the Chemical Services department

The list will also be used for:

- Internal and external audits where applicable
- Flow meter verification tracking
- Technical Specification data for flow meter verifiers, maintainers and engineers during maintenance activities, determining replacement meter requirements, keeping track of equipment changes/ swops , etc.
- Life cycle planning

<u>The excel document is split in 3 sections:</u>

- Flow meter (FM) detailed description
- Flow meter technical specification
- Flow meter verification details

[1] Level transmitters are used for water and salt balances. They are listed on the master sheet for informational purposes and are not calibrated or verified.

C1.1 FM DETAILED DESCRIPTION

FM DETAILED DESCRIPTION							
Equipment Index No	AKZ / KKS Nr	Water Stream Type	Water Use Type	Location Area Decription	FM Description	Volume Measured or Calculated?	Location GPS

These are the basic details internal and external staff needs to identify and report issues and faulty equipment correctly, perform maintenance and verifications of meters, etc.

- Equipment index number – This ensures easy identification of equipment. The index number is useful to sort the information in a chronological order if the spreadsheet was sorted by any of the other columns.
- AKZ/KKS number – Unique number for the equipment.
- Water stream type: Described as per the WAF Standard (Annexure A and B)
    - Raw water received
    - Potable Water produced
    - Demineralised water produced.
    - Supplementary water received
    - Cooling Water
    - Sewage
    - Waste Water
- Water Use type – Further classification of water measured for the specific stream e.g. Filter water, RO Plant water, Effluent water
- Location Area Description – Clear description of the installation site, e.g. equipment located at the RO plant
- FM Description - Clear description of the equipment used, typically the SAP description for the AKZ/KKS
- Volume Measured or Calculated:
    - Indicate which streams are measured and which ones are calculated.
    - Typically, streams classified as per Appendix A, or classified as high priority during the risk rating identification process (for example, payment meters, WUL meters, etc.) would need to be measured.
    - Streams classified as “to be accounted for” as per Appendix A, or classified as medium or low during the risk rating identification process i.e. where installing flow meters is for water balance purposes but cannot be installed due to site condition or effective cost implications versus impact on the station water balance may be calculated using an approved calculation method.
- GPS Location - Flow meter location GPS co-ordinates which allows internal and external staff to locate the site as and when required (not compulsory but advised)

C1.2 FM TECHNICAL SPECIFICATIONS

FM TECHNICAL SPECIFICATIONS															
Type of meter	OEM Name	SCADA/Historian/ Manual	Instalation date (use calibation)	Obcelecance year	Pipe Size NB (mm)	Upstream Straight Run	Downstream Straight Run	Pressure Rating (Bar)	Flange standard	Approximate wall thickness (mm)	Pipeline Material	Pipeline Coating	Analog output	Flow rate @20mA	Flow units

These details shall include:

- Type of flow meter i.e.:
  - Electromagnetic flow meter
  - Ultrasonic flow meter
  - Differential pressure flow meter
  - Mechanical flow meter
  - Open Channel / Flume flow meter
  - Vortex flow meter
  - Other
- OEM Name – To allow C&I to attend to flow meters as per OEM specifications
- SCADA/ Historian/Manual – Where and how is the meter reading captured daily. Manual refers to where a meter reading is taken local to the plant.
- Installation date – This date will be used to determine the obsolesce year for life cycle planning
- Obsolesce year – Using the equipment lifespan to determine planning to replace the meter
- Pipe Size Nominal bore (mm) - Data used for in-situ verification of the meter and setting up of new meter parameters during installation
- Upstream straight run pipe length before FM (mm) - Data used for selecting technology type
- Downstream straight run pipe length after FM (mm) - Data used for selecting technology type
- Pressure rating in bar - Data used for ordering replacement equipment
- Flange standard – Specify the flange standard as it is important for inline flowmeters
- Wall thickness- Data used for in-situ verification of the meter and setting up of new meter parameters during installation
- Pipeline material - Data used for in-situ verification of the meter and setting up of new meter parameters during installation
- Pipeline Coating - Data used for in-situ verification of the meter and setting up of new meter parameters during installation
- Coating thickness - Data used for in-situ verification of the meter and setting up of new meter parameters during installation
- Flow rate @20 mA - Data used for in-situ verification of the meter and setting up of new meter parameters during installation
- Flow Unit – Assist with correct conversion of usage volume when calculating station statistics and water balances
  - m^3/h (preferable)
  - m^3/s
  - l/s

