



# MAINTENANCE RELATED CLAUSES FOR CAPITAL AND OPERATIONAL PROJECTS

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Version 8

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Document Number: **MEFA0001**

Document Owner: **Reliability Planning  
Manager, SP&AS**

Page 1 of 38

Version Number: 7

Issue Date: 23/02/2018

Next review Date: 28/12/2018

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## Executive Summary

All capital and operational project deliverables need to meet the requirements of the Asset Maintenance Policy AMQ0002. This policy applies to all assets delivering water, waste water, recycled water and stormwater services including information systems and property.

The clauses contained in this document are designed to support the above policy and apply to all asset creation and operating phase work carried out for Sydney Water as well as to the developer funded works.

The Maintenance Related Clauses for Capital and Operational projects apply to all Sydney Water facilities.

**Planning and Design Stage Activities** need to include a process level risk assessment and equipment level risk assessment called the Failure Mode Effects and Criticality Analysis (FMECA) and a Reliability Block Diagram (RBD). These are undertaken at the concept design stage to develop contingency plans and manage risks by the Contractor.

For all drawings shall refer to **Computer Aided Drafting (CAD) Standard** for Engineering drawings.

**Enterprise Asset Management System (MAXIMO)** will be used for storage of asset related data. The Contractor is responsible for entry of asset details into MAXIMO. Details of spare parts and decommissioned assets will be provided by the Contractor via the spreadsheet(s) specified by the Principal. Entry of asset details will require access to the MAXIMO system. Sydney Water Project Manager will follow procedures to provide access to the contractor.

For new facilities, an **Asset Identification** will be created by the Principal in Maximo with a unique asset number, based on data supplied by the Contractor. Standard templates are available from the Principal to assist in this process.

**Labelling and Identification** will be provided by the Contractor as per the specification provided by the Principal. This is to ensure that labels are consistent on all Sydney Water assets.

**Operation and Maintenance Manuals** will be submitted in the format and with the number of copies specified by the Principal. It is particularly important that the document chapters are as per the standard template to avoid resubmissions and reviews which can be time consuming both to the Contractor and the Principal.

**A Testing and Commissioning** procedure will be developed by the Contractor for approval by the Principal, unless otherwise specified in the contract. This is to ensure that that the Contractor has followed the relevant clauses during the commissioning phase in conjunction with the Principal's approval, as required by the Contract.

**Hand-Over Documents** will be submitted according to the format and number of copies specified by the Principal. Site works remain the responsibility of the Contractor until the completion of Contract. The Contractor will ensure all documents submitted are accompanied by an electronic document transmittal form to avoid time consuming resubmissions, reviews and amendments.

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For new assets, any **Critical Spare Parts** and **Special Tools** for maintenance purposes will be supplied by the Contractor to the Principal prior to Completion of Contract. This will ensure all critical spares are in stock with the Principal to avoid procurement at a later date where the costs of items might vary upon the time of installation and avoid accidental failures that might occur during the hand over stage.

For new assets, the contractor shall provide the Principal's nominated staff with **Operational and Maintenance Training** to explain all aspects of operation and maintenance where assets can be reliably, effectively and safety operated and maintained under all conditions without supervision.

**Warranties** will be obtain by the Contractor as specified in the contract to ensure the Principal will have the benefit of warranties specified in the Contract obtained by subcontractors.

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# 1. Planning and Design Stage Activities

## 1.1 Concept Design/Planning Stage

A **process level** risk assessment Failure Mode Effects and Criticality Analysis (FMECA) and a Reliability Block Diagram (RBD) shall be undertaken at the concept design stage to develop contingency plans and manage risks. The Principal can supply a sample document, upon request.

The responsibility to carry out this work rests with the Contractor. The Contractor may be required to engage a competent FMECA facilitator to co-ordinate this work, if these expertise are not available within the Contractor's organisation. The FMECA facilitator is required to co-ordinate the work with the designers and Principal's stakeholders including planners, operators and maintainers.

Asset selection shall be based on minimizing the total life cycle costs. Where possible, assets selected should be consistent with similar existing assets performing reliably within the operating facilities owned by the Principal. The Designer must seek advice from Principal's relevant engineering representative during the asset selection process. This clause is not meant to discourage innovative solutions.

Where available, the Principal will provide to the Contractor FMECA assessments and RBD previously carried out for reasonably similar projects. The existing assessments, if applicable, may be modified and adopted with necessary amendments to meet the requirements in the current application.

The basis of selection of processes and assets shall be to minimise life cycle costs.

## 1.2 Design Stage

### 1.2.1 Reliability Studies and Asset Selection

An **equipment level** risk assessment (FMECA) and a detailed RBD shall be prepared at the detailed design stage to:

- Identify monitoring requirements for assessed risks
- Identify spares to be kept by Sydney Water, and
- Develop and provide Maintenance Plans

Assets are to be disaggregated on a process basis to the equipment level.

The Contractor may be required to engage a competent FMECA facilitator to co-ordinate this work, if these expertise are not available within the Contractor's organisation. The FMECA facilitator is required to co-ordinate the work with the designers and Principal's stakeholders including planners, operators and maintainers.

The equipment level risk assessment (FMECA) and RBD are to be updated following commissioning to reflect the "as built" condition of the assets and submitted to the Principal prior to hand-over of the assets.

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It is important for the designer to consider the access requirements for maintenance of equipment. All lubrication points and other maintenance inspection points must be positioned where they can be easily reached. Consideration must also be given to lifting and easy removal or exchange of components when renewals or refurbishments are required. It is the responsibility of the Contractor to ensure that the designer takes these into account in the design.

In addition to maintenance and reliability requirements, asset selection shall be based on minimizing the total life cycle costs. Where possible, assets selected should be consistent with similar existing assets performing reliably within the operating facilities owned by the Principal. The Designer must seek advice from Principal's relevant engineering representative during the asset selection process. This clause is not meant to discourage innovative solutions.

Where available, the Principal will provide to the Contractor FMECA assessments and RBD previously carried out for reasonably similar projects. The existing assessments, if applicable, may be modified and adopted with necessary amendments to meet the requirements in the current application.

### 1.2.2 Commissioning Plans

During design stage, the Contractor shall prepare a commissioning plan and a series of Inspection and Test Plans (ITPs) setting out all tests to be undertaken to prove that the completed works meet the performance requirements of the design and the Contract.

The commissioning plan and ITPs shall be submitted to the Principal for review and approval.

## 2. Sydney Water CAD requirements

Sydney Water CAD templates are available on the [Sydney Water website](#).

The Contractor shall submit all WAC drawings, as follows:

<b>Electronic copies (CD-R/DVD/USB)</b>	1 copies – Distribution (Plan Room & In AutoCAD format, PDF format and Meta data CSV file.
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## 3. Enterprise Asset Management System (Maximo)

During completion of the installation work (and no later than 20 working days prior to handover), the Contractor is responsible for collation and compilation of necessary information in the required format for inclusion in MAXIMO. The Contractor is responsible for entry of asset details into MAXIMO. Details of spare parts and decommissioned assets will be provided by the Contractor via the spreadsheet(s) specified by the Principal.

Entry of asset details will require access to the MAXIMO system. Sydney Water Project Manager to provide access to the contractor. Training documentation and instructional DVD are available from the Principal on request.

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The Contractor shall liaise with the Principal before data entry is commenced to ensure that data entry standards and the Principal's requirements are fully understood. A Specialist from the Principal will be available for consultation on matters involving data entry.

Data to be supplied under this Clause can be submitted to the Principal at any stage throughout the duration of the project. Completion of data entry by the contractor shall be at least 20 working days prior to commencement of hand over, for a joint review and acceptance by the Principal.

The Project Manager shall request verification at least 20 working days prior to hand over. The Principal will issue a Verification Certificate upon satisfactory verification of supplied data. It shall be the responsibility of the Contractor to carry out amendments requested by the Principal and submit amended documentation in the required formats prior to hand over of assets. All revisions to location/asset data resulting from changes carried out during hand over shall be submitted to the Principal within no later than 20 working days after hand over.

## 4. Asset Identification

### 4.1 General

In general terms, an asset refers to a physical asset such as plant, equipment or structure. Certain plants are classified as Facilities in Sydney Water and the equipment within such facilities are termed Assets.

For all types of facilities and assets the contractor shall refer to the Asset Identification Policy ACP0001 and the Asset Numbering Standard Operating Procedure ACP0055, both of which can be obtained from the Principal if required

In Maximo each Facility or Asset is identified with a unique number, which is termed a "Location Code". The Principal is responsible for allocation of Facility Code and Location Code based on the Sydney Water Asset Identification Policy ACP0001. The contractor is responsible for requesting Facility Number(s) (if not already requested) and Location Number(s) for new Assets at design stage.

