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| Assets Planning and Delivery GroupEngineering |
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DESIGN STANDARD DS 26-12

Type Specifications – Electrical

Type Specification for Pump Control Cubicle

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**FOREWORD**

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

[Overview of Western Australia’s Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)](https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/overview_general_regulations.pdf)

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**Head of Engineering**

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REVISION STATUS

The revision status of this standard is shown section by section below

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Type Specifications – Electrical

Type Specification for Pump Control Cubicle

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# SCOPE

This Specification covers the requirements for the design, construction and testing of a switchboard controlling system designated as a Pump Control Cubicle and arranged so as to control the monitoring, protection and operation of the pumps with drives rated greater than 150 kW and described in the Annexure.

This Specification covers the requirements for a Pump Control Cubicle to be located indoors and controlling a relatively large switchboard.

This Specification shall be read in conjunction with the accompanying Annexure and Principal’s drawings.

# DEFINITIONS

Throughout this Specification the following abbreviations shall have the meanings listed hereunder.

1. PLC shall mean Programmable Logic Controller
2. RTU shall mean Remote Terminal Unit
3. SCADA shall mean Supervisory Control and Data Acquisition

# SITE

The location of and access to the site for the installation of the Pump Control Cubicle shall be as described in the Annexure.

# OPERATING MODE

The Pump Control Cubicle will be required to control and monitor the associated pump station plant unattended and on a continuous basis. The Pump Control Cubicle will be interfaced with the SCADA equipment described in the Annexure, but will be required to control the plant independently in the event of a failure of the communication link to the SCADA central station.

# WORK BY THE PRINCIPAL

The Work to be performed by the Principal shall be as detailed in the Annexure.

# SUPERVISING ENGINEER

Supervising Engineer shall mean the engineer who approved the relevant drawings or an engineer authorised to act on his/her behalf.

# INFORMATION TO BE SUPPLIED BY THE CONTRACTOR

Within the number of calendar days after the receipt of the Principal’s order stated hereunder, the Contractor shall submit to the Principal the following Pump Control Cubicle documentation for approval.

1. General Arrangement including Equipment Layout 21 days
2. Equipment List 21 days
3. Other drawings 28 days
4. Inspection and Test Plan 21 days
5. Test Certificates Within 14 days after delivery
6. Operating and Maintenance Manual Within 14 days after delivery
7. As-Constructed Drawings Within 14 days after delivery

The Principal shall be entitled to a period of 10 calendar days to review each submission of the above documentation in order to verify that the Contractor’s proposals are in accordance with the Contract.

No Contract Extension of Time shall be allowed for such periods.

The Contractor shall not proceed with any work which is subject to the above approval process until the Principal’s approval in writing has been received.

Within 28 calendar days of the Supervising Engineer’s acceptance of the Pump Control Cubicle the Contractor shall supply three sets of A1 sized prints of “As-Constructed” drawings for the Pump Control Cubicle. Such drawings shall show a detailed dimensioned general arrangement, equipment schedules, terminations diagram and all operator interface screen display layouts.

# CONTRACTOR’S DRAWINGS

## General

The Contractor shall submit two A3 paper copies of the Contractor’s drawings for approval.

All drawings provided by the Contractor to the Principal under the Contract shall be in accordance with the latest issue of the relevant Australian Standard and the Contractor’s standard drafting practice and shall be prepared electronically using either AutoCAD or Microstation software, preferably the former.

Adequate contrast shall be maintained between drawing and background, and the clarity and quality of the drawings shall enable the Principal to microfilm the prints and to reproduce by photographic processes clear and legible A3 copies for records purposes.

Contractor’s drawings to be provided to the Principal under the Contract shall be provided in electronic form as AutoCAD or Microsoft files incorporating the Principal’s standard drawing sheet border and title block.