C1.3 FM VERIFICATION DETAILS

FM VERIFICATION DETAILS									
Asset Owner	Agreed verifier	Verifying Section	Verification frequency	Verification Frequency Reason	FM Application	Risk ranking	FM Serial Nr	Last dated verification	MV Certificate Nr

- Asset Owner – Identify the asset owner who is responsible to repair, replace and perform preventative maintenance of the meter
- Asset Verifier – Identify the agreed verifier required to perform in-situ verifications pending the risk requirements of the meter
- Verification Section – If the meter is verified by station staff – identify the department since that accountability differs between stations i.e. C&I Maintenance, Performance and Testing, etc.
- Verification Frequency Reason - Pending the risk assessment. May be determined by:
  - Legal requirements
  - Meter Reading Procedure requirement
  - Station Internal Water Use License requirement
  - 3rd Party Supply meter for billing and/or station specific water consumption (I/USO net calculations for Eskom KPI's)
  - Legal and /or Environmental requirements outside the WUL
  - Internal Water balance calculations and sheet
- FM Application
  - Payment flow meter
  - Backup to payment meter
  - 3rd Party Meter
  - Process flow meter
  - License flow meter

- Risk Ranking - High, moderate or low Risk Ranking:
  - High Risk or Priority 1 risk ranking – Streams where meters are required to measure volumes used for payment or determining the station specific water use, for legal and or environmental requirements and streams critical for the water balance of station systems (inputs and outputs into major processes). Examples of such water balance streams are raw water to cooling water (make-up), raw water to the water treatment plant, total demineralised water sent to the station and total potable water produced. Frequency of verification for these meters are usually annually at a minimum.
  - Moderate or Priority 2 risk ranking - Streams where meters are required to measure volumes used to determining the station process streams critical for the water balance and/or secondary process meters. The risk ranking is dependent by mostly the volume (typically lower volume streams) and type of water that would pass through the flow meter on a yearly basis.
  - Low or Priority 3 - Streams where meters are required to measure volumes used to provide detailed water balance capabilities for the water balance of station systems. Typically very small volume streams with little or no significant impact on the station water balance, streams already accounted for in parent

streams, etc. Low risk ranking would typically be the rest of the flow meters that do not fall under high and moderate risk ranking.

- FM serial number - Data used for in-situ verification of the meter and tracking of equipment
- Last Verification Date - Data used for in-situ verification and planning of the meter verification schedule
- MV certificate number – Proof of verification required by auditors. These meter verifications and/or calibration certificates need to be kept electronically on record as a minimum and accessible to end users, C&I engineering and maintenance personnel alike. The certificates should be stored on a common drive of the station IT server.

Table 1 provides an example of a process that can be followed when conducting the assessment of all water and process flow meters as identified in Appendix A

Table 1: Power Station WAF Flow Meter List and Dam Level Transmitter Risk Assessment Template

<u>The excel document is split in 3 sections and have dropdown menus where required:</u>

1. **FM Detailed Description:**

FM DETAILED DESCRIPTION							
Equipment Index No	AKZ / KKS Nr	Water Stream Type	Water Use Type	Location Area Decription	FM Description	Volume Measured or Calculated?	Location GPS
1							
2							
3							

2. **FM Technical Specifications**

FM TECHNICAL SPECIFICATIONS															
Type of meter	OEM Name	SCADA/Historian/ Manual	Instalation date (use calibation)	Obcelecance year	Pipe Size NB (mm)	Upstream Straight Run	Downstream Straight Run	Pressure Rating (Bar)	Flange standard	Approximate wall thickness (mm)	Pipeline Material	Pipeline Coating	Analog output	Flow rate @20mA	Flow units

3. **FM Verification details**

FM VERIFICATION DETAILS									
Asset Owner	Agreed verifier	Verifying Section	Verification frequency	Verification Frequency Reason	FM Application	Risk ranking	FM Serial Nr	Last dated verification	MV Certificate Nr

APPENDIX D: MONITORING, MANAGEMENT, RECORDING AND REPORTING FRAMEWORK

D.1 Water Use Performance versus target

Calculate the actual monthly water use performances figures i.e. gross litres/USO and nett litres/USO. Compare to the nett litres/USO figure with the SI target and year to date (YTD) figure. Record this information in the table below.