### 4.2 Facility Code or Location Code

The Principal will issue Facility Codes or Location Codes to the Contractor for all new locations to be provided under the Contract. For the purpose of issuing Location Numbers (up to 400 locations), the Principal requires 10 working days from the date of receipt of the relevant inputs. For projects requiring more than 400 location numbers, requests for numbers can be released in batches not exceeding 400, or the additional time required for issuing of location numbers shall be discussed and agreed mutually. Additional time may be required if the information provided by the Contractor is incomplete and requires clarification.

The contractor shall request Facility or Location codes using standard templates which are available from the Principal. The information supplied in each request spreadsheet shall relate to only one Project. A contractor working on multiple projects for the Principal shall, where

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required to supply information, do so using a separate spreadsheet for each project. Contractor requests shall be provided to the Principal via Sydney Water Project Manager.

Contractor requests for location codes shall be accompanied by a Process and Instrumentation Diagram (P&IDs).

Upon receipt of a Facility number request form, the Principal will issue Facility Numbers from MAXIMO. The Principal may seek additional information on the location of the Facility, where required. The Principal will return the Facility number request spreadsheet containing the allocated Facility Code to the Contractor.

Upon receipt of a Location number request form, the Principal will issue Location Numbers and enter these numbers into MAXIMO. The Principal will return Location number request spreadsheet containing the allocated location numbers and relevant external reference number to the Contractor. The Contractor shall then amend the P&IDs and other relevant documentation, by replacing the provisional Location Numbers with the allocated Location Numbers.

If the Principal identifies from the Contractor's P&IDs and location layout drawings that there are location(s) not included in their Location number request spreadsheet, which require Location Numbers, the Principal will allocate these additional Location Numbers. The Contractor shall include the additional Location Numbers (and their corresponding locations) in the P&IDs and other relevant documentation.

The Contractor is responsible for providing information on existing locations and assets made redundant (decommissioned) or replaced by the project, using standard templates available from the Principal. The information shall be provided to the Principal, via Sydney Water Project Manager, most appropriately at the same time the contractor is requesting new location codes, but no later than 20 working days prior to commencement of hand over.

### 4.3 Asset Information

Asset information is to be entered directly into MAXIMO via the 'Contractor Asset Update Application' and submit for 'Validation' by the Principal at least 20 working days prior to the commencement of hand over. This will require access to the Sydney Water MAXIMO application for data entry personnel. The Project Manager / SWC Representative shall arrange MAXIMO access for the contractor's data entry personnel.

The Contractor is responsible for creating asset numbers and entering asset specifications in Maximo. The Contractor shall comply with the Asset Identification Policy ACP0001 and the Asset Numbering Standard Operating Procedure ACP0055 when entering asset data. The Principal has tools available to assist in entering asset information.

Principle will validate asset data supplied by contractor and notify the contractor via Project Manager of any issues that need to be resolved.

For the purpose of validating asset data (up to 400 locations), the Principal requires 10 working days from the date of notification. For projects requiring more than 400 location numbers, requests for validation can be released in batches not exceeding 400, or the additional time

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required for validation shall be discussed and agreed mutually. Additional time may be required if the information provided by the Contractor is incomplete and requires clarification.

#### 4.4 Data Verification

Sydney Water Project Manager shall request Verification Certificate from Asset Data Management to ensure the required asset information has been provided by the project. The request shall include a list of locations requested along with final P&IDs, a list of redundant or replaced assets. The request shall be made at least 20 working days prior to the commencement of hand over.

A representative of the Principal will issue a Verification Certificate after satisfactory verification of asset information provided by the project. Any issues or concerns identified during verification shall to be resolved prior of issuing of the Verification Certificate. Verification Certificate is a prerequisite for project handover and Commissioning Engineer will require this certificate at the handover of any project.

## 5 Labelling and Identification

### 5.1 General Requirements

The Contractor shall supply and install labels to identify locations in accordance with the location numbers issued by the Principal. Where no such identification is available, the Contractor shall seek the Principal's direction as to the identification to be used. This will be referred to the Asset Identification Policy DRAFT followed by Asset Numbering Procedure and Asset Hierarchy Procedure.

In cases where there are two contractors working within one facility, eg: Vacuum systems, the contractor working inside the building for all electrical and mechanical assets shall provide Sydney Water approved labelling. The contractor working outside the building including civil, mechanical and site within the facility grounds shall provide all Sydney Water approved labelling.

### 5.2 Label Dimensions

The size of the label shall be determined by the number of letters, size of letters, space available to install the label and the text shall be understood without ambiguity. The location number shall remain on a single line.

### 5.3 Label Materials

All labels that are subjected to the weather, e.g. installed on outdoor enclosures such as kiosks, cubicles, buildings etc, are to be 1.2 mm thick, 316 Stainless Steel, 0.2 mm engraved and in-filled with black paint. Labels in chemical contact process areas shall be treated similarly.

All labels that are within enclosures or buildings shall be of Traffolyte or similar material with black lettering engraved on a white background, unless specifically nominated otherwise. Edges of labels shall be bevelled on all sides. Shutdown system labels (example emergency stop buttons) and warning labels will be white lettering engraved on a red background.

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Labels installed in corrosive environments such as wet wells maintenance holes and the like shall be made of stainless steel and fixed with a minimum of two stainless steel screws. Labels identifying physical assets i.e. wet wells, motors, instruments shall be visible without the removal of a cover or access lid. The manufacturer's nameplate, attached to the assets installed under the Contract, shall be in addition to the Location Number label described above and shall be visible from the access position.

If Contractor is in doubt, communication between the Principal and the Contractor shall take place for confirmation on label material.

## 5.4 Font Sizes

All label lettering shall be in "CAPITAL" and "ARIAL" font. The wording on the labels shall be horizontal.

Unless otherwise stated elsewhere in the Contract documents, the following font sizes are applicable.

- a) Facility Numbers such as SP1140 on kiosks or equipment enclosures should be 12 mm and on superstructures (eg SP1139) 100 mm high.
- b) Where permissible (except for physically small assets) font size 10 mm shall be used for location labels. For very small assets, the font size may be reduced to fit. The exceptions to this rule are listed below.
- c) Location number labels for electrical components shall be 4 mm.
- d) In certain facilities such as SPSs, and WPSs, a pump unit number may be specified in the drawings. In such cases, the Pump Unit Number label shall have a font size of 50 mm.
- e) The labels that describe operating procedures shall have headings of 6 mm and the content shall be of 4 mm.

## 5.5 Installation of Labels

All stainless steel labels shall be secured using stainless steel fixtures.

The Traffolyte labels on front panels of switchgear & control assemblies shall be secured using stainless steel fixtures. Gluing is not acceptable.

Self-adhesive Traffolyte labels, where the adhesive covers the complete back plane of the labels, are acceptable for use inside enclosures, buildings and switchgear & control assemblies.

To prevent re-doing the labels after maintenance/replacement of the equipment, the location labels shall not be directly secured to replaceable components. For such assets, the labels shall be installed on a permanent structure as close as possible to the equipment.

For example, the valve label shall not be fixed to the valve body but could be mounted on a suitable bracket on the valve flange or valve-supporting plinth, except in the case of small valves where a hanging label fixed with stainless steel wire is acceptable.

When labels are fitted close to access covers, they must be visible with the cover in both open and closed positions.

The labels for electrical equipment within cubicles shall be on the mounting plate. Attaching labels to cable trays and other removable parts is not acceptable.

All inscriptions on the labels shall be visible from the ground or a level platform.

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If Contractor is in doubt on location of an asset label, communication between the Principal and the Contractor shall take place for a confirmation on exact location before printing.

## 5.6 Examples of Labelling

Facility Number	SP1139 (for example)
Description of asset	Inlet Penstock
Location Number allocated by Maximo	SP1139PEN01
Location Number in the drawings	PEN01 (exclude facility no.)

Field Label

PEN01
INLET PENSTOCK

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## Exemptions to labelling rules

- a) Where labeling requirements are specifically stated in the Principal approved drawing/s, Contractor shall comply with such instructions instead of the labeling requirements under this clause.
- b) Under special circumstances, for example, where locations belonging to two facilities are physically in close proximity to each other or where a location is remote from the parent facility, the Principal may request the Contractor to include the facility number in the labels. e.g. SP1139PEN01 instead of PEN01

Field Label Example

SP1139PEN01
INLET PENSTOCK

- c) for specific assets including High Voltage assets, sewer gauges and vacuum sewerage systems, reference to these rules will be referred to Asset Numbering guidelines and procedures
- d) the Contractor is uncertain of labelling requirements, clarifications should be sought from the Principal.