## Content of Contractor’s Drawings

The Contractor shall provide the Principal with the following drawings:

1. Project specific cubicle layout.
2. Project specific equipment and materials list.
3. Project specific logic diagrams as per clause 25.3 (e)
4. Project specific power diagram similar to drawing no. FS00-8-1.
5. Project specific serial communication connection diagram similar to drawing no. FS00-8-2.
6. Unit control operator interface display diagram.

## Marked Up Principal’s Drawings

Except for minor variations approved in writing by the Supervising Engineer, the work shall be constructed strictly in accordance with the Principal’s drawings. Any approved variations to the Principal’s drawings shall be marked up in red on a paper copy of the drawings and submitted to the Supervising Engineer for course to the Principal’s Infrastructure Design Branch.

## Ownership

Drawings provided by the Contractor to the Principal under the Contract shall become the intellectual property of the Principal.

# STANDARDS

## Water Corporation Type Specification

In addition to the requirements of this Specification, the Pump Control Cubicle shall be constructed in accordance with the requirements of the Water Corporation’s Type Specification for L.V. Switchboards – General Requirements.

## Australian Standards

In addition to the Australian Standards specified in the Water Corporation’s Type Specification for L.V. Switchboards – General Requirements, the following Australian Standards are referred to in this Specification.

AS 60529 Degrees of protection provided by enclosure (IP code)

AS3439.1 Low-voltage switchgear and control assemblies

 Part 1: Type-tested and partially type-tested assemblies

AS/NZS ISO9001:2000 Quality Management Systems – Requirements

## International Standards

The following International Standards are referred to in this specification.

1. EN50081-2 Generic emission standard – part 2 – industrial environment
2. EN50082-2 Generic immunity standard – part 2 – industrial environment

# CONFORMANCE WITH THE DRAWINGS

The Pump Control Cubicle shall be constructed and configured strictly in accordance with the Principal’s drawings and with this Specification. In the event of a discrepancy between the Principal’s drawings and this Specification, the matter shall be referred to the Supervising Engineer for resolution.

# PREFERRED EQUIPMENT

Where practical, equipment supplied shall be selected from the Water Corporation’s list of preferred equipment.

# SERVICE CONDITIONS

The Pump Control Cubicle shall be suitable for continuous operation in an indoor location and under the ambient conditions specified in the Annexure. Local operation of the Pump Control Cubicle will be by authorised non-electrical staff.

# POWER SUPPLY

The electrical power supply to the Pump Control Cubicle shall be single phase 240 volt + 10%, -15%, 50 Hz, with total harmonic distortion less than 8%.

# CONSTRUCTION

## Type of Enclosure

The Pump Control Cubicle shall be of the floor mounted cubicle type with front access door only.

Operator interface equipment including the Pump Control Cubicle main switch shall be mounted on the front door.

Opening the front door shall provide access to all other equipment and wiring.

## Placement of Equipment

Controls, meters and screen displays shall not be mounted greater than 1.8 metres above floor level, not less than 0.6 metres above floor level.

## Door Locks

Door locks shall be fitted with cylinders suitable for the Lockwood EL-2 key system.

## Form of Separation

The Pump Control Cubicle shall be designed and constructed so that all live conductors on the line side of the Pump Control Cubicle main switch shall be either:

1. fully insulated, or
2. finger protected by barriers which do not restrict access to any equipment or wiring which is connected to the load side of the main switch.

## Electronic Equipment Separation

A separation of not less that 100mm shall be maintained between the case of any piece of equipment which contains electronic repetitive switching devices and any other piece of equipment which contains electronic circuitry, except where both pieces of equipment are of the same manufacture and the manufacturer advises that a lesser clearance will be acceptable.

Similarly, a separation of not less than 100mm shall be maintained between the power supply cable running to any piece of equipment which contains electronic circuitry and the case of any other piece of equipment which contains electronic repetitive switching devices, except where both pieces of equipment are of the same manufacture and the manufacturer advises that a lesser clearance will be acceptable.