Table 2: Station water use performances figures

Month	Gross water use (litres)	Nett water use (litres)	Unit send out (kWh)	Gross litres/USO	Nett litres/USO	SI Target l/USO	YTD l/USO	Comments
Jan								
Feb								
Mar								
Apr								
etc								

Provide a plot of water use performance for the last 12 months.

D.2 Monthly Trends on major streams

For each of the major streams, plot the monthly trends together with the nominal (benchmark) flows. Create a plot for each of the following categories, where applicable.

- Raw water used
- Potable water used
- Demineralised water used
- Recovery to Cooling system
- Cooling water

D.3 Deviation from the nominal flows

Analyse the plots generated above. Identify any abnormal flows (high or low) or worrying trends (increasing usage, flow meter unavailability, flow meter not verified, etc.).

List any significant water related incidents or events that happened during the period under review.

Detail the consequence of the incidents. Ensure that Incident Notifications are raised for each incident. Record this information in the table below.

Table 3: List of deviations from nominal flows

Date	Deviation/Incident/Defect	Consequences	INO notification number	SAP notification number

D.4 Action plan

Propose an action plan to resolve the deviations / defects identified. Assign a responsible person and a

Close-out date to each action. Record this information in the table below. Closed out actions shall be removed from the table, as and when they are closed out. Two tables shall be populated, for short term and long term action plans, respectively. Chemical services (water management) shall use this action plan to track progress on deviations/defects and shall ensure that these are addressed and close-out by the relevant parties.

The relevant power station systems (for example, defect notification system, SAP QIM system, etc.) shall be used for management of the deviations where applicable.

Table 4: List of action plans to correct deviations

Major stream	Deviations / defects identified	Proposed action(s)	Responsible person	Close-out date

D.5 Conclusion

Summarise the reasons for good or poor water use performance.

D.6 Water balance

Develop a water balance in line with the document: Water Balance Guideline for Coal-Fired Power Stations, document number 240-153971516. Monthly figures shall be reflected on all major streams.

………………………………………..

Water Management Officer

…………………………………………

Chemical Services Manager

APPENDIX E: EXAMPLE OF FLOW METER IN-SITU VERIFICATION CERTIFICATE

SUSTAINABILITY, RESEARCH TEST & DEVELOPMENT
PETROLEUM & FLOW SCIENCES
FLOW SCIENCES

IN-SITU FLOW CALIBRATION CERTIFICATE U20EO9748-1

Customer: **Primary Energy (Water) Department**
Private Bag X 3
2146 Sunninghill

End User: **Arnot Power Station**
Private Bag X 2
1097 Rietkuil

Date of Issue: **14 June 2019**

Calibrated: S A Mashaba
Metrologist

Checked: L V Mahlangu
Metrologist

At the time of calibration, all instrumentation used to measure Flow, Volume, Temperature, Length and Flowmeter Output, during the performance of the calibrations was traceable to SANAS, ISO 17025 accredited calibration laboratories Density and viscosity is derived from standard tables at the measured temperature

The values in this certificate are correct at the time of calibration Subsequently the accuracy will depend on such factors as the care executed in handling and use of the device, and the frequency of use Re-calibration should be performed after the period so chosen to ensure that the instrument's accuracy remains within the desired limits

This certificate is a correct record of the measurements made This certificate may not be reproduced other than in full except with prior written approval of the issuing laboratory

Legal liability arising from this work shall be limited to the cost of re-calibration, but the applicant indemnifies Eskom against any consequential or other loss