## 5.7 Survey Datum Marks

During construction of wet wells Survey Datum reference marks with labels shall be installed on the wet well roof slab, on the top of the inlet maintenance hole, on top of emergency storage tank and wherever else level measuring instruments and/or switches are installed.

Sitting of survey reference marks and labels shall be as close as possible to the instruments as follow:

- Wet Well – on the roof slab adjacent to the instrument access hatch.
- IMH – on the rim of the MH above the instruments.
- Storage Chambers – on the roof slab adjacent to the instrument access hatch.
- The reference mark label shall clearly indicate the reduced level and datum e.g. RL 123.45 AHD.

## 5.8 MGA coordinate

For all WAC MGA submissions should follow the design criteria as per the current WSAA codes.

## 6 Operational and Maintenance Manuals

The requirements for the Treatment Plants are different from that of the network facilities like pumping stations and reservoirs. Detailed requirements are specified in Sections 6.2 & 6.3 below.

### 6.1 Type of O&M Manuals

O & M Manuals can be prepared at Process Level, Area Level or Equipment / Asset Level. Depending on the Contract, the Contractor shall discuss and agree with the Principal on the type/s of O & M Manuals required. Each manual shall have a content page indicating the chapters and corresponding page numbers.

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## O&M Manuals (Applicable to WWTPs, WFPs & WRP only)

Deliverables submitted;

<b>Hard Copies</b>	1 hard copies of the Manuals A4 hard copy in 3 ring folder
<b>Electronic copies (CD-R/DVD/USB)</b>	1 electronic copy of the Manual on CD-R/DVD/USB

These PDF documents will then be considered into one PDF file, with PDF bookmarks (destination set) for each section and headings in the content page to create one O&M Manual.

The typing shall be prepared using MS Word. The collection of documents that make up the manual shall be converted to PDF format using the print command.

- a) The Manuals shall contain sufficient information on the specification, installation and maintenance of the equipment supplied, installed, or modified under the Contract. The Manuals shall be supplied to the Principal prior to handover of the assets. Delivery of the assets under the Contract will not be considered complete until all Manuals and required copies are supplied by the Contractor and accepted by the Principal.
- b) Each copy of the Manual shall be adequately bound or contained in a three-ring, hard cover binder, with the equipment and plant identification permanently marked on the outside cover. Each page shall be numbered. The page format shall be A4 (or A3/A4 for drawings as approved by the Principal), and printed in a clear typeface with a 35 mm margin for binding. Alternative methods of binding and page size format may be submitted, but acceptance of these will be subject to the approval of the Principal.
- c) The contents shall be presented as follows (alternative compilation will be subject to approval):
  - Title Sheet - containing:
    - i. Name of the Plant;
    - ii. Contract Details;
    - iii. Name of Supplier;
    - iv. Address and Telephone Numbers for Service Calls.
- d) The information to be supplied in each Chapter shall be as follows (where applicable):

Contents

Chapter 1: Description - A full description of the equipment type (engineering description for example Centrifugal pump), with a tabulation of dimensions and performance ratings.

Chapter 2: Technical Data - A copy of the Technical Data Sheet including make, model, size & serial number supplied by the manufacturer; reliability data (MTBF, MTTR, Reliability Block Diagram and MTBR– for replaceable assets) shall be provided for each equipment type supplied by the Contractor. Attach a copy of FMECA if carried out by the Contractor.

Chapter 3: Principles of Operation - A basic working description, including novel features and any automatic control.

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- Chapter 4: Operating Instructions - A step-by-step procedure organised into sections entitled:
- 4.4.1.1.1.1 Checks before Starting;
  - 4.4.1.1.1.2 Starting;
  - 4.4.1.1.1.3 Continuous Operation;
  - 4.4.1.1.1.4 Stopping;
  - 4.4.1.1.1.5 Emergency Stopping;
  - 4.4.1.1.1.6 Abnormal Operation as applicable.
- Chapter 5: Installation and Commissioning Instructions - Details of Standards and procedures for mounting or erecting, wiring and lubricating the equipment. The commissioning instructions shall include step-by-step procedures for checks before the first start, first start, after starting and operational tests. They should be co-ordinated with Chapters 3 and 8 and may refer to both.
- Chapter 6 Maintenance Plans (Preventive Maintenance) Step-by-step procedure for preventative maintenance work to be carried out at various intervals, supported by FMECA, if available. (eg. two weeks, four weeks, six weeks etc;) Procedure should also clearly indicate replacements of consumables where necessary and the labour-hours required for each activity.
- Chapter 7: Maintenance Plans (Overhaul / Major Periodic Maintenance) Step-by-step procedures for fault finding and correction and for overhauling (major periodic maintenance) involving parts other than consumables. A list of necessary special tools should be included. Indicate Design Life.
- Chapter 8: Test Data, Inspection Results (eg Test Sheets, FAT, SAT etc) and Troubleshooting -- Instructions to qualified tradesman for assessing the operational performance of the equipment and system.
- Chapter 9: Parts List and Recommended Spares - Illustrations and schedules for identification and specifications for all items in the equipment. Exploded diagrams are required, if available. The recommended spare parts stock must be indicated.

## Appendices

### Notes:

The information in Chapters 1 to 5 must be included for each item supplied, while the extent of information in Chapters 6 to 9 may vary with the complexity of the equipment. The text shall be in English and easily understood by plant operators and fitters. Information irrelevant to the equipment supplied in the Contract shall not be included in the Manual.

The PDF Version of the manual shall have bookmarks for each chapter with major headings. The bookmark shall include the reference number and description. Documents that are locked

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and cannot be included into a single PDF document shall be scanned at 250dpi, saved as jpeg with maximum compression. This document shall then be included into the single PDF document. When converting documents to PDF use the print command and select the PDF printer. This will automatically create the “Bookmarks” while converting other formatted documents to PDF. When collating various documents into a single PDF document use the Acrobat “Combine Files into PDF Command”.

Advertising brochures and catalogues are not acceptable. Remove all pages not associated with the equipment installed.

All electronic files should be in “Vector” format (not scanned) if possible. Some signed documents will need to be in “Raster”. Documents in “Raster” that are available in “vector” format are not locked for collating and will be rejected.

Equipment such as cable connectors, lamp holders, non-repairable equipment or items that are readily available at the local electrical equipment supplier, **are not required in the O&M Manual.**

## 6.2 O&M Manuals (Applicable to all facilities other than WWTPs, WFPs & WRPs)

Deliverables submitted:

<b>Hard Copies</b>	1 hard copies of the Manuals in A4 with 3 ring folder
<b>Electronic copies (CD-R/DVD/USB)</b>	1 electronic copy of the Manual on CD-R/DVD/USB using MS Word (preferred)

When a combination of different software is used or where there are several components / pages of PDF documents forming one O & M Manual, the document shall be consolidated into one PDF file, with bookmarks for each section in the content page. PDF Version of the manual shall have bookmarks for each chapter and each major heading. The bookmark shall include the reference number and description. All electronic files should be in “Vector” format (not scanned) if possible. Operation and Maintenance instructions that are of a general nature are not acceptable.

Documents that are locked and cannot be included into a single PDF document shall be scanned at 250dpi, saved as jpeg with maximum compression. This document shall then be included into the single PDF document.

Advertising brochures and catalogues are not acceptable. All pages not associated with the equipment installed will be removed.

Operation and maintenance information for each of the following asset types shall be included in the O&M Manual. O&M Manuals shall also be supplied for any additional asset, if it is specified.

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- Operation and maintenance of the pumping station.
- Pump and motor
- Control equipment
- Specialised equipment
- Odour Control Unit
- Chemical Dosing Unit
- Power Generating Equipment
- Cranes and Hoists
- Ventilation systems

Ensure that the O&M Manual specifies the assets that are installed and used **within the facility ONLY**, do not include manufactures specifications for all equipment's with the company's product list as this will be rejected by the Principal.

Chemical Dosing and Odour Control units shall be treated as standalone and the O&M manual for them will be separate to the one supplied for the pumping station.

The contents of the O&M Manual shall be in accordance with 6.1 a), b) and c) above.

### 6.3 Manufacturer's Instructions Manuals

The Contractor shall supply manufacturer's instruction manuals if available for each asset installed or key component of an asset. Examples of key components include PLCs, Motors, Gear boxes etc. Items such as connectors, lamp holders and contactors are not regarded as key assets or key components.

The manufacturer's instruction manuals shall be included as appendices to the relevant O&M manual. Refer to Clause 6.1 d) on how to produce a consolidated O & M Manual.