## Terminals

1. Terminal rails shall be mounted vertically.
2. All terminals shall be numbered sequentially in accordance with terminal numbers indicated on the Contractor’s drawings.
3. Terminals shall be mounted to allow cable marker ferrule numbers to be read easily.
4. All internal connections shall be made on one side of the terminal strip and all field connections shall be made on the other side of the terminal strip.
5. Where it is necessary to mount terminal strips side by side, at least 100 mm clearance shall be provided between terminals on adjacent terminal strips.

# PAINT SYSTEMS

The paint systems used shall be as described in the Water Corporation’s Type Specification for L.V. Switchboards – General Requirements, DS26-9, unless otherwise approved by the Supervising Engineer.

# DEGREE OF PROTECTION

The design of the Pump Control Cubicle shall be such that:

1. with the front door closed the degree of protection provided shall be IP52 in accordance with AS 60529, and
2. with the front door open the degree of protection provided shall be IP2X in accordance with AS 60529.

# RATED MAXIMUM OPERATING VOLTAGE

The Pump Control Cubicle rated maximum continuous input supply operating voltage shall be 265 VAC.

# RATED INSULATION VOLTAGE

The rated insulation voltage of 240 VAC circuit equipment shall be 500 volt.

# CREEPAGE DISTANCES

The Pump Control Cubicle shall be rated for operating in a micro-environment with atmospheric pollution to degree 4 in accordance with AS 3439.1

# RATED IMPULSE WITHSTAND VOLTAGE

The Pump Control Cubicle 240 VAC circuits shall have a rated withstand voltage rating of 4 kV.

# PROGRAMABLE LOGIC CONTROLLERS

## General

Programmable logic controllers (PLC’s) and all other electronic equipment shall be rated for industrial use and shall comply with European Standards

EN 50081-2 and EN 50082-2 for electromagnetic emissions and immunity respectively. In addition, such equipment shall be of a type approved by the Australian Communications Authority in respect to electromagnetic compatibility.

## Power Sources

1. The power source for the PLC’s, Display Units and the Remote Control Modules shall be derived within each PLC from the PLC’s 240 VAC power supply and shall be used only for powering the internal operation of these units and the associated serial communication links.
2. The Pump Control Cubicle shall include a suitable separate 240 VAC / 24 VDC power supply capable of driving all analogue and digital I/O. The negative side of this power supply shall be earthed.
3. The SCADA RTU will be powered from a separate battery backed power supply.

## Analogue Inputs

Analogue inputs shall be 4/20 mA with the negative side earthed unless the external signal loop is to be earthed at the associated transmitter, in which case the input shall be made fully floating, by the provision of a loop isolator if necessary. Analogue inputs required to be fully floating are listed in the Annexure.

## Analogue Outputs

Analogue outputs, other than serial communication links, shall be 4/20mA with the negative side earthed.

## Digital Inputs

Digital inputs other than serial communications links shall be rated at 24 VDC and shall be opto isolated with the negative side grounded.

## Digital Outputs

Digital outputs other than serial communications links shall be normally open, shall be relay isolated and shall be capable of switching 200 mA, 24 VDC inductive.

## Diagnostics

PLC’s shall incorporate a comprehensive set of diagnostic programme routines which shall run prior to start up and continually during PLC operation. In the event of an error being detected which offers a risk of system malfunction, the PLC shall shut down the application and raise an alarm.

All PLC modules shall incorporate operational status including PLC input and output status indicators.

# SCREEN DISPLAYS

Screen displays on the common operator interface panel shall be as shown on the Principal’s drawings.

# CONNECTION OF INPUTS AND OUTPUTS TO PLC’S

Communications between PLC’s, switchboard, separately mounted variable speed controllers, Display Units, SCADA RTU’s and Remote Control Modules shall be as shown on the Principal’s drawings (i.e. as shown on the control system block diagram) and as detailed in the Annexure.