The results in this certificate only apply to the particular item/system calibrated A calibration label has been affixed to the instrument bearing certificate number, calibration date and serial number The label relates only to the calibration carried out on the date stated on the label, however the label does not imply compliance with a specification, approval of quality or performance of calibration

IN-SITU FLOW CALIBRATION CERTIFICATE U20E09748-1

DESCRIPTION

Calibration of the Arnot No: 8A flowmeter for Arnot Power Station

Item	Make	Model	Serial No
Primary	ABB Kent Taylor	MS/F102 Special HB6	V/33830/7/1
Secondary	ABB Kent Taylor	Magmaster	VKE458527
Nominal Diameter	DN1200 mm	Calibration Date	03 June 2019

DEFINITIONS & ABBREVIATIONS

Abbreviation	Description	Abbreviation	Description
% omf	% of measured flowrate	extens cable	Extension cable
% omt	% of measured total	rdg	Reading
adj	Adjustment	Ref	Reference standard
Amb.	Ambient	Std dev of mean	Standard deviation of the mean
downstr	Downstream	temp	Temperature
Exp Uncert	Expanded Uncertainty	upstr	Upstream
Term	**Definition**	**Term**	**Definition**
Calibration	Compare item versus standard	Error	Deviation compared to standard
Test	One calibration measurement cycle	Mean	Arithmetical average
Series	Number of consecutive tests		

CALIBRATION METHOD

The reference flowrate was measured directly with the recorded clamp-on ultrasonic flow meter The reference flow was measured at a point with the recorded lengths of inlet and outlet pipe assumed to be running full The item flow measured was compared to the reference flow under the existing on-site conditions for a minimum period of 60 seconds The item flowrate outputs were measured at approximately 2 sec intervals and averaged whereas quantity outputs were totalised over the test period The flowing medium was raw water The Laboratory procedure No FM-TCP-201 was followed

REFERENCE EQUIPMENT

Instrument	Application
Flexim CDM1NZ S/No ChA-34891 & 20m extens Cable	Ref Flow Transducer
Flexim Fluxus F601, S/No 06013637/2012	Ref Flow & Wall thickn Converter
Flexim DWQ1LZ7 S/No 81717	Wall thickn Transducer
Pt100, S/No's T254 & T250	Flow & Amb Temp Sensors
Fluke Hydra Logger S/No 9256002/M9253013	Current & Temp Data-logger
Hultafors 20m, S/No FL162	Dimensional Tape measure
Komelon 3m, S/No S0043	Dimensional Tape measure
Mitutoyo 150mm, S/No 15152544	Dimensional Vernier
Lenovo L460 S/No 1S20FVS1WB00PF0SBA0Q	Data Acq Computer
SITEDAQ_R9-0 2_SAM Lenovo Copy xlsm	Software application

IN-SITU FLOW CALIBRATION CERTIFICATE U20E09748-1

DESCRIPTION

Calibration of the Arnot No: 8A flowmeter for Arnot Power Station

Item	Make	Model	Serial No
Primary	ABB Kent Taylor	MS/F102 Special HB6	V/33830/7/1
Secondary	ABB Kent Taylor	Magmaster	VKE458527
Nominal Diameter	DN1200 mm	Calibration Date	03 June 2019

ITEM CONDITION

Flowmeter convertor housed in cubicle for protection The meter flow rate and total display is clear and readable The meter is accessible, clean and dry The working conditions are safe

PIPEWORK AND ENVIRONMENT

Reference flowmeter:

Flow Disturbance:	Nominal Int. Dia:	Upstr. seperation (diameters)	Downstr. seperation (diameters)
Upstr - Elbow 1 X 90°	1206 mm		
	Actual:	16 6 D	16 6 D
	Min Required:	10 0 D	N/A

Item:

DUT Pipe-work	Nominal Dia:	Upstr. length (dia's)
Upstream	1200 mm	16 7 D
Downstream	1200 mm	16 7 D