## 7 Testing and Commissioning

### 7.1 General

Commissioning is the process of firstly checking the performance of individual elements of the new works and then the checking and tuning of the system as a whole in order to bring the works into service.

Commissioning should proceed in accordance with the Contractor's "Testing and Commissioning Plan" that has been reviewed and approved by the Principal. During the process of review of the Commissioning Plan, the Principal will nominate the inspections and tests that will be witnessed by the Principal. This will allow all parties to be aware of the proposed transition methodology, where applicable.

The Contractor shall be responsible for the commissioning of the entire works. The Contractor shall be responsible to test, calibrate and fine-tune all instrumentation, protective devices and all field equipment to put the whole works into automatic operation. The commissioning of the plant shall include all possible modes of operation including emergency situations such as power failures, control failures etc.

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The commissioning shall demonstrate that all guaranteed performance criteria have been met for individual equipment as well as the complete system during:

- i. normal operating condition
- ii. extreme operating condition, where possible
- iii. fault condition
- iv. alarm condition
- v. power failure condition

The Contractor shall ensure all equipment is correctly installed and connected including conduits, pits, cables, labels, wire numbers, etc. before the Principal is requested in writing to inspect and witness the operational performance of the complete installation.

During the period of testing and commissioning, the Contractor shall have on-site technical personnel specialising in the various aspects of the Contract (i.e. pumps and motors, control systems, instrumentation, software development, etc.)

The Contractor shall be responsible for the testing and operation of all circuits, adjustment of switches, relays, timers, etc. to ensure the correct functioning of all equipment installed under the Contract. The Principal will determine correct settings, etc. during the commissioning of the work.

Before testing the complete installation the Contractor shall carry out insulation, continuity and operational tests on the electrical equipment and services installed under the Contract.

The Principal will witness selected commissioning tests and the Contractor shall assist the Principal's staff to witness the testing.

Equipment will only be accepted after satisfactory completion of testing and meeting the operational requirements. If any test is unsuccessful, the equipment shall be repaired as appropriate and shall be re-tested until successful.

Refer to IMS0035 Water and Waste Water Asset Data Management & Commissioning in providing instruction on how to manage asset data and commission new or modified assets or systems to bring them into normal plant operation mode.

## 7.2 Commissioning Process

The Testing and Commissioning shall be carried in the following order:

- Contractor provides Commissioning Plan showing the "Scheduled Dates for Testing and Commissioning" for review and acceptance by the Principal.
- Contractor provides Factory Acceptance Tests (FAT), Preliminary Site Acceptance test (Pre-SAT) and Site Acceptance Test (SAT) formats to the Principal and obtains approval.
- Contractor provides written notification to the Principal of the proposed commencement of the Preliminary Factory Acceptance Tests (Pre-FAT) and Factory Acceptance Test (FAT), where applicable.
- Contractor provides testing equipment calibration documentation, Drawings and Operations and Maintenance Manuals.
- Where applicable, the Contractor completes all Pre-FATs requirements and at the same time completes the "Pre-FAT Test Results Record Sheets".

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- Contactor completes FAT and submits the completed “Pre-FAT Test Results Record Sheets” and “FAT Test Results Record Sheets” to the Principal.
- The Contractor delivers and installs the equipment on site after the Principal has accepted the Pre-FAT and FAT results and has approved the delivery and installation.
- Contractor provides written notification to the Principal of the proposed commencement of the Pre-SAT and SAT.
- Contractor provides updated Drawings and Operations and Maintenance Manuals.
- Contractor arranges and meets with the Principal at least 5 working days prior to Pre-SAT and SAT. At the meeting the proposed commissioning methodology and site-specific issues including Operator and Maintainer training plans shall be discussed.
- Contractor completes all Pre-SATs and the “Pre SAT Test Results Record Sheets” and submits the “Pre-SAT Test Results Record Sheets”. The Principal will advise the Contractor of the acceptance or otherwise of the Pre-SAT results.
- Contractor provides all relevant information and confirms date for the SAT.
- Contractor completes all SAT and submits the “SAT Test Results Record Sheets”. The Principal will advise the Contractor of the acceptance or otherwise of the SAT results.
- Contractor modifies the FMECA carried out at Design Stage by incorporating all the as built assets. (Only required when as built assets differ from those in the original design)
- Operator and maintainer training plan and obtained acceptance from the Principal.
- Contractor handover of final Operations and Maintenance Manual, Work-As-Constructed Drawings and any other documentation to Principal, after submission of test results.
- Contractor carries out Operator and Maintainer training.

### 7.3 Commissioning Plan and Testing

The Contractor shall be responsible for arranging and conducting all tests to demonstrate compliance with the requirements of the Contract.

The Designer shall prepare a “Commissioning Plan” (Prepared by Designer-see clause 1.2.2 Commissioning Plan) to cover all aspects of factory testing, site testing, Operator and Maintainer training and commissioning. The “Commissioning Plan” may be of any format to suit the Contractor. Where a Commissioning Plan has been prepared under Clause 1.2.2, the Contractor shall amplify on the original plans and ITPs to comply with this Clause. It shall include detailed testing procedures, commissioning procedures and test check sheets. Site tests shall include testing of the equipment supplied under the Contract under all operating modes and shall fully test all equipment, systems, controls and procedures supplied, developed or installed as part of the Contract. The commissioning trials shall demonstrate that all sections of the work are fully operational and that the guaranteed performance criteria have been met.

The “Commissioning Plan” shall be given to, and fully discussed with, the Principal at least 20 working days before testing is due to commence. The program and schedule of tests may require modification to integrate with other elements of the Principal’s system.

With the submission of the “Commissioning Plan” under this clause, the Contractor shall include the proposed Acceptance Criteria for all tests and commissioning and undertake a review of the criteria with the Principal.

After agreement with the Principal, the Contractor shall provide two sets of detailed testing, pre-commissioning and commissioning instructions together with an agreed program.

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Testing shall consist of four formal tests:

- Preliminary Factory Acceptance Tests (Pre-FAT) supplied by the Contractor
- Factory Acceptance Test (FAT) supplied by the Contractor,
- Preliminary Site Acceptance Tests (Pre-SAT) supplied by the Principal (Pre SAT forms) and
- Site Acceptance Test (SAT) supplied by the Principal (SAT forms).

The Principal shall be notified 10 working days before each of these test are to commence so that the Principal can be present to witness the testing.

The Contractor shall provide all expertise, labour, materials and test equipment required for testing and commissioning. All test equipment shall have been checked for calibration prior to tests. Calibration documentation shall be made available for Principal's inspection.

The Contractor shall have available a complete set of spare parts for minor items, such as, relays, lamps, contractor coils, etc. so that the testing process is not delayed due to the failure of such items.

The Principal shall have the right to witness any tests and inspect any equipment at any stage of the Contract to confirm progress and conformance. This may involve re-testing if considered warranted by the Principal. This shall not relieve the Contractor of any responsibility to ensure proper operation.

#### **7.4 Scheduled Dates for Testing and Commissioning**

The Contractor shall submit a "Scheduled Dates for Testing and Commissioning" and provide updates to the Commissioning Plan when changes occur.

The plan shall allow sufficient time for testing (including Pre-FAT and Pre-SAT), and if necessary re-testing of equipment and fit in with the overall project completion time. The plan shall take into consideration the Contractor's experience obtained from previous sites of a similar type and complexity. The Principal may defer the scheduled dates if the Contractor is considered not sufficiently well prepared for the tests.

The Commissioning Plan shall show commencement and completion date and times and the number of personnel present for the FAT and the SAT.

When scheduled dates for commissioning and testing are cancelled or not utilised as planned by the Contractor, the Contractor shall pay to the Principal all costs due to the non-utilisation (as programmed) of the scheduled dates. These costs will include:

- the cost of arranging the cancellation and/or alteration;
- the cost of the cancellation and/or non-utilisation;
- the cost of arranging a substitute scheduled date and
- any other costs associated with the cancellation and/or non-utilisation.

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As the cost of cancellation varies dependent upon the amount of notification of the cancellation the costs vary commensurately.

## 7.5 Testing

### 7.5.1 Pre- Factory Acceptance Testing (for electrical equipment)

A Pre-FAT shall be carried out when:

- manufacturing is complete;
- the system or sub-system is fully assembled;
- the assembly is ready for transportation to site and
- calibration sheets are complete and available.

The Pre-FAT shall be carried out at the manufacturer's works by the Contractor and prior to a FAT. This is intended to check the scope of work and minimise the amount of time required to complete the FAT by eliminating wiring, labelling, workmanship and equipment functionality problems. Some Pre-FATs may be repeated during the FAT to verify correctness of the results. The Contractor shall supply the "Pre-FAT Test Result Record Sheets" and they shall detail all tests required during Pre-FAT.