# VOLTAGE SURGE PROTECTION

## Incoming Supply Surge Protection

The incoming supply circuit to the Pump Control Cubicle shall be protected at the Pump Control Cubicle against overvoltage surges by a MOV surge diverter with a rated continuous operating voltage or not less than 275 volts and a let through voltage of not more than 850 volts for a 3 kA 8/20 μs current pulse.

## Extra Low Voltage Circuit Surge Protection

All PLC switched contact input signals originating from transducers mounted on steel pipework or which are located outside the pump station building and all PLC 4/20 mA analogue input and output signals shall be protected against overvoltage surges at the Pump Control Cubicle with combined gas arrestor and transient protection diode surge diverters having a rated continuous operating voltage of not less than 29 volts and a let through voltage of not more than 60 volts for a 3 kA 8/20 µs current pulse.

# PROGRAMME CODING

## General

1. Electrically maintained latches shall be used for on/off control functions. Permanent memory latches shall be used only for protection and alarm functions.
2. The convention shall be adopted that “set” overrides “reset”.
3. Otherwise programme coding shall be such that it is scan sequence independent.
4. PLC programme coding shall be developed on a Personal Computer based high level language programmer.
5. Logic shall be coded precisely as defined by the logic module internal logic diagrams and by the logic module connection diagrams, both of which are included in the Principal’s drawings.
6. No attempt shall be made to optimise the logic or to otherwise change its format.

## Coding of Standard Logic Modules

Programmes including standard logic modules shall be programmed strictly in accordance with the ‘Directions for Use’ shown on Water Corporation Drawings FS00-1-2 and FS01-1-2 as applicable.

## Logic Documentation

1. Programme coding read out shall be provided directly from the PLC and shall be in either block logic or ladder logic format.
2. If the PLC coding documentation is in ladder diagram format, the documentation shall:-

 (i) include an introduction at the beginning of the ladder diagram documentation with a list of the logic modules and their functions as well as a list of the internal buses used,

 (ii) provide annotation on both logic “contracts” and logic “coils”.

 (iii) provide cross references between logic “contacts” and “coils” (to the extent allowed by the particular PLC),

 (iv) show logic “coils” in coil order number within each logic module (wherever possible within the limits of the PLC used), and

 (v) show each latch reset function immediately before each associated latch set function.

1. All inputs, outputs and internal buses shall be annotated with the same descriptions shown on the Principal’s drawings, i.e. on the standard module logic diagrams.
2. Block logic diagrams shall mirror the logic diagrams shown on the Principal’s drawings i.e. on the standard module logic diagrams.
3. Once the programme has been tested successfully, the Contractor shall produce a set of project specific logic diagrams based on the project specific logic diagrams provided under the contract, but showing the PLC address of each logic bus and logic function.

Such logic diagrams shall include the standard logic modules used and the module interconnection diagrams as well as any special logic. These logic diagram drawings shall be assigned a new drawing number in the project drawing set.

# PUMP CONTROL CUBICLE POWER SYSTEM

The Pump Control Cubicle power system shall be arranged in a manner similar to that shown on the typical Pump Control Cubicle power diagram included in the Principal’s drawings. Each instrument loop, partial loop or instrument, which needs to operate separately shall be provided with separate circuit fusing. All such fusing shall be graded appropriately

# LABELLING

In addition to the special explanatory labels detailed in the Principal’s drawings, each panel and each item of equipment shall be labelled in accordance with the approved Contractor’s drawings.

# TESTS

1. The Contractor shall subject the Pump Control Cubicle to the following tests and provide appropriate test certificates detailing the test results obtained.
	1. Visual inspection to verify all equipment and wiring is in accordance with the approved drawings,
	2. Insulation test of 240 VAC circuits,
	3. Verification of logic coding by visual comparison of logic programme print outs against logic diagrams shown on the Principal’s drawings,
	4. Verification of correct operation by use of simulated digital and analogue inputs and outputs,
	5. Inspection of all screen displays to verify conformance with the Principal’s Drawings.
2. The cost of all testing shall be to the Contractor’s account.
3. All testing shall be carried out in the presence of, and to the satisfaction of, the Supervising Engineer or his authorised representative.

