

**OMAN WASTEWATER
SERVICES COMPANY S.A.O.C**



**الشركة العمانية
لخدمات الصرف الصحي ش.م.ع.م**

OMAN WASTEWATER SERVICE COMPANY

ICA STANDARD SPECIFICATION

SECTION 02

INSTURMENTATIONS STANDARD

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TABLE OF CONTENTS

Item	Description	Page
1-0	INTRODUCTION	1/14
2-0	KEY CONDITIONS	1/14
3-0	FLEXIBILITY	1/14
4-0	CONDUCTOR COLOURS	1/14
5-0	TESTING	2/14
6-0	IP RATINGS	3/14
7-0	POWER SUPPLY	4/14
8-0	MOTOR STARTER MONITORING	5/14
9-0	FLOW MEASUREMENT	6/14
10.0	LEVEL MEASUREMENT	8/14
11.0	TEMPERATURE MEASUREMENT	9/14
12.0	PRESSURE TRANSDUCERS	9/14
13.0	TURBIDITY MEASUREMENT	10/14
14.0	ANALYTICAL MEASUREMENT	11/14
15.0	SLUDGE BLANKET LEVEL MEASUREMENT	11/14
16.0	pH MEASUREMENT	11/14
17.0	METHANE MEASUREMENT	12/14
18.0	HYDROGEN SULPHIDE (H ₂ S) MEASUREMENT	12/14
19.0	CONDUCTIVITY MEASUREMENT	13/14
20.0	WEIGHT MEASUREMENT	13/14

21.0	DISSOLVED OXYGEN MEASUREMENT	14/14
22.0	MIXED LIQUOR SUSPENDED SOLID MEASUREMENT	14/14

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INSTRUMENTATION STANDARD

1.0 INTRODUCTION

This document describes the installation requirements for Instrumentation used for the sewage treatment measurement and plant monitoring.

2.0 KEY CONDITIONS

All installations shall comply with BS.6739 "INSTRUMENTATION IN PROCESS CONTROL SYSTEMS INSTALLATION DESIGN AND PRACTICE".

Equipment for use in hazardous areas shall be selected and installed in accordance with the relevant standards and codes of practice.

The *Contractor* shall ensure that the equipment supplier is fully aware of the circumstances and materials to which the equipment is being applied, particularly where hazardous fluids are present e.g. Chlorine.

All instruments shall be mounted at a height and in a location, which is readily accessible for maintenance and calibration.

3.0 FLEXIBILITY

Where cables enter transducers, which are removable for routine cleaning or calibration, the cables and their fixings shall have sufficient slack for this purpose.

4.0 CONDUCTOR COLOURS

Panel wiring insulation shall be coloured as below:

- 110V a.c. Red
- 24V a.c. Yellow
- 24V d.c. Yellow
- 12V d.c. Pink

Note: All Analogue cores within panels to be prefixed with the letter 'A'.

5.0 TESTING

Testing of all equipment shall be in accordance with the requirements of BS.6739 Part 11 and Part 12.

Where witness testing of any nature is required, at least 7 days notice shall be given by the *Contractor*.

Instrument testing work shall only be carried out by personnel that are fully skilled to do the work. Where unfamiliar specialized equipment is being installed, the testing personnel shall be given supplementary training on that equipment.

All test equipment necessary to test the system shall be supplied by the *Contractor*. Calibration certificates traceable to national standards shall be available for all test equipment used.

Testing and Commissioning shall be carried out by trained personnel from the manufacturer or supplier: all staff subject to approval by the Engineer of Project Manager.

- Measurements

All measuring devices shall be demonstrated to provide the correct indication, at appropriate points (indicators and recorders) on the loop. This shall be done at zero and full range of the system, as a minimum. This shall be achieved, wherever practicable, by varying the measured parameter at the primary transducer, not by electrical simulation.

- Controls

All control devices shall be demonstrated to provide the correct response, at appropriate points on the loop. This shall be done at zero and full range of the system, as a minimum. This shall be achieved, wherever practicable, by varying the controlling parameter at the primary transducer, not by electrical simulation.

- Alarms

All alarms shall be demonstrated to provide the correct response and logic. The settings shall be checked to ensure that the alarm occurs at the values specified.

