Eskom	Standard	Technology

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FIGURES

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1. INTRODUCTION

All flow meter technologies have recommended installation and engineering practices to ensure they meet their published specifications and for optimal performance, accuracy and repeatability. Flow meter users are frequently challenged with wide variations in their actual field conditions and installation constraints that are much different from the ideal conditions under which their flow meter was calibrated.

2. SUPPORTING CLAUSES

2.1 SCOPE

This standard specifies installation requirements for flow meters primarily intended for Power Stations within Eskom. The paper describes requirements for the following flow meter types as these are the more commonly used flow meters, therefore types not described in this paper shall strictly follow manufacturer requirements.

- Differential Pressure Flow meters
- Turbine Flow meters
- Magnetic Flow meters
- Vortex Flow meters
- Ultrasonic Flow meters
- Mass Flow meters

Should the manufacturer specifications for the above meters be stricter than the requirements of this specification, the manufacturers specifications will take precedence.

2.1.2 Purpose

The purpose of this standard is to define the minimum installation requirements for flow measurement devices at Eskom Power Stations. The intent is to establish installation requirements and standards to maximize flow instrument life and ease of maintenance.

2.1.3 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions. The document is applicable to all Eskom power stations equipment that uses flow measuring devices to measure flow.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Where specific references are made to specifications this shall imply the latest revision of that specification and also parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] Process Measurement Instrumentation, American Petroleum Institute Recommended Practice 551, 1993.

[3] 240-89147446 Instrument Piping for Fossil and Hydro Power Plants

[4] 240-56355754 Field Instrument Installation Standard

[5] 240-56355815 Junction Boxes and Cable Termination Installation Standard

[6] 240-56355535 Process Calibration Equipment Standard

2.2.2 Informative

None

2.3 DEFINITIONS

Definition	Description
Acceptability Criteria	The characteristics of the system that shall allow evaluation for acceptance of that system.
Accuracy of measurement	Closeness of the agreement between the result of a measurement and a true value of the pressure. Note: accuracy is a qualitative concept.
Calibration	A set of operations that establish, under specified conditions, the relationship between the values of quantities indicated by a measuring instrument or measuring system
Closed piping systems	Closed pipe flow refers to fluid movement through a conduit in which the fluid occupies the full cross-section and is under pressure.
Differential	The value of the difference between two pressures.
Employer	Persons that authorize modifications to the existing wiring system or persons that authorize the installation of new wiring systems.
Flow conditioner	Includes conventional flow straighteners such as tube-bundles, plate or honeycomb types for swirl.
ISO	International Organisation for Standardisation.
Sensor	Element of a measuring instrument or measuring chain that is directly or indirectly affected by the measured.
Termination	In electrical wiring termination is the process of connecting one cable to another at the point at which it ends.
The Installation Contractor	Responsible for the termination of all C&I cabling and associated equipment and for the development of the Termination Schedules.
Transducer	Device that provides an output quantity having a determined relationship to the pressure. *Commonly used in pressure measurement to refer to pressure transducers with voltage outputs*.

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
BSP	British Standard Pipe
C&I	Control and Instrumentation
GT	Group Technology
HART	Highway Addressable Remote Transducer
I/O	Input / Output
IEC	International Electrotechnical Commission
IP	Ingress Protection
SANS	South African National Standard
SIL	Safety Integrity Level
V	Volt

2.5 ROLES AND RESPONSIBILITIES

2.5.1 Installation Contractor

The installation Contractor is responsible for the termination of all C&I cabling and associated equipment and for the development of the Termination Schedules and associated documentation, which shall be signed off together with the Employer.

Only once the appropriate acceptance documentation has been signed off can the system be commissioned.

2.5.2 Employer

The Employer is responsible for the evaluation and acceptance of the cable termination and associated documentation and together with the installation Contractor shall signoff the appropriate documents.

2.5.3 Operation

Operation is being responsible for the monitoring and responds to malfunctioning pressure devices. They are also responsible for the initial response to alarms and routine system operational.

2.5.4 Maintenance

Maintenance is responsible for the on-load system verification and off-loads system calibration including inspections and system diagnostics.

2.5.5 C&I Engineering

C&I Engineering are responsible for the life cycle management of the system, regular audits, response procedures and the maintenance base of the system.