# INSTRUCTION MANUALS

## General

Instruction Manuals shall be bound in high grade A4 loose leaf 4 ring binders.

With the exception of “As-Constructed drawings” and electronic copies of logic programmes, the information included in instruction manuals shall be printed on high grade A4 size paper.

“As-Constructed drawings” included in instruction manuals shall be printed on high grade A3 sized paper.

Electronic copies of logic programmes shall be in block logic or ladder logic form.

The instruction manuals shall contain full documentation of the Pump Control Cubicle and shall be in a form approved by the Supervising Engineer.

## Information Required

Each instruction manual shall contain the following information:

1. full operating and maintenance instructions for the Pump Control Cubicle including all equipment mounted thereon,
2. a copy of the Pump Control Cubicle test results,
3. a full set of “As-Constructed drawings”,
4. technical details, manufacturer’s name and catalogue number for all equipment used in the Pump Control Cubicle,
5. a fully annotated print out of all logic programmes,
6. an electronic copy of all logic programmes.

# QUALITY ASSURANCE

The Pump Control Cubicle shall be manufactured under a quality system certified by an accredited authority in accordance with AS/NZS/ISO 9001:2000 or an approved equivalent.

**Annexure to Specification**

**for**

**Pump Control Cubicle**

A1. Project:

A2. Principal’s Drawings:

 A2.1 Single line power diagram for Controlled Plant (similar to Dwg. FK80-4-1)

Dwg No.

A2.2 Principal’s standard logic diagrams Dwg. Nos.

(including revision numbers selected from standard modules listed Dwg. FS00-1-1)

 A2.3 Project specific logic diagrams Dwg. Nos.

 A2.4 Project specific logic module interconnection diagrams (similar to Dwgs. FS00-3-1)

 Dwg. Nos.

A2.5 Project specific common control operator interface panel screen displays

(similar to Dwgs. FS00-8-1 to FS00-8-6)

 Dwg.Nos.

 A2.6 Project specific control system block diagram (similar to Dwg. FK80-7-1)

 Dwg No.

 A2.7 Typical panel power diagram Dwg. No. FS00-8-1

 A2.8 Typical serial communications connection diagram Dwg. No. FS00-8-2.

 A.2.9 Project specific special explanatory labels

 Dwg. No.

A3. Site Location

**Annexure to Specification**

**for**

**Pump Control Cubicle**

A4. Type of Access to Site:

A5. Type of SCADA Interface:

A6. Work to be done by the Principal:

A7. Service Conditions

 A7.1 Location air conditioned, yes or no?

 A7.2 Maximum Ambient Air Temperature: °C

 A7.3 Maximum Ambient Air Humidity: %

 A7.4 Air Borne contaminants:

A8. Analogue inputs to be fully floating

A9. Analogue outputs to be full floating

A10. Type of Communications – Pump Control Cubicle to Switchboard and Pump Control Cubical

to Water Treatment Plant

 Direct wired or field bus

 If field bus type i.e. Modbus, Profibus or Devicenet

A11. Type of Communications – Pump Control Cubicle to Separately Mounted Variable Speed Controllers