6.0 IP RATINGS

First number (Protection against solid objects)	Definition	Second number (Protection against liquids)	Definition
0	No protection	0	No protection
1	Protected against solids objects over 50mm (e.g. accidental touch by hands)	1	Protected against vertically falling drops of water
2	Protected against solids objects over 2mm (e.g fingers)	2	Protected against direct sprays up to 15° from the vertical
3	Protected against solids objects over 2.5mm (e.g. tools and wires)	3	Protected against direct sprays up to 60° from the vertical
4	Protected against solids object over 1mm (e.g tolls wires and small wires)	4	Protected against sprays from all directions – limited ingress permitted.
5	Protected against dust – limited ingress (no harmful deposit)	5	Protected against low pressure jets if water from all directions limited ingress permitted
6	Totally protected against dust	6	Protected against strong jets of water (e.g. for use on ship decks – limited ingress permitted
		7	Protected against

			the effects of temporary immersion between 15cm and 1m. duration of test 30 minutes
		8	Protected against long periods of immersion under pressure

All instruments and instrumentations shall be protected against direct sunlight.

7.0 POWER SUPPLY

- Instrumentation Supplies
Instrumentation systems shall operate at 24 volts D.C. wherever practicable.
- Power Supply Failure

A Supply Failure Detector shall be installed to monitor the incoming supply to the equipment. The detector supplied shall be suitable for the number of incoming phases and voltage. Where the incoming supply is a three phase supply, the detector shall include phase failure detection.

For a panel with no generator connection, the mains fail relay shall be connected to the load side of the main isolator.

For a panel with a permanently wired generator, two relays shall be fitted to monitor the incoming mains supply plus the incoming generator supply.

Alternatively, if a reliable generator running status signal is available then this can be used instead of the generator supply relay.

The detectors shall provide voltage-free contacts, normally closed, for connection to the telemetry outstation. The closed condition shall indicate 'supply failed' (or one or more phases failed in the case of a three phase supply). The open condition shall indicate supply available.

8.0 MOTOR STARTER MONITORING

- General

All process drives shall include the following signals:-

- Isolated / Power on
- Standing / Running
- OK / Failed
- Where a starter is to be controlled from a PLC then the following additional signal shall be provided:
- Control Unavailable / Control Available

Start / stop control signals shall have one contact i.e. close to stop, open to start. For open close signals on actuated valves etc two signals shall be used, i.e. one contact for open and one contact for close.

- Methods of Providing Signals

The following methods of providing the signals and control shall be the preferred methods. Any deviations shall be submitted for approval by the Engineer.

- Isolated / Power on

Isolated / Power on is a normally open contact which closes when the power is healthy. This signal shall be obtained from an isolator auxiliary. Alternatively, where this is not practical, a combined 3 phase failure/phase reversal relay connected via fuses to the supply side of the main contactor may be used.

- Standing / Running

Standing / Running a normally open contact which closes when the drive is running. This signal shall be obtained by use of an auxiliary contact on the drive contactor. Where this is not possible, a slave relay shall be used.

- OK / Failed

OK / Failed is a normally open contact which closes when the drive has tripped due to overload or any other monitored fault condition.

- Emergency Stop

Emergency Stop operated is a normally closed contact which opens when the emergency stop is operated and shall be obtained from the emergency stop operated relay.

- Control Unavailable / Control Available

Control Unavailable / Control Available is a normally open contact which closes when control is available. The signal is obtained by installing an interface relay connected to monitor the supply side of the last control contact, before the contactor coil.

- Installation of starter interface relays

The starter interface relays shall be mounted inside the starter wherever practicable. If there is insufficient space, then a separate enclosure shall be used. The door of the enclosure shall be fitted with a warning label which identifies where to isolate incoming supplies.

9.0 FLOW MEASUREMENT

- Closed Conduit Flow-meters

For closed pipe flow metering, Magnetic Flow-meters shall be used unless specified otherwise.

The installation shall comply with the manufacturers' recommendations and with the following British Standards:-

- BS 5792 : 1993 : Measurement of Conductive Liquid Flow in Closed Conduits
- BS 7405 : 1991 : Guide to Selection and Application of Flow-meters for the Measurement of Fluid Flow in Closed Conduits

- Open Channel Flow-meters

Weirs and Flumes shall utilise ultrasonic instruments deriving flow from level measurement.