The Principal will not normally witness the Pre-FAT, however, but shall have the right to do so.

The copies of the "Pre-FAT Test Results Record Sheets" shall be submitted prior to commencement of the FAT for approval. Each test shall be dated and signed off by two representative of the Contractor.

The Pre-FATs shall itemise and cover all tests associated with the following:

- completeness of work;
- labelling and wiring;
- all work complies with relevant standards and workmanship;
- compliance with the IICATS I&C Standards Manual;
- correctness of drawing/equipment;
- equipment rating, eg. circuit breakers, etc.;
- firmness of equipment and
- set overloads, soft starter / variable speed parameters; Note the Contractor shall supply a full set of variable speed parameters in a spreadsheet including a listing of all those that have been left untouched and left as factory set (for future reference, Also any software and tools required to alter the VSDs.
- Functional operations of switches, circuit breakers, push buttons, drives, PLC / RTU inputs and outputs etc.

### 7.5.2 Factory Acceptance Testing

As a minimum, all electrical panels, cabinets and kiosks shall be factory inspected and tested (FAT). Other equipment that requires factory acceptance testing along with the type of test maybe specified in the contract, needs specification or concept design document.

#### 7.5.2.1 General

A FAT shall be carried out when:

- All Pre-FAT's have been successfully completed;

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- Operation and maintenance manuals are complete;
- An updated set of all drawings are available;

The “Pre-FAT Test Results Record Sheets” are completed and recorded by the Contractor. The FAT shall be carried out at the manufacturer’s works.

At least 10 days’ notice or 90 days (for international attendance) shall be given for a proposed FAT. The Contractor shall complete all test detailed on the “FAT Test Result Record Sheets”. Each test shall be dated and signed off by the Contractor.

During the FAT the Principal may issue Non Conformance Reports (NCR)/ Action Requests (AR). These will indicate that equipment or the procedure does not conform to the Contract or relevant standard. In this case, the Contractor shall modify and re-test the system. This process shall be repeated until the test is successful. The Principal shall determine whether re-testing can be carried out as part of the current FAT or re-scheduled to another date. The Contractor shall sign all NCR/AR.

At the conclusion of the FAT and after all NCR/AR are cleared and approval given by the Principal, the equipment shall be delivered and installed on site.

#### 7.5.2.2 Hydrostatic Testing of Pumps

All pump casings, after machining, shall be subject to a hydrostatic test at the manufacturer’s works by the Contractor. Alternatively, the hydrostatic tests may be carried out after the pump has been assembled.

The total test pressure shall be 1.5 times the sum of pump maximum shut off head and maximum suction head. The use of long bolts or other similar apparatus extending through the pump casing to seal off the suction, discharge, shaft or other openings during the test shall not be permitted.

The pressure shall be sustained for at least two hours. During the hydrostatic test, there shall be no visible leakage through the shaft seals or any other part of the casing. The exterior of the casing shall remain completely dry and there shall be no visible deformation or distortion of the casing or other pump components.

The Contractor shall replace all casing or parts found defective or unsound in any respect under this test at no cost to the Principal.

#### 7.5.2.3 Performance Testing of Pumps

Pumps shall be witness works performance tested with their respective motors and starters (or variable speed drives, if supplied) at the manufacturer’s /works by the Contractor in accordance with AS 2417 – 2001: “Rotodynamic pumps – Hydraulic performance acceptance tests – Grades 1 and 2”. Grade 1 tolerance factors shall be adopted for pumps driven by motors 50kW or larger, and Grade 2 for pumps with motors smaller than 50kW. The Manufacturer / Contractor shall provide all materials, equipment (including test starters if not supplied with the pumps) and labour for the works tests.

Unless stated otherwise, the performance tests shall include pump capacity (Q), head (H), net positive suction head required (NPSHr) and overall efficiency ( $\eta_{O/A}$ ). The overall efficiency

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guarantee shall include pump, motor and starter or, if supplied, variable speed drive losses. Acceptance of NPSHr tests shall be based on satisfying the stated NPSHr at 3% head drop, i.e. "NPSH3", at the pump minimum head / maximum flow duty point. The NPSHr tests will include a minimum of three tests, ie one at this duty point and one on either side of it, to confirm the trending of the NPSHr curve.

#### **7.5.2.4 Performance Testing- Factory, General (applicable to all assets including pumps)**

The tests carried out at the manufacturer's works shall form the basis of the Factory Acceptance Tests for assets / equipment supplied under the Contract. Test certificates and performance curves shall be provided for each test.

Should any defect show up or develop, or the capacity, efficiency or net positive suction head required fall short of that guaranteed, the Contractor shall, within a reasonable period, make good such defects at his own expense. If the Contractor does not carry out the necessary corrective work, the Principal may reject the complete unit or reduce the payment. If the unit is rejected, the Contractor shall refund any payments already made.

#### **7.5.2.5 Bearing Tests**

In conjunction with the performance tests, the Contractor shall continuously record bearing housings temperatures while operating at the most adversely loading conditions. The test should be conducted for a minimum of four hours and until the temperatures have peaked and stabilised relative to the ambient temperature for a period of at least one hour. The bearing housings temperatures, after adjustment for an ambient temperature of 45°C, shall not exceed the maximum bearing temperature stated by the equipment manufacturers. These tests shall be repeated on site for final acceptance.

#### **7.5.2.6 Vibration Tests**

Preliminary vibration tests are to be undertaken at the manufacturer's works during performance tests and repeated on site for final acceptance. The vibration tests shall be conducted and evaluated in accordance with the relevant Australian Standard.

#### **7.5.2.7 Noise Tests**

Preliminary noise tests shall also be undertaken at the manufacturer's works during performance tests and repeated on site for final acceptance. The preliminary noise tests shall identify any obvious noisy operating condition within the asset / equipment operating range. The obtained data are to be evaluated and translated to defined site noise performance conditions. The equipment shall only be delivered to site if the above evaluation indicates that the specified site noise levels will be achieved.

#### **7.5.2.8 Testing of Valves, Pipes and Fittings**

All valves, pipes and fittings shall be subject to hydrostatic and leakage acceptance tests and all other production and batch release tests as specified in the relevant standards at the manufacturer's works. The valves shall also be supplied with Type Test Certificates. The tests shall be carried out in accordance with relevant Australian Standards.

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### 7.5.2.9 Testing of Electrical Control Equipment

The FAT shall be a fully simulated test of all operating hardwired functions. External equipment shall be connected to simulate actual field devices, eg switches, signal generators, etc. The FAT shall cover as much of the hardwired operational system of the site as practicable.

Where applicable, the Contractor shall download a test program, provided by the Principal, to the RTU and PLC. The Contractor shall use these programs to test the integrity of the RTU and PLC. This is part of the FAT and the results shall be recorded on the "FAT Test Results Record Sheets". The Principal will free issue the PLC / RTU programming software for use on this Contract, where applicable. The Contractor shall purchase the PLC / RTU hardware, PC or laptop and PLC programming software.

Where applicable, RTU may be supplied by the Principal. If the RTU supplied by the Principal is found to be faulty the Contractor shall record the nature of the failure and notify the Principal. The Contractor shall return the RTU to the Principal. The Principal will then provide a new RTU. Tests shall be repeated when a replacement RTU is installed.

Any drawing changes resulting from the FAT shall be recorded and incorporated into the next drawing issue. The copies of the "FAT Test Results Record Sheets" shall be submitted for approval at the conclusion of the FAT.

The FATs shall itemise and perform all tests associated with the installed assets and shall include the following:

- continuity tests;
- insulation test;
- 24 V DC output;
- three phase power up tests;
- hardwired status indication, control, interlocks and logic functions;
- RTU/PLC digital and analogue signals for all I/Os;
- Soft starter / variable speed drive checks in manual operation and parameter setting;
- GPO, panel light and panel cooling fans;
- simulate and check all analogue signals indicators and generation;
- noise test;
- instrument test to prove calibration, accuracy, repeatability, hysteresis checks, etc.;
- analogue loop tests;
- running the RTU/PLC test program. This shall include testing digital inputs/outputs, analogue inputs/outputs and the five communication ports on the RTU and
- point to point operations test.

### 7.5.2.10 Testing of Electrical Switchboards

The following requirements apply for the power supply/main distribution board, motor starters etc.

