Sydney WATER

Technical Specification – Odour Control Unit

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Revision details

Version No.	Clause	Description of revision
7	Various	Clause 1.9 – Updated reference documents. New Clause 2 – Passive OCUs. Clause 3.1.2.2 (Odour Best Practice review) – Inlet envelope design requirements include H_2S and non-H_2S substances. Requirement to monitor for VOC on inlet and outlet where incorporated into design requirements. Figure 1: Note Provide negative pressure testing under covers to prove capture rates. Clause 3.1.3.1 – Service life increased from 20 to 25 years. Clarification of leak containment/bunding requirements for different OCU types. Requirement for all containment facilities to be installed prior to tanks being used for storage and sizing requirements for secondary containment. Clause 3.1.3.5 – FRP design and construction requirements amended. Design life reduced from 50 years to 35 years. Reference to BS4994 removed. New Clause 3.1.3.5.1 – FRP Odour Covers. Clause 3.1.3.8 – Inlet isolation valve requirements amended. Provision for safe isolation included. Clause 3.1.3.9 – High risk considerations amended. FRP requirements included. Clause 3.1.3.10 – PVC included, minimum drainage slope and reference to BMIS0209 regarding FRP ductwork. Clause 3.1.3.11 – Design, construction and inspection requirements of vent stacks amended. Clause 3.1.3.14 – FRP dampers, UPVC dampers, damper requirements for non-intrinsically safe isolation and flow modulation, damper bearing requirements for marine environments included. Dampers not permitted for safe isolation of filters. Clause 3.1.7.2 – Air flow measurement requirements for OCUs in parallel included. Clause 3.1.8 – Eyewash station requirements included. Clause 3.2.2 – Pre-filter spare filter storage and wash bay requirements included. Clauses 3.3.2 and 3.4.2 – BTF roof loading and nozzle location requirements included. Clause 3.3.7 and 3.4.6 – Nutrient dosing requirements amended. Clause 3.5.5 – Access for acid wash requirements included. Clause 3.6.2 - Included requirement for monitoring of pressure under covers at furthest point to prevent fugitive release of odours. Removed requirement to use photo optical paper tape for H_2S monitoring and included requirement to use Acrulog or equivalent sensors. Clause 5.3 – Performance testing amended. SEW1700-1702 – Removed safety shower and eyewash. SEW1700-1705 – removed 5L/M requirement for air pump.
6	All	Reformat, Foreword, Copyright, General Terms and Definitions added, update references changed 'shall' and 'should' to 'must' where relevant. 'Principal' replaced with 'Sydney Water'. Clause 1.4 added. Minor editorial changes, general removal of duplication with other specifications, removal of reference to "Supplement to WSA 201 (ACP0166)", addition of requirement for OCUs to operate 100% of the time at treatment plants in Clause 2.1, addition of reference to "Sydney Water Procedure for Odour Dispersion Modelling for SW Projects" in Sydney Water Standards reference documents and Clause 2.2.1, addition of requirement to consider non H_2S loads on OCU performance in Clause 2.2.1, addition of requirement to provide sufficient air extraction to prevent fugitive odours or corrosion in Clause 2.2.2, addition of reference to EPA Noise Policy for Industry (NPfI) 2017 in Clause 2.2.2, change of noise level definition and inclusion of minimum airflow chart for treatment processes in Clause 2.2.2, addition of requirement for appropriate instruments to replace H_2S sensors where non H_2S contaminants are priority in Clause 2.2.3, update of drawings SEW1700-S1701 and SEW1700-S1703, addition of drawing SEW1700-S1703_A for single-pass

Version No.	Clause	Description of revision
		BTFs, addition of provision of an airflow meter for continuous airflow reading in Clause 2.7.2. Exclusion of Platform ladder or scissor lift for cleaning in Clause 3.2. Addition of a humidity sensor at heater inlet for activated carbon type OCUs (Clause 3.3 and drawing SEW1700-S1701). Addition of a free chlorine monitor requirement in Clause 4.5, addition of recirculation tank for single-pass BTFs (Clauses 4.6, 5.5) and removal of standby pump requirement for nutrient dosing at treatment plants (Clauses 4.7, 5.6)
5	All	Updates (including current standards, Valves and Dampers, EBRT, formatting, monitoring, DTC drawings, Safety in Design, fibreglass design requirements) with key stakeholder inputs based on lessons learnt from installations such as North Head BTF, Cronulla and Warriewood.
4	All	Minor change in residence times for BTF.
3	All	Updated together with CH2MHill several specifications among them documentation, BTF, BTF with activated carbon polishing, performance testing as well as I&C.
2	All	Minor formatting amendments
1	All	First Issue

Introduction

This Specification is for the design, supply and construction of Odour Control Units for Sydney Water.