The sensor shall be positioned at a height which equates to the maximum water level plus the transducer blanking distance, wherever this is practicable. If the sensor is positioned at a higher location, then the system accuracy will be reduced. The actual sensor location depends on the weir or flume type utilised. The locations shall comply with BS 3680: Methods of Measurement of Liquid Flow in Open Channels. The data provided in Table 1 of BS 3680 is a guide to the location of the sensing device for various types of weirs or flumes. The sensor shall be easily accessible for accuracy checks.

- **Foaming**

Ultrasonic instruments are affected by foam on the liquid surface. If foaming is a major, consistent problem, the ultrasonic method of measurement shall not be used.

- **Gas Flow-meters**

Small flows of gas such as purges to instrument tapping, or sample flows to on-line analysers shall be measured by variable area meters. For large gas flows, thermal transfer flow-meters shall be used.

- **Bypass Piping**

Where bypass piping is specified, block and bypass valves shall be provided to permit process operation while the meter is being serviced. If bypassed, the meter shall be in the main run and the block valves shall be line size and placed at least 10 diameters upstream and 5 diameters downstream of the meter. The bypass valves shall be capable of positive shut-off to prevent measurement errors.

- **Differential Pressure Instruments**

Orifice plates shall not be used for the measurement of flow in new installations. Where there is a requirement to connect to an existing Orifice plate, the connection shall be as described in BS.6739 "INSTRUMENTATION IN PROCESS CONTROL SYSTEMS INSTALLATION DESIGN AND PRACTICE".

- **Magnetic Flow-meters**

Magnetic flow-meters shall always be installed with full pipe conditions. If abrasive slurry is being measured, a vertical orientation with a straight run on the inlet side and upward flow shall be used. This arrangement distributes wear evenly.

Pipelining material shall also be incorporated to reduce wear.

10.0 LEVEL MEASUREMENT

The preferred measurement technique for level is by ultrasonic transducer. Other techniques shall only be used where specified or by agreement.

- Ultrasonic Level Measurement

The transducer shall be positioned to comply with the following:

- The sensor beam is angled at 90 degrees to the measured surface
- The paths to and from the liquid surface are not obstructed for the full width of the transmitted and reflected beam, to prevent ghost signals resulting in erroneous level measurement
- The use of multiple sensors in close proximity shall be avoided because of the risk of ultrasonic beam interaction between adjacent devices. Where multiple sensors are absolutely essential, full consultation shall take place with technical experts from the equipment manufacturers

Temperature compensation measurement shall be included in ultrasonic measurement devices. A loss of echo alarm should be connected as a discrete PLC digital input.

- Conductive Level Switches

On all sewage and sewerage installations, electrodes shall be installed as far apart as possible to avoid fouling and bridging by rags. Composite mounting brackets, used for grouping sets of two and three electrodes together shall not be used.

- Float Switches

Float switches shall be used for simple High Level or Low Level detection.

- Connections to Vessels

Level instrument connections shall be made directly to vessels and not to process flow lines or nozzles (continuous or intermittent) unless fluid velocity in the line is below 0.2 m/s.

Connections and interconnecting piping shall be installed in such a manner that no pockets or traps can occur. Where pockets are unavoidable, drain valves shall be provided at the lowest points.

- Stilling Tubes

Where Stilling Tubes are specified they shall conform to the following requirements:

- Be manufactured from UPVC with a minimum bore of 100mm

- Be adequately fixed and supported over its full depth, at sufficient points to prevent damage by adverse weather, accidental damage or vandalism

11.0 TEMPERATURE MEASUREMENT

Instrumentation for Temperature Measurement shall be as described in BS.6739 "INSTRUMENTATION IN PROCESS CONTROL SYSTEMS INSTALLATION DESIGN AND PRACTICE".

12.0 PRESSURE TRANSDUCERS

- Equipment selection

To achieve optimum accuracy, transducers shall be selected to have a range as close as possible to the anticipated operating range.

- Site needs

A datum point shall be provided adjacent to the transducer installation. An engraved plate shall define any offsets resulting from its elevation relative to the tapping point (zero level) and also define the range of the transducer. All elevation measurement shall be in metres, with the equivalent bar offset shown.

- Sensor positioning and connection

Before tapping into any pipe work or vessel, the Contractor shall ensure that the pipe work or vessel is sufficiently robust, and tappings are below a guard valve.