Weather Conditions:
Outdoors bright sunshine

Site location:
East of Power Station security gate

UNCERTAINTY OF MEASUREMENT

The reported uncertainties of measurement were calculated and expressed in accordance with the document entitled "Assessment of Uncertainties of Measurement for Calibration & Testing laboratories" by R R Cook, 2nd Edition 2002 This document describes the assessment of uncertainty of measurement using the principles given in ISO *Guide to the Expression of Uncertainty in Measurement*

CALIBRATION OVERVIEW

Series : Tests	*Status & Test condition*
S1: 1 - 6	As found, normal operation
S2: 7 - 12	As left, normal operation
S3: 13 - 18	As left, normal operation

CALIBRATION NOTES

1 The calibration was performed at one flow condition only
2 The meter accuracy was adjusted
3 The meter factory default factor is Cal Fact = 2.2417
4 Meter factor As found Probe P= 1 050, As left Probe P = 1 090

IN-SITU FLOW CALIBRATION CERTIFICATE U20EO9748-1

DESCRIPTION

Calibration of the Arnot No: 8A flowmeter for Arnot Power Station

Item	Make	Model	Serial No
Primary	ABB Kent Taylor	MS/F102 Special HB6	V/33830/7/1
Secondary	ABB Kent Taylor	Magmaster	VKE458527
Nominal Diameter	DN1200 mm	Calibration Date	03 June 2019

FLOWRATE OUTPUT RESULTS

Table 3: Results of Rate from Current

Series : Tests	*Status & Test condition*	*Amb. temp.*	*Flow temp.*	*Ref. flowrate*	*Item flowrate*	*Mean Error*	*Exp. Uncert.*
		°C	*°C*	*m3/s*	*m3/s*	*% omf*	*± % omf*
1 : 1 - 6	As found, normal operation	18 2	17 2	0 84	0 80	-4 88	3 0
2 : 7 - 12	As left, normal operation	18 6	17 2	0 83	0 82	-1 24	3 0
3 : 13 -18	As left, normal operation	18 9	17 2	0 87	0 86	-1 09	2 9
	Series 2 - 3 Mean	***18.8***	***17.2***	***0.85***	***0.84***	***-1.16***	***3.0***

1 As found, the meter was calibrated over 1 series of measurements at approximately 0 8 m3/s, and found to have an error of -4 9 % omf
2 As left, the meter was calibrated over 2 series of measurements at approximately 0 9 m3/s, and found to have a mean error of -1 2 % omf
3 The estimated measurement uncertainty for the measurements is ± 3 0 % omf.

IN-SITU FLOW CALIBRATION CERTIFICATE U20EO9748-1

DESCRIPTION

Calibration of the Arnot No: 8A flowmeter for Arnot Power Station

Item	Make	Model	Serial No
Primary	ABB Kent Taylor	MS/F102 Special HB6	V/33830/7/1
Secondary	ABB Kent Taylor	Magmaster	VKE458527
Nominal Diameter	DN1200 mm	Calibration Date	03 June 2019

FLOW TOTAL OUTPUT RESULTS

Table 5: Results of Total from Display

Series : Tests	*Status & Test condition*	*Ref. flowrate*	*Ref. Total*	*Totalising Period*	*Meter Total*	*Mean Error*	*Exp. Uncert.*
		m3/s	*m3*	*s*	*m3*	*% omt*	*± % omt*
S1: 1 - 6	As found, normal operation	0 84	678 0	809 0	651 0	-3 98	2 5
S2: 7 - 12	As left, normal operation	0 83	686 5	827 0	681 0	-0 80	
S3: 13 - 18	As left, normal operation	0 87	703 9	813 0	697 0	-0 98	
	Series 2 - 3 Mean flow	***0.85***	***Series 2 - 3 Mean Total Error***			***-0.89***	***2.5***

1 As found, the meter was calibrated over 1 series of measurements at approximately 0 8 m3/s and found to have an error of -4 0 % omt
2 As left, the meter was calibrated over 2 series of measurements at approximately 0 9 m3/s, and found to have a mean error of -0 9 % omt
3 The estimated measurement uncertainty for the total measurements is ± 2 5 % omt