2.5.6 Boiler and Turbine Engineering

Boiler Engineering is responsible for defining the measurement requirements (sensor positions) and to do final confirmation for device functioning.

2.6 PROCESS FOR MONITORING

This document will be reviewed as per the next review date or earlier if warranted.

2.7 RELATED/SUPPORTING DOCUMENTS

None

3. FLOW MEASUREMENT SYSTEMS INSTALLATION STANDARD

3.1 INSTALLATION REQUIREMENTS

3.1.1 General

During the installation and commissioning phase, all manufacturers' specifications should be adhered to for providing power or other utility sources and for installing, connecting, programming, operating and maintaining the devices. All aspects of the installation, design and operation should be carefully and accurately documented and completed by competent personnel.

3.1.2 Installation Location

3.1.2.1 General

The flow meter installation shall be aesthetically pleasing and conform to the best practices.

The mounting location of flow meters and installation thereof shall comply with Field Instrument Installation Standard: 240-56355754, and to this specification.

The location and configuration of the flow meter installation shall take into consideration environmental aspect such as temperature, vibration, magnetic fields, hazardous zoning classification, or any other special requirements.

The mounting location and positioning for the transmitter shall take into consideration sufficient space for secure mounting, full opening of the transmitter covers, and the local indicator should be visible and legible to the observer from permanent walkways. The transmitter should be mounted in a manner that prevents moisture from collecting in the transmitter.

The flow meter should be located in a location accessible from a permanent walkway for ease of cleaning and servicing, but shall take into consideration maintenance activities and particular the removal of large objects of plant in the area.

3.1.3 Labelling

- All labelling shall be on permanent structures that remain when the instrument is replaced according to the site specific labelling standard.
- Labelling must not be affected by maintenance activities and should facilitate the ease of maintenance.

3.1.4 Ingress Protection

All transmitters shall have an IP rating of at least IP67 according to SANS 60529:2001.

3.1.5 Hazardous Locations

All hazardous locations installations shall be issued with Certificate of Compliance by a person registered as a Master Installation Electrician in terms of regulation 11(2) of Electrical Installation Regulations in OHS Act.

Any additional requirements for equipment in hazardous area systems shall take precedence over this specification and be in accordance with the zone classification but should be indicated so in the deviation list of this specification.

3.1.6 Safety Integrity Level

All transmitters shall be certified for installation in a SIL1 / SIL2 system, unless otherwise specified.

3.1.7 Signal Transmission

The standard transmission shall be 2-wire HART enabled 4 – 20 mA.

3.1.8 Measuring Principle

All flow meters shall use smart transmitters unless specified.This requirement may not always be practical. Where flow switches are used it should be switches with changeover contacts to cater for wire break monitoring.

3.1.9 Local Indication

All transmitters shall have local indication.

3.1.10 Piping Requirements

Unless otherwise required for specific meters, a general straight-run pipe allowance of 10 pipe diameters upstream and 10 pipe diameters downstream shall be made. In this portion of the pipe, no pipe beds, branches, valves, or pipe size changes are allowed.

If this is unattainable, flow straighteners must be installed at least 5 Pipe diameters upstream of the meter. If this cannot be done, a pipe modification must be made to accommodate the meter.

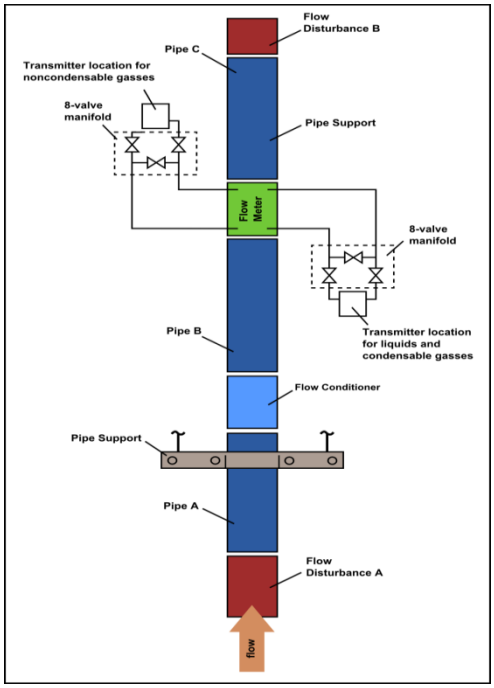

Figure 1: Flow meter installation on a vertical pipe. Source (ABB Instumentation Alliance)