Sensors shall be positioned in a location accessible for safe maintenance by a lone technician. It shall be coupled to the tapping point via suitably rated impulse pipe work.

All pipes shall be terminated by isolating valves and drain cocks at the tapping point. All pipes and cocks shall be labelled.

The sensor shall be connected to the pipe work using a "T" piece and two isolating/bleed valves. These shall permit zeroing and connection to pressurising/reference gauges by a lone technician.

Where separate transducers and transmitters are used, the transmitter shall be positioned locally to the transducer to facilitate calibration, and Site operatives provided with a local readout at a convenient point. This shall be driven from the 4-20mA loop.

- Configuration

The transducer shall be configured to read from zero to the maximum appropriate figure (10% over maximum pressure = x bar). Thus 4mA shall represent zero head, i.e. ambient pressure,

and 20mA the maximum pressure required. The display and the telemetry system would then be calibrated to read 0 - x bar.

Example: A pumping main monitor, delivering against a maximum 27.5 metre head.

Using a 3.0 bar range instrument, set at 0 - 2.75 bar. 4mA would represent the zero and 20mA would be 2.75 bar. The display and the telemetry system would then be calibrated to read 0 metres at ambient (0 bar) and 2.75 bar at a pressure of 2.75 bar (20mA).

- Display needs

If the instrument does not contain a display of the pressure measurement, a local indicator shall be provided at an agreed location, for Site operators to confidence check the instrument.

- Installation requirements

The installation of Pressure instrumentation shall be as described in BS:6739 "INSTRUMENTATION IN PROCESS CONTROL SYSTEMS INSTALLATION DESIGN AND PRACTICE".

13.0 TURBIDITY MEASUREMENT

Where possible, the hydraulic pressure from the process shall be used to deliver the sample to the instrument. The sample shall be taken from the process using a sample probe which protrudes into the pipe by an amount equal to a 1/3 of the pipe diameter. The probe shall be withdrawable and the mouth of the probe shall face downstream to minimise the risk of blockages. For each analyzer, a flow regulator and flow detector shall be installed. These shall be installed as close as possible to the sensor. The flow sensor pipe work must be arranged so that the detector head is always covered by the sample water. On the sampling system, the last 10cm of waste pipe above the collection cup shall be of flexible hose, to allow manual samples to be taken.

In situations where the sample is pumped, the pumps must be in a duty/standby arrangement, with duty selection and automatic changeover on pump failure or sample loss of flow.

The sample should not be taken from a point where solids may settle and care should be taken to avoid air entering the system. If a bubble trap is fitted, it is to be positioned at a height recommended by the manufacturer.

Sample pipe work should be installed to have a minimum number of bends and also to be as short as possible to reduce the response time of the instrument.

The flow rate through the instrument must be regulated to be as recommended by the manufacturer. A loss of flow detector shall be installed on the outlet of the instrument.

14.0 ANALYTICAL MEASUREMENT

Process analysers are generally complicated systems and shall be properly applied and installed in order to ensure a high degree of accuracy with trouble free operation. The exact requirements for housing, supplies, services, sample conditioning etc. Applicable to each type of process analyzer shall require individual consideration.

MANUFACTURERS' INSTRUCTIONS SHALL BE COMPLIED WITH IN ALL RESPECTS.

15.0 SLUDGE BLANKET LEVEL MEASUREMENT

Fixed point sludge blanket level detectors shall be mounted vertically downwards into the tank from above wherever this method of installation is practicable. It is important that the instrument is installed in a position which will allow easy access for routine cleaning, maintenance & calibration. A chain shall be used to support the sensor in the tank.

The control panel, sensors and any associated wiring shall be installed where it will not be disrupted by the movement of any mechanical plant e.g. scraper bridges etc.

16.0 pH MEASUREMENT

- Positioning of pH instrument

pH instruments shall be positioned to analyse a sample which is representative of the process water. When pH is being used to control the dosing of chemicals, the pH instrument shall be installed immediately after mixing. Measuring downstream of a chemical dosing point may introduce an unacceptable time lag for the control of chemical dosing. If a bypass sampling loop is used in a control application the pipe work shall be as short as possible.

- Consideration for calibration

Sufficient spare cable and space shall be provided for electrode removal to allow calibration when the instrument is installed. Clamps and shelving which will support electrodes during calibration shall be installed.