- a) The switchgear shall be tested in accordance with the requirements of the appropriate Australian Standards and as required by authorities having jurisdiction, such as the Supply Authority.
- b) As a minimum, tests shall include:
  - i. insulation resistance,
  - ii. power frequency voltage withstand,

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- iii. resistance of primary circuits and earthing circuits, including busbars, switching devices and earthing switches,
  - iv. verification of correct wiring,
  - v. mechanical operation of all switch devices and interlocks,
  - vi. verification of instrument and control transformer ratios, polarities and connections,
  - vii. magnetising curves of current transformers,
  - viii. measurement of partial discharges of CTs and VTs,
  - ix. functional tests of control and protection circuits, including tests at the stated limits of control and auxiliary supply voltages,
  - x. accuracy check of meters and transducers, at 25%, 50%, 75% and 100% of full scale, minimum,
  - xi. performance checks of protection relays at a minimum of four points on the operating curve, including pick-up,
  - xii. verification of correct functioning of all ancillary devices and equipment such as slow-close levers, manual spring charging devices, test leads, earthing equipment, wear gauges.
- c) Primary injection shall be used to verify the correct polarity and ratio of each protection current transformer and the operation of the associated protective relay(s) for at least one current. Testing for verifying the protective relays' calibrations at other currents shall be secondary injection testing.
- d) Primary injection tests shall be performed on each metering current transformer and its associated meter(s) or transducer(s). As a minimum, these tests shall be performed at one half and at full-scale values.

Note: If, due to limitations of test equipment, a phase-controlled 3-phase current test source is not readily available, 3-phase meters and transducers may be tested using single-phase current sources.

#### 7.5.2.11 Testing of Electrical Motors

Each motor shall be routine tested strictly in accordance with AS1359.101 and any subsequent amendments.

### 7.5.3 Pre Site Acceptance Testing

This clause is applicable to all assets / equipment procured under the Contract, as per the Forms supplied by the Principal.

#### 7.5.3.1 General

Pre-SAT is the activity of verifying the individual components of the assets meet their specification and performance requirements in preparation of plant and equipment for Site Acceptance Tasting and subsequent operation.

Pre-SAT shall be conducted in a logical sequence in accordance with the approved Commissioning Plan.

A Pre-SAT shall be carried out when:

- all equipment has been installed and ready for dry / wet testing;
- point to point wiring checks completed;
- the new switchboard has been connected to the power supply (if feasible);
- all new equipment, that will not interfere with the operation of existing equipment, has been connected;

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- the site is ready for disconnection of the old equipment and connection of the remaining new equipment;
- all preparation work and notifications are complete;
- the new RTU is connected to the communication network via the MDF and is ready to be connected to IICATS and put into operation. This will require the communications service provider to terminate and connect the lead-in cable (if feasible);
- all documentation has been provided and available on site;
- calibration sheets are complete and available on site and
- SCADA programming & I/O testing has been completed.

The Pre-SAT is intended to minimise the amount of time required to complete the SAT by checking the scope of works and preliminary testing of wiring and eliminating workmanship or equipment functional problems.

The Principal will witness the activities nominated in the Commissioning Plan and any other activities deemed necessary.

The “Pre-SAT Test Result Record Sheets” will detail all checks and tests required during Pre-SAT. The Contractor shall complete these sheets during Pre-SAT and submit to the Principal at the completion of the Pre-SAT for approval. Each test shall be dated and signed off by the Contractor and the Principal.

The copies of the completed “Pre-SAT Test Results Record Sheets” shall be submitted at the conclusion of the Pre-SAT.

The Pre-SAT’s shall itemise and cover all tests associated with the following:

- completeness of installation work / part of installation;
- conformance and performance testing of equipment to specification;
- protective coatings and repair work when necessary;
- pressure testing of pipe work;
- noise tests;
- electrical continuity;
- dry run functional tests;
- wet-run functional tests;
- simulated fault condition tests;
- equipment is correctly labeled;
- direction of rotation of rotating equipment;
- clearance end play and operation of major bearings;
- set and calibrate protection devices, instruments, safety interlocks, emergency stops, field equipment etc;
- alignment of drive systems;
- control System of PLC / RTU logic test and
- performance testing

#### 7.5.2.2 Power and IICATS/SCADA Tests

The following tests shall be carried out during the Pre-SAT stage:

The Contractor shall re-test some items that have been tested during the FAT. This will provide a confidence check to establish assurance that critical components are still operational and

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that equipment operation has not been altered during transport. All of these FAT tests shall be repeated on all the sites.

The Principal will carry out IICATS Telemetry and picture testing. The IICATS site-commissioning engineer will be in verbal contact (mobile phone) with a remote IICATS workstation operator (IICATS Commissioning Technical Support Officer) during these tests. The Contractor shall assist and make allowance for this time in his schedule and necessary modifications to the RTU/PLC software.

#### 7.5.2.3 Pipework Hydrostatic Tests

No work shall be backfilled, covered or concealed until it has been inspected and tested. Pipe joints and structures shall be exposed to enable observation during hydrostatic tests.

Pipelines shall be tested for leakage and defects in the pipes, joints, fittings, valves and thrust blocks. The test shall be carried out in sections as soon as practicable after each section has been laid, jointed and cleaned and not earlier than seven days after the last concrete thrust block in the section has been cast unless suitable strutting and bracing is installed to take the thrust. Solvent cement joints shall be cured for at least 24 hours before testing.

In order to achieve stable testing conditions, the pipe section to be tested shall be filled slowly with water, ensuring all air is expelled and allowing for absorption. The section shall be kept full of water for 24 hours prior to the commencement of the pressure testing. During pressure testing of a pipeline each isolation valve shall sustain the full pressure on one side of the valve with no pressure on the other side.

The Contractor must ensure that all pipe components under test (including thrust blocks) have rated pressure or manufacturers recommended maximum test pressure above the hydrostatic test pressure. The test report is to be supplied to the Principal.

Any defects found during the hydrostatic testing shall be repaired by the Contractor at his own cost and the test repeated until the Principal is satisfied that the whole work is watertight and sound.

Pipework shall be tested in accordance with relevant Australian Standards. The test pressure for all pipework shall be the design pressure plus 25%. The design pressure for pumping station discharge pipework and pressure mains shall be the larger of the pump shut-off head plus the maximum head at pump suction and the maximum pressure determined by water hammer analysis. For all other pipework the design pressure shall be the larger of the maximum head and the maximum pressure determined by water hammer analysis.

The pipe work shall be deemed tested when the test pressure has been maintained for two hours without topping up and there is no visible leakage or sweating or pressure drop. Test certificates are to be supplied by the Contractor.

#### 7.5.2.4 Pump Performance Tests – On site

After completing the individual equipment tests at the site, the Contractor shall test each pumping unit in the manual mode of operation. Only after individual pumping units are proved to be operating satisfactorily in the manual mode shall the pumping unit be allowed to be tested in other modes of operation. Prior to IICATS/SCADA operated testing, the Contractor

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shall have calibrated all equipment, including starters, VSDs, operating level sensors and protective devices. The testing shall include the checking of all the signals that are required to be sent to the IICATS/SCADA System.

The Contractor is required to carry out performance testing of the pumps installed under the Contract to verify that each unit, running at the stated speed and operating against the stated head, provides a continuous net output which is not less than the output specified in the Contract. Details of these pump performance tests are to be incorporated in the final pumping station O&M Manuals.

The site tests shall confirm that the pumps in situ performances agree with the works tests and guarantees. Unless stated otherwise, the test shall include pump capacity (Q), head (H), overall efficiency ( $\eta_{O/A}$ ), noise and vibration. In case of any major discrepancy the Contractor shall investigate the reasons and make every effort to rectify the defect within a reasonable period and at his own expense.

The site pump performance tests shall include bearing temperature rise and vibration tests. The tests shall also be conducted for the most adversely loading conditions.

The Principal reserves the right to carry out on-site tests jointly with the Contractor.

#### 7.5.2.5 Crane Tests

Cranes shall be tested and commissioned in accordance with AS1418.3. Prior to the testing, the crane shall be inspected in accordance with AS 1418.1. Following testing a Work Cover Certificate will have to be obtained for the lifting device and provided to the Principal.

#### 7.5.2.6 Noise Tests

The Contractor shall conduct noise tests on all individual equipment installed and the complete plant carried out under full operational load. The noise tests shall be conducted under the noisiest loading conditions within the defined operating range. The sound pressure level shall be measured with a precision sound level meter conforming to AS1259. All measurements to be carried out and certified by trained personnel with currently N.A.T.A. calibrated equipment and shall conform to the requirements of the Contract. The measured data shall be supplied in Sound Pressure Levels (SPL) and Sound Power Levels (SWL) – refer to table below – Noise Analysis Data sheet.

The Contractor shall supply full details of the test procedure, conditions and standards used. The Contractor shall enter the results of the above tests in a “NOISE ANALYSIS, Data Sheet” which shall be included in the commissioning records.