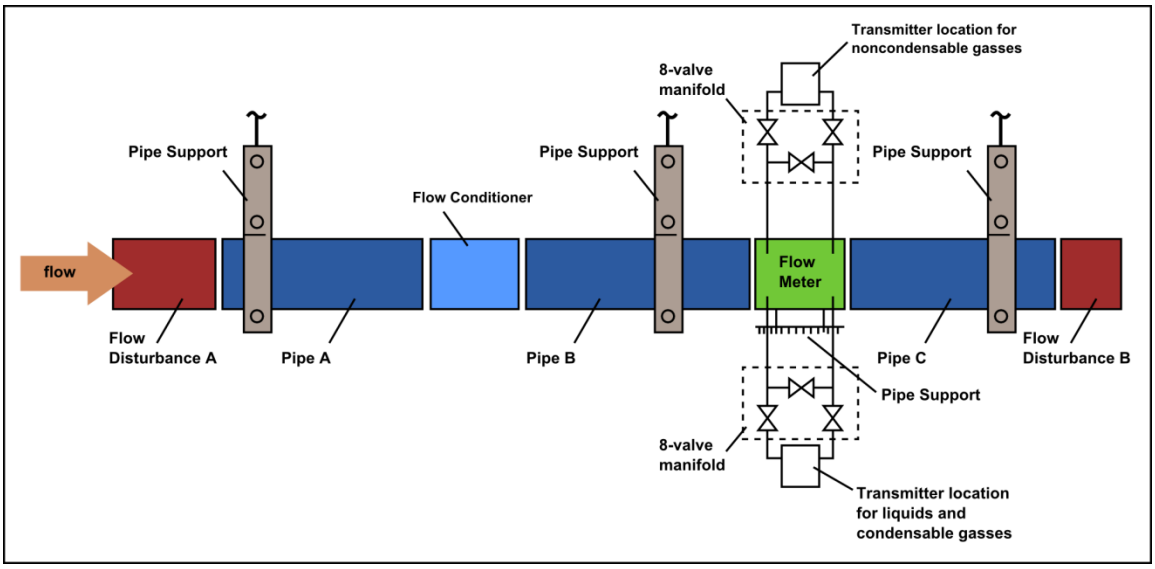

Figure 2: Flow meter installation on a horizontal pipe. Source (ABB Instumentation Alliance)

3.1.11 Documentation of Installation

Environmental information critical to meter maintenance and calibration will be captured during installation, documented, and handed over to the client. This critical information includes details such as

- Pipe inner diameter
- Pipe wall thickness
- Pipe material
- Coating type and thickness

3.1.12 Differential Pressure Flow Meter Installation Considerations

Welds should be ground smooth and gaskets trimmed so that no protrusion can be detected by physical inspection.

On services where the process fluid can plug the pressure taps or might gel or freeze in the lead lines, chemical seal protectors can be used. When chemical seals are used, it is important that the two connecting capillaries experience the same temperature and are shielded from sunlight; this is because the capillaries are routed to the differential pressure cell.

The differential pressure transmitter should be located as close to the primary element as possible, but taking into consideration the installation requirements.

Impulse lines shall comply with 240-89147446.

In steam service, the horizontal impulse lines should be kept as short as possible and be towards the tap, so that the condensation can drain back into the pipe. Both impulse lines should be exposed to the same ambient conditions and be shielded from sunlight. In clean liquid or gas service, the impulse lines can be purged through the differential pressure cell vent or drain-connections, and should be flushed for several minutes to remove all air from the lines.

Condensate pots are on the wet leg in differential pressure cell installations with small ranges in order to minimize the level variation in the legs. In steam applications, use of filling tees is recommended to ensure equal height condensate legs on both sides of the differential pressure cell. If for some reason the two legs are not of equal height, the differential pressure cell can be biased to zero out the difference, as long as that difference does not change.

If the process temperature exceeds the maximum temperature limitation of the differential pressure cell, either chemical seals have to be used or the impulse lines need to be long enough to cool the fluid. If a large temperature drop is required, a coiled section of tubing (pigtail) can be installed in the lead lines to cool the process fluids.