 Direct wired or field bus

 If field bus type i.e. Modbus, Profibus or Devicenet

A12 field Instruments to be connected to field bus

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| **Type Specification for Pump Control Cubicle Tender Technical Response Schedule** |
| Clause | **Subject** | **Noted** | Compliance | **Comments** |
| **No.** |  |  | **Yes** | **No** |  |
| **1** | **Scope** |  |  |  |  |
| **2** | **Definitions** |  |  |  |  |
| **3** | **Site** |  |  |  |  |
| **4** | **Operating Mode** |  |  |  |  |
| **5** | **Work by the Principal** |  |  |  |  |
| **6** | **Supervising Engineer** |  |  |  |  |
| **7** | **Information from Contractor** |  |  |  |  |
| **8** | **Contractor’s Drawings** |  |  |  |  |
| 8.1 | General |  |  |  |  |
| 8.2 | Content |  |  |  |  |
| 8.3 | Marked Up Drawing |  |  |  |  |
| 8.4 | Ownership |  |  |  |  |
| **9** | **Standards** |  |  |  |  |
| 9.1 | General Requirements Specification |  |  |  |  |
| 9.2 | Australian Standards |  |  |  |  |
| 9.3 | International Standards |  |  |  |  |
| **10** | **Conformance with Drawings** |  |  |  |  |
| **11** | **Preferred Equipment** |  |  |  |  |
| **12** | **Service Conditions** |  |  |  | For lowest temperature rated equipment item |
|  |  |  |  |  | Ambient temperature rating, deg. C = |
| **13** | **Power Supply** |  |  |  |  |
| **14** | **Construction** |  |  |  |  |
| 14.1 | Type of Enclosure |  |  |  |  |
| 14.2 | Placement of Equipment |  |  |  |  |
| 14.3 | Door Locks |  |  |  |  |
| 14.4 | Form of Separation |  |  |  |  |
| 14.5 | Electronic Equipment Separation |  |  |  |  |
| 14.6 | Terminals |  |  |  |  |
| **15** | **Paint Systems** |  |  |  |  |

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| **Type Specification for Pump Control Cubicle Tender Technical Response Schedule** |
| Clause | **Subject** | **Noted** | Compliance | **Comments** |
| **No.** |  |  | **Yes** | **No** |  |
| **16** | **Degree of Protection** |  |  |  |  |
|  |  |  |  |  | Door closed IP rating = |
|  |  |  |  |  | Door open IP rating = |
| **17** | **Rated Maximum Operating Voltage** |  |  |  | Max. operating volts = |
| **18** | **Rated Insulation Voltage** |  |  |  | Rated insulation volts = |
| **19** | **Creepage Distances** |  |  |  |  |
| **20** | **Rated Impulse Voltage** |  |  |  | For 240V circuits, rated impulse kV = |
| **21** | **PLC’s** |  |  |  |  |
| 21.1 | Power Sources |  |  |  |  |
| 21.2 | Analogue Inputs |  |  |  |  |
| 21.3 | Analogue Outputs |  |  |  |  |
| 21.4 | Digital Inputs |  |  |  |  |
| 21.5 | Digital Outputs |  |  |  |  |
| 21.6 | Diagnostics |  |  |  |  |
| **22** | **Screen Displays** |  |  |  |  |
| **23** | **Connection of I/O** |  |  |  |  |
| **24** | **Voltage Surge Protection** |  |  |  |  |
| 24.1 | Incoming Supply Surge Protection |  |  |  | Surge Diverter continuous volts = |
|  |  |  |  |  | 3 kA 8/20 microsec let through volts = |
| 24.2 | ELV Circuit Surge Protection |  |  |  | Surge Diverter continuous volts = |
|  |  |  |  |  | 3 kA 8/20 microsec let through volts = |
| **25** | **Programme Coding** |  |  |  |  |
| 25.1 | General |  |  |  |  |
| 25.2 | Coding of Standard Logic Modules |  |  |  |  |
| 25.3 | Logic Documentation |  |  |  |  |
| **26** | **Cubicle Power System** |  |  |  |  |
| **27** | **Labelling** |  |  |  |  |
| **28** | **Tests** |  |  |  |  |

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| **Type Specification for Pump Control Cubicle Tender Technical Response Schedule** |
| Clause | **Subject** | **Noted** | Compliance | **Comments** |
| **No.** |  |  | **Yes** | **No** |  |
| **29** | **Instruction Manuals** |  |  |  |  |
| 29.1 | General |  |  |  |  |
| 29.2 | Information Required |  |  |  |  |
| 30 | Quality Assurance |  |  |  |  |

END OF DOCUMENT