Sydney Water makes no warranties, expressed or implied, that compliance with the contents of this Specification shall be sufficient to ensure safe systems of work or operation.

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Acronyms

Acronym	Definition
ACF	Activated Carbon Filter
ASTM	American Society for Testing and Materials
BTF	Biotrickling Filter
CASANZ	Clean Air Society of Australia and New Zealand
dBA	Decibels, the unit of measurement for loudness, weighted for the human ear frequency range
EBRT	Empty Bed Residence Time (seconds) of the gas
H_2S	Hydrogen Sulphide
HSS	Hydraulic System Services
GPO	General Purpose Outlet, a connection point to access 240 V AC power

Acronym	Definition
Gravity sewer system	Sewer system laid on a grade that allows flow due to gravity alone
IICATS	Integrated Instrumentation, Control, Automation, and Telemetry Systems
LEL	Lower Explosive Limit, the lowest concentration (percentage) of a gas or a vapour in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat). LEL concentrations vary greatly between combustible gases. At 20 degrees Celsius the LEL of methane is 5.1 % by volume.
MAXIMO	Sydney Water's Maintenance Management System
MSDS	Material Safety Data Sheet
Pressure sewer system	Sewer system that uses pumping units to generate flow
O&M	Operation and Maintenance
OCU	Odour Control Unit
OU	Odour Units (measurement) as defined in AS/NZS 4323.3
P&ID	Process and Instrumentation Diagrams
PLC	Programmable Logic Controller
ppm_v	Air pollutant concentration, in parts per million by volume
RCD	Residual Current Detector, (safety switch)
RPZ	Reduced Pressure Zone, a backflow prevention device for the protection of drinking water supply
RTU	Remote Terminal Unit
SAP	Standard Administration Procedure
SCADA	Supervisory Control And Data Acquisition, control system design standards for Sydney Water designers, consultants and contractors to use in order to ensure the uniformity and consistency of control system projects in Sydney Water facilities.
SOP	Standard Operating Procedure, a set of step-by-step instructions to help workers carry out complex routine operations
SPS	Sewage Pumping Station
UPG	Unit Process Guideline, a document that describes in detail the operation and maintenance philosophy of the unit.
VOC	Volatile Organic Compound, usually generated by industrial sources.
VSD	Variable Speed Drive, a device for controlling the speed of an electric motor by changing the alternating current frequency
WAC	Work As Constructed
WSAA	Water Services Association of Australia
Wet well	A section of pressure sewer system where sewer is collected prior to being pumped
WRRF	Water Resource Recovery Facility

General Terms and Definitions

Term	Definition
Competent Engineer	Suitably qualified and experienced engineer with the ability to apply knowledge and skills to achieve the intended design, construction, testing or monitoring task. For engineering tasks related to design, engineering personnel who meet requirements of the Sydney Water Engineering Competency Standard.
Sydney Water	The nominated person or organisation that has written authority to act on Sydney Water's behalf.
Contractor	The person or organisation responsible for the delivery, installation and commissioning of products, materials, equipment, and components described herein.
Supplier	The person or organisation responsible for the fabrication or manufacture and supply of products, materials, equipment, and components described herein.
Tenderer	The person or organisation responsible for the submission of the tender.
Vendor	Supplier of goods
WSAA Codes	Code of Practice issued by Water Services Association of Australia

1. General

1.1 Scope

This document specifies the design, installation and performance requirements for Odour Control Units (OCUs) in Sydney Water's sewerage network and Water Resource Recovery Facilities (WRRFs). For WRRFs, this extends to the design and installation of covers and ventilation systems in accordance with Sydney Water's Technical Specification – Mechanical (BMIS0209).

1.2 Objective

The objective of this Specification is to provide designers, manufacturers, and installers of an OCU with Sydney Water's requirements for its design, construction, installation, and performance testing.

1.3 Purpose

In the procurement of an OCU, it is intended that this document would be appended to a procurement Contract document