The following piping requirements, as detailed in Table 1, shall be adhered to depending on the type of differential pressure meter.

Note that the required length of straight upstream pipe increases with the need for accuracy. It also increases with an increasing Beta-ratio, where that is a factor. It also varies with the type of upstream disturbance and whether or not the correct flow conditioner is used.

Table 1: DP Meter Piping Requirements

Meter Type	Minimum Pipe Length (diameters) Before	Minimum Pipe Length (diameters) After	Ancillary Equipment Requirements
Orifice	10	4	Flow conditioner if upstream space is limited.
Venturi/Flow Nozzle	6	2	Flow conditioner if upstream space is limited.
Flow Tube	4	0	Flow conditioner if upstream space is limited.
Elbow	10	4	Flow conditioner if upstream space is limited. Low-range differential transmitter is required.
Pitot/Averaging Pitot	7	3	Flow conditioner if upstream space is limited. Low-range differential transmitter is required.
VA Meter	0	0	None

3.1.13 Magnetic Flow Meter Installation Considerations

If it is essential to drain the magnetic flow meter periodically, it should be provided with an empty tube zero option. When this option is activated, the output of the transmitter will be clamped to zero The empty tube zero feature can also be activated by an external contact, such as a pump-status contact.

The magnetic flow meter must be electrically grounded to the process liquid.

Electrical bonding to the process fluid shall be achieved by metal ground straps. These straps connect each end of the flow tube to the adjacent pipeline flanges, which in turn, are in contact with the process liquid. Straps are used when the piping is electrically conductive.

When the pipe is non-conductive or lined, grounding rings, grounding electrodes or a plastic grounding ring with metal electrode insert shall be used. The grounding ring is similar to an orifice plate with a bore equal to the nominal size (inside diameter) of the flow tube. It is installed between the flanges of the flow tube and adjacent process piping on the upstream and downstream sides.

The flow tube is bonded to the process fluid by being connected to the metallic grounding rings, and is grounded by being wired to the earth mat.

The following piping requirements, as detailed in Table 2, shall be adhered to for magnetic flow meter installation, unless otherwise specified by the manufacturer.

Table 2: Magnetic Flow Meter Piping Requirements

Meter Type	Minimum Pipe Length (diameters) Before	Minimum Pipe Length (diameters) After	Ancillary Equipment Requirements
Magflow	5	2	none

3.1.14 Vortex Flow Meter Installation Considerations

The bores of the meter, the gaskets, and the adjacent piping must be carefully aligned to eliminate any obstructions or steps.

Excessive pipe vibration can be eliminated by supporting the piping on both sides of the meter or by rotating the meter so that the sensor is moved out of the plane of the vibration.

The following piping requirements, as detailed in Table 3, shall be adhered to for vortex flow meter installations unless otherwise specified by the manufacturer.

Table 3: Vortex Flow Meter Piping Requirements

Meter Type	Minimum Pipe Length (diameters) Before	Minimum Pipe Length (diameters) After	Ancillary Equipment Requirements
Vortex shedding	10	5	Flow conditioners are recommended for persistent swirl profiles or jet flow profiles.
Vortex precession (Swirl Meter)	3	1	None

3.1.15 Coriolis Mass Meter Installation Considerations

Normal pipe vibration should not affect the performance of the Coriolis meter if it is properly supported by the process piping. No special supports or pads are needed for the flow tube, but standard piping-supports shall be located on either side of the meter.

If the installation instructions require special hardware or supports, the particular meter design is likely to be sensitive to vibration, and the pulsation dampeners, flexible connectors, and mounting/clamping attachments recommended by the manufacturer should be carefully installed.

If the application requires installation of two Coriolis flow meters in series or mounting two Coriolis meters near each other, the manufacturer shall be consulted to prevent crosstalk between the two units.

If air bubbles are likely to be present in the process fluid, it is recommended to install an air release unit upstream of the meter.

Prior to zeroing the meter, all air should be removed.

When zeroing the meter, any associated pumps or other equipment should be running so that their noise can be zeroed out.

The following piping requirements, as detailed in Table 4, shall be adhered to for coriolis mass meter installations unless otherwise specified by the manufacturer.