#### Noise Analysis – Data sheet

<b>NOISE ANALYSIS – DATA SHEET Description</b>	<b>dB(A) <math>L_{Aeq}</math></b>	<b>63 Hz</b>	<b>125 Hz</b>	<b>250Hz</b>	<b>500Hz</b>	<b>1kHz</b>	<b>2kHz</b>	<b>4kHz</b>	<b>8kHz</b>

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Sound Pressure Levels (SPL) at 1m (or other – specify)*
Sound Power Levels (SWL)

Standard by which noise measured – AS.....  
 Ambient Noise Levels .....dB(A)  
 Directivity index.....  
 Test description.....  
 Test room condition.....  
 Other information.....

The test results shall be used to verify compliance with both OH&S and environmental noise regulations.

Assets / equipment tested to meet the environmental noise requirements should have an allowance for noise increase with age and wear. This means the maximum acceptable noise level shall be at least 2 dBa below the legal limit.

Assets will not be accepted unless they meet the specified noise levels. When assets fail to meet the required noise levels, the contractor shall take necessary actions to remedy the problems to the satisfaction of the Principal, at no extra cost to the Principal.

**7.5.2.7 Vibration Tests**

The Contractor shall provide results of site vibration tests on all installed equipment. The vibration tests shall be carried out over the full operation range and full operational load and be witnessed by a representative nominated by the Principal. The vibration tests shall be conducted and evaluated in accordance with relevant Australian Standard applicable to newly commissioned assets / equipment. All measurements to be carried out and certified by trained personnel with currently N.A.T.A. calibrated equipment and shall conform to the requirements of the Contract. The Contractor shall supply full details of the test procedure, conditions and standards used.

The Contractor shall enter the results of the above tests in a “VIBRATION ANALYSIS, Data Sheet” which shall be included in the commissioning records.

Note: Onsite vibration testing will not be required for submersible pumps and mixers mounted in a wet wells, reservoirs, storages and channels etc. unless pump has remote monitoring points fitted.

**7.5.2.8 Site Acceptance Testing**

This clause is applicable to all assets / equipment procured under the Contract, as per the Forms supplied by the Principal.

Site Acceptance Testing is running adjustment of plant and equipment, carrying out all necessary adjustments and testing to verify the performance under varying operating conditions. A SAT should be carried out as soon as possible after successful completion of the Pre-SAT and when:

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- all possible scope of works is completed;
- no outstanding major NCRs;
- all parties have been notified and are ready;
- all documentation is available for viewing on site including latest drawings, strategy plans, data sheets, test sheets, calibration certificates, supply authority approvals, site access, contingency plan, etc.;
- operation and maintenance manuals are complete;
- an updated set of all drawings are available;
- the “Pre-SAT Test Results Record Sheets” are completed and approved;
- there is a period of dry weather. SAT’s may have to be postponed, if unexpected wet weather occurs and
- approval has been given to carry out the SAT by the Principal.

At least 10 working days’ notice shall be provided for the proposed SAT. This should allow sufficient time to co-ordinate all relevant parties associated with the SAT. It is expected that a SAT notification will be provided at the same time as a Pre-SAT notification.

Before agreeing to a SAT the Principal may visit the site to confirm its readiness. The Principal will witness the SAT. The Contractor shall arrange and meet with the Principal at least 5 working days prior to a proposed SAT to review the proposed commissioning methodology.

Unless the SAT is carried out immediately after the Pre-SAT, the Contractor shall ensure that critical components are functional, and if required by the Principal, re-test some Pre-SAT results to verify their correctness. If any fault is found, the Principal shall determine whether the SAT can commence or be re-scheduled to another date.

During the SAT the Principal may issue Non Conformance Reports (NCR)/ Action Requests (AR). These will indicate that the equipment does not conform to the Specification or that the correct procedure has not been followed. The Contractor shall sign all NCR. The Contractor shall modify and re-test the system if any test is not approved. This process shall be repeated until the test is successful. The Principal shall determine whether re-testing can be carried out as part of the current SAT or re-scheduled to another date.

No repairs or modifications shall be carried out unless agreed by all parties. Equipment shall not be put into operation unless all tests have been completed and approval is obtained from the Principal.

The Contractor shall supply “SAT Test Result Record Sheets” and complete all tests detailed on the “SAT Test Result Record Sheets”. Each test shall be dated and signed off by the Contractor.

The copies of the completed “SAT Test Results Record Sheets” shall be signed off and submitted for approval at conclusion of the SAT. Any drawing changes resulting from the SAT shall be recorded and incorporated into the Work as Constructed Drawings. The results of each test shall be recorded immediately after the test is performed.

Any tests postponed from the Pre-SAT due to lack of mains power or a new communications line shall be included in the SAT. This includes all tests listed under the Pre-SAT section “Power and IICATS Tests”. The implications that this will have on the transition time and the

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addition risk involved in carrying out these tests during the SAT shall be reflected in the Contractor's transition strategy.

In addition to any tests carried out at the Pre-SAT stage, the Principal will carry out further IICATS Telemetry and picture testing.

The SAT's shall itemise and cover all tests associated with the following:

- tests from the Pre-SAT not carried out at Pre-SAT;
- conformance and performance of equipment to specification;
- IICATS/SCADA telemetry and operations test including instrument range settings;
- IICATS/SCADA /PLC software logic tests;
- normal operational tests;
- testing and commissioning of electrical equipment, instrumentation, control system alarm annunciation, set points etc;
- functional checks and interlocks in control systems for the entire plant;
- calibration of all instruments;
- completeness of entire installation including sub-systems;
- integration of control system with existing system;
- activation of alarms by inducing actual fault conditions (electrical simulation not acceptable);
- two cycle runs of the site under the control of the IICATS RTU /SCADA (normal operation);
- valve operational tests;
- motor circuit analysis (for motors exceeding 30kw)
- noise tests not carried out at Pre-SAT;
- vibration tests not carried out at Pre-SAT;
- abnormal operational tests;
- IICATS /SCADA picture tests;
- IICATS /SCADA alarms, trends/alarms and
- decommissioning check.

## 7.6 Testing and Commissioning Record Sheets

The Contractor shall complete the test check sheets during testing and submit test data for approval. These sheets will be a site-specific document providing a formal comprehensive testing procedure and test record. The Principal will check the test results during formal testing and during various audits. The Contractor will be required to explain any testing or recording inaccuracies and indicate what measures will be put into place to eliminate the problems and prevent re-occurrence.

Separate test results record sheets are to be prepared for and used during Pre-FAT, FAT, Pre-SAT and SAT. Typically, the test results record sheets shall include, but shall not be limited to the following:

- test title, eg. Motor Starter AUTO operation;
- purpose of test, eg. prove operation of fault interlocks;
- test conditions or configuration, eg. Switch in AUTO position;
- description of each test in sequential order;
- expected result on local panel, eg. light on, relay energised;
- expected result on IICATS RTU, eg. LED on;

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- expected result on PLC, eg. LED on;
- acceptance criteria;
- duration of test, eg. 1 minute for soft starter / variable speed drive ramp up;
- comments;
- Pass or Fail and
- sign off by tester, another witness from Contractor's organisation and the Principal.

Typically, separate test sheets shall be provided for the following, where the requirements were specified in the Contract:

- FAT cable test, including insulation test;
- FAT pump performance test to confirm the performance curves, operating points for the pumping station, and the pump duty as specified;
- SAT Confidence Tests;
- FAT/SAT visual check;
- SAT equipment location and completeness check;
- FAT/SAT Instrument Calibration;
- FAT/SAT Analogue Input Test (local analogue testing);
- FAT/SAT Analogue IICATS /SCADA Test (analogue testing via IICATS workstation);
- FAT/SAT Integration Test (RTU and PLC sequence testing);
- FAT/SAT point to point tests;
- SAT hydrostatic tests;
- SAT functional check in manual/auto modes;
- FAT/SAT IICATS /SCADA telemetry check;
- SAT well rising/falling cycle test;
- FAT/SAT Picture Test Record (via IICATS /SCADA workstation);
- FAT/SAT Systemic Test;
- SAT equipment decommissioning checks and
- FAT/SAT documentation check.

## 8 Operational and Maintenance Training

The Operational and Maintenance Training clause is applicable when the requirement of operator and maintainer training are not specified elsewhere in the Contract. This clause does not apply when assets are replaced with like assets.

The Contractor shall train the Principal's nominated staff in the operation and maintenance of the works. The purpose of training is to teach the Principal's Operation and Maintenance personnel all aspects of the operation and maintenance of the works so that these personnel can reliably, effectively and safely operate and maintain the Works under all conditions without supervision, direction or assistance of the Contractor.