- Prevention of Earth leakage

The coaxial cable shall be used to connect transmitter and electrode, the length of which shall be as short as possible. If the cable length is greater than 10 m a preamplifier shall be used.

- Pressurised Installation

If the reference electrode uses liquid electrolyte the electrode shall be pressurised at a positive pressure which is just greater than the sample flow pressure.

17.0 METHANE MEASUREMENT

The detector shall be installed together with a local display. This system enables the sensor to be adjusted on Site i.e. zero and span.

The detector shall be mounted on a place where maintenance can be easily performed.

There are two choices of mounting area which depend on the system and the ease of maintenance.

- The detector shall be mounted where the gas occurrence is most likely. To detect methane, which is lighter than air, the detector shall be mounted at the top of an enclosed area.
- The detector shall be installed in a pipe mounting. The sensor shall be mounted in straight parts of the duct where the air flow is laminar. Avoid mounting the sensor in duct bends and places where the air flow is turbulent.

The sensor shall be suitably lagged to prevent condensation on the optics.

The detector shall be positioned so that the longitudinal axis of the detector is horizontal, in order to obtain a vertical position of the detector mirror and window. This vertical position will prevent accumulation of water and dust on the optics.

18.0 HYDROGEN SULPHIDE (H₂S) MEASUREMENT

The detector shall be installed together with a local display. This system enables the sensor to be adjusted on Site i.e. zero and span.

The detector shall be mounted on a place where maintenance can be easily performed. There are two choices of mounting area which depend on the system and the ease of maintenance.

- i The detector shall be mounted where the gas occurrence is most likely. To detect methane, which is heavier than air, the detector shall be mounted at the bottom of an enclosed area.

OR

ii The detector shall be installed in a pipe mounting. The sensor shall be mounted in straight parts of the duct where the air flow is laminar. Avoid mounting the sensor in duct bends and places where the air flow is turbulent.

The sensor shall be suitably lagged to prevent condensation on the optics.

The detector shall be positioned so that the longitudinal axis of the detector is horizontal, in order to obtain a vertical position of the detector mirror and window. This vertical position will prevent accumulation of water and dust on the optics.

19.0 CONDUCTIVITY MEASUREMENT

Conductivity instruments shall be positioned to analyse a sample which is representative of the process water. The sensor shall be positioned in a vertical plane to avoid any water stagnation, or partial filling of the cell.

Sufficient cable and room shall be allowed to ensure the sensor is accessible for maintenance and calibration.

20.0 WEIGHT MEASUREMENT

The load cells shall be positioned such that each load cell shall bear the same amount of weight.

The outputs of the individual load cells, before filling the vessel shall be measured. The outputs shall be similar. As a general rule, an imbalance of less than 10% is satisfactory. If the outputs differ greatly, this indicates an overload situation on the load cells exists. This shall be corrected by placing shim plates underneath the load cells with the lower outputs.

For hoppers, vessels and silos, it is important that the centre of gravity lies within the locus of the load cells and they are in the same horizontal plane.

Where excessive vibration or shock is anticipated, it is necessary to incorporate anti-vibration mountings.

For outdoor installations the wind influences shall be taken into account. Side or non-axial loadings caused by wind or other factors, require the installation of tie-rods.

All connections to the vessel shall be decoupled by the use of flexible couplings.

21.0 DISSOLVED OXYGEN MEASUREMENT

The equipment shall be installed in a position such that it allows easy access for routine maintenance & calibration. Mounting fixtures provided by the manufacturers which make removal of the equipment for maintenance / repositioning easier, shall be used where available.

The transmitter shall be mounted adjacent to the sensor in order that local display readings can be taken for calibration / maintenance procedures and is mounted pointing downstream to promote self cleaning.

When installed in the open the instrument's transmitter will be installed in a suitably weather proofed enclosure.

Positioning of the dissolved oxygen sensor within the aeration lane is very important for process control and a detailed Site survey shall be conducted prior to siting the sensor.

22.0 MIXED LIQUOR SUSPENDED SOLID MEASUREMENT

The equipment shall be installed in a position such that it allows easy access for routine maintenance & calibration. Mounting fixtures provided by the manufacturer which make removal of the equipment for maintenance / repositioning easier shall be used were available.

The transmitter shall be mounted adjacent to the sensor in order that local display readings can be taken for calibration / maintenance procedures and is mounted pointing downstream to promote self cleaning.