Table 4: Coriolis Meter Piping Requirements

Meter Type	Minimum Pipe Length (diameters) Before	Minimum Pipe Length (diameters) After	Ancillary Equipment Requirements
Coriolis	Refer to manufacturer.	Refer to manufacturer.	Block valves are recommended to do zero adjustments with no flow.

3.1.16 Ultrasonic Flow Meter Installation Considerations

Any rusty pipes should be cleaned before using an ultrasonic flow meter.

Ultrasonic jelly should also be used under the sensor to ensure a solid contact on the pipe.

The ultrasonic flow meter should be installed on conduit or pipe of suitable material (e.g., the material must be able to conduct ultrasonic pulses). Porous material such as concrete and cast iron are not suitable.

The following piping requirements, as detailed in Table 5, shall be adhered to for ultrasonic meter installations unless otherwise specified by the manufacturer.

Table 5: Ultrasonic Flow Meter Piping Requirements

Meter Type	Minimum Pipe Length (diameters) Before	Minimum Pipe Length (diameters) After	Ancillary Equipment Requirements
Ultrasonic, Time of Flight	10	2	None
Ultrasonic, Doppler	Follow recommendations for a 0.7 Beta ratio orifice plate meter installation. Swirling and jet flows must be avoided.	Follow recommendations for a 0.7 Beta ratio orifice plate meter	None

3.1.17 Turbine Flowmeter Installation Considerations

The following piping requirements, as detailed in Table 6, shall be adhered to for turbine meter installations unless otherwise specified by the manufacturer.

Table 6: Turbine Flow Meter Piping Requirements

Meter Type	Minimum Pipe Length (diameters) Before	Minimum Pipe Length (diameters) After	Ancillary Equipment Requirements
Turbine	10	5	Flow conditioners and strainers or filters are usually required. A separator for condensate removal is recommended for gas flows.

3.2 MEASUREMENT AND VERIFICATION

3.2.1 Pre-Installation Verification

Flow measurement devices should be shipped to the user after having undergone factory acceptance testing by qualified personnel. The shipment should include documented certification reports and operation and maintenance manuals.

All information provided with the flow measurement equipment should be kept and filed, and form part of the documentation of a quality management and preventive maintenance program.

3.2.2 Post Installation Verification

The manufacturer's recommended installation practices shall be used as the measure for the flow meter installation acceptance. Any deviations from the manufacturer's recommended installation practices shall be listed in the Deviation List.

In the event of the manufacturer's installation practices being contrary to this specification, the manufacturer's specification shall take precedence but be indicated as such in the Deviation List.

All flow measurement systems should be calibrated in situ as part of the commissioning phase.

In situ calibrations are necessary to establish and confirm conformance with the specified requirements for flow measurement accuracy. The Flow Meter Installation Checklist shall be used to determine acceptability of the flow meter installation.

4. AUTHORISATION

This document has been seen and accepted by:

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5. REVISIONS

Date	Rev.	Compiler	Remarks
December 2017	0.2	M. Nkambule	First Draft document for Review by Care Group
January 2018	0.4	M. Nkambule	Document for SCOT Comments Review
February 2018	0.8	M. Nkambule	Document for Second Review and Voting by SCOT
March 2018	0.9	M. Nkambule	Final Draft Document after SCOT Review Process
June 2018	1	M. Nkambule	Final Document for Authorisation and Publication

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- C&I Field Devices & Loop Design Care Group (SC08-03-C-05)

7. ACKNOWLEDGEMENTS

- C&I Field Devices & Loop Design Care Group (SC08-03-C-05)

APPENDIX A: FLOWMETER INSTALLATION CHECKLIST

Special Requirements:			
No Defect Items Found			
Defect Items were Found			
Recheck necessary		**Not necessary**	
Remarks			

APPENDIX B: DEVIATION LIST

Specification Page Number	**Specification Deviation Description**	**Proposed deviation/modification/alternative**

APPENDIX C: FLOWMETER INSTALLATION ACCEPTANCE CERTIFICATE

Item No	Description	Remarks	Acceptable	Defect
1	Suitability of mounting location			
2	IP67			
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

ACCEPTED ☐

NOT ACCEPTED ☐

Customer			
Project		**Project No**	
Plant/Unit			
Junction Box No		**Finished on**	

PERSON IN CHARGE

Customer		**Dep.**	
Vendor		**Dep.**	