The training shall be conducted in a series of programmed half-day sessions attended by up to ten persons per session, prepared, submitted and agreed with the Principal 30 working days prior to commencement of training.

The contractor shall issue to each of the Principal's personnel nominated to attend the training courses a set of classroom training hand-outs containing information that the Contractor consider as necessary to properly train Principal's personnel.

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The Contractor shall be prepared to vary the hours of training to fit in with the availability of Principal's operating and maintenance personnel.

The Contractor will be responsible to confirm, in writing, that all the Principal's personnel who attend the training have demonstrated the required degree of competence.

## 9 Handover of Assets

Handover will normally occur after commissioning of the plant. Site works remain the responsibility of the Contractor until the Completion of Contract.

The conditions for Handover are:

- successful completion of Pre-FAT, FAT, Pre-SAT and SAT and approval of all test sheets;
- all NCRs resulting from FAT and SAT have been rectified and signed off by the Principal;
- removal of redundant equipment and restoration of the site;
- all redundant cables be removed. Where it is impractical, cost prohibitive or unsafe to remove all or a part of the cable, the cable needs to be made safe in accordance with *Technical Specification Part 3 – Electrical*.
- submission and approval of final Work As Constructed drawings;
- submission of WAC – Needs Specification (where applicable);
- submission of the design report (where applicable);
- issue of all tests and calibration certificates;
- submission of as built FMECA and Reliability Block Diagram for the assets.
- Verification Certificate issued by Principal advising Asset Information is complete;
- submission and approval of final Operations and Maintenance Manuals;
- submission of HYDRA data sheets (where applicable);
- submission of Environmental records;
- submission of Community relations records;
- submission of software programs and documentation;
- submission of UPGs and SOPs;
- submission of any other relevant documents;
- satisfactory completion of operator and maintainer training; (including technical and trades personnel) and
- closure of all items in omissions and major defects list.

**(The following paragraphs apply to Developer funded works only.)**

Handover can take place when:

- a) the execution of the work specified in the Concept Design /Needs Specification is completed with the exception of minor non- conformance that:
  - do not prevent the Works from being reasonably capable of being used for their stated purpose; and
  - the Sydney Water determines the Developer has reasonable grounds for not promptly rectifying and the rectification of which will not prejudice the convenient use of the Works; and

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- b) those tests required in the Needs Specification and Designers Commissioning program have been carried out and accepted as satisfactory by Sydney Water; and
- c) those documents and other information required under the Needs Specification, which the Sydney Water considers are essential for the use, operation and maintenance of the Works, have been supplied; and
- d) The developer has lodged the required bond for the Defect Liability Period.

As soon as Sydney Water accepts the Project Completion Package that includes the above items, the Developer will be advised of the transfer of ownership (or “Handover”) of the Works from the Developer to Sydney Water. (In accordance with the Developer Agreement, the transfer of ownership to Sydney Water will not relieve the Developer of the obligation to rectify and defects during the defect liability period.

## 10 Handover of Documents

Requirements for submission of electronic copies are specified in Clauses 2 and 6 of this document.

All other documents supplied in electronic formats shall conform to the following

- each document shall be supplied as a single file. Where documents are made of several files, they are to be made into a single consolidated file.
- documents shall not contain links to other documents. References to other documents are permitted.
- all electronic files provided to the Principal shall not be password protected, locked or read only.
- electronic copies of all documents shall be supplied in their native formats as well as in PDF format.

The Principal’s responsibility to save these documents into SWIMS (Sydney Water Information Management System) as per Corporate Document Management System.

### 10.1 File naming convention

File names shall consist of the following components:

Facility Number - Asset Number File Name - Date as per following example  
 SP1234PMP02 Operation & Maintenance Manual 04-05-09

Where there are documents common to several assets, only one document is required and including all identified asset numbers associated followed by an electronic file names shall be kept to a minimum character length. (Maximum of 128 characters).

All documents shall be categorised into document types as shown in the following table.

Document Type	Description
Specifications & Technical Data	All specification & technical data for critical equipment. Example: Instrumentation Calibration details, pump curves etc

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Safety & Statutory	All Safety & Statutory Reports. Example: Hazard Reports, Crane Inspection Reports etc.
General Documents	All general documentation that is not relevant to the other folders in this table.
Maintenance Reports	All Maintenance Reports for critical equipment. Example: Pump Overhaul Report.
O&M Manuals	All Operation & Maintenance Manuals. Example: Pump O&M manual.
Drawings	See section 2
Photos	All photos of critical equipment. Example: Photos of Pumps, Motors, Critical Instrumentation etc.
Maps	All location maps. Example: Location of pots for vacuum stations, facility location maps, location of critical equipment for a large site etc.
Contingency Plans	All contingency plans. Example: contingency plan drawings for tanker routes & wet well configurations.
Condition Monitoring	All Condition Monitoring Reports. Example: Pump Vibration Analysis Report etc.
Commissioning Documentation	All commissioning documentation that is not relevant to the other folders in this table. Example: Pump or High Voltage equipment commissioning check lists etc.
Environmental Records	All documents relating to environmental assessments
Reliability Reports	FMECA reports, Reliability Block Diagrams

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Use of sub-folders is not permitted and all documents shall be accompanied with an electronic document transmittal form providing the following information:

Document Type	File Name	Relevancy of the document to other assets supplied under the contract (State Asset Numbers against the relevant file)

## 11 Critical Spare Parts and Special Tools

The following clauses are applicable to all new installations. This clause does not apply when assets are replaced with like assets.

The Contractor shall nominate a recommended list of spare parts and stock levels (refer to Clause 1.2.1) inclusive of description, part numbers, supplier details, price, recommended minimum stock level and re-order level.)

Following consultation with the Principal, the initial stock of spares shall be procured by the Contractor and shall be delivered to the Principal prior to handover.

The Contractor shall provide a recommended list of special tools and software for maintenance purposes (eg program loader and proprietary software etc.). All recommended special tools should be supplied prior to hand-over.

## 12 Warranties

The Contractor shall obtain warranties as specified in the Contract and shall ensure that the Principal will have the benefit of the warranties. The Contractor shall ensure that the Principal will have the benefit of any warranties specified in the Contract that are obtained by subcontractors.

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## Definitions

Facility	A system of infrastructure components designed to work together and controlled as a single entity. Facilities generally have all components located on the same site.
Failure Mode Effects and Criticality Analysis (FMECA)	FMECA is a bottom-up, inductive analytical method which may be performed at either the functional or piece-part level.
Enterprise Asset Management System (MAXIMO)	Sydney Water's current enterprise asset management system
Reliability Block Diagram (RBD)	is a diagrammatic method for showing how component reliability contributes to the success or failure of a complex system
Commissioning	Process by which an equipment, facility, or plant (which is installed, or is complete or near completion) is tested to verify if it functions according to its design objectives or specifications.
Warranties	Providing assurance by one party to the other party that specific facts or conditions are true or will happen
P&ID	Process and Instrumentation Drawing
WAC	Work As Constructed
MGA	Mercator Geocentric Australia
WWTP	Waste Water Treatment Plant
WFP	Water Filtration Plant
WRP	Water Recycled Plant
SPS	Sewage Pumping Station
WPS	Water Pumping Station
AHD	Australian Height Datum
RL	Reduced Level
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
IICATS	Integrated Instrument Control Automation Telemetry System
SCADA	Supervisory Control And Data Acquisition
I&C Standard Manuals	Instrument and Control Standard Manual
PLC	Programmable Logic Controller
RTU	Remote Terminal Unit
CT	Current Transfer
VT	Voltage Transfer
WSAA code	Water Services Association of Australia code

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NATA	National Association of Testing Authorities, Australia
HYDRA	Sydney Water geographical information system that allows the user to update land and asset data using a desktop or centralised Application.
UPG	Unit Processing Guidelines
SOP	Standard Operating Procedure

## Document Change Summary

Version number	Date revised	Author/s	Brief description of change
1	15/03/05	Yong Chai	<b>Original issue</b>
2	29/08/09	Yong Chai	<b>Labelling requirements added</b>
3	15/03/07	Fredrick Rodrigo	<b>Review of clauses &amp; inclusion of commissioning clauses</b>
4	04/09/09	Fredrick Rodrigo	<b>Comprehensive review of clauses</b>
5	20/08/11	Fredrick Rodrigo	<b>Comprehensive review of clauses</b>
6	18/11/2014	Hanka Shabilla	<b>Comprehensive review of document</b>
7	03/12/2015	Chris Salkovic	<b>Minor changes including formatting</b>
8	23/02/2018	Ujjaval Mehta	<b>Redundant cable clause added in section 9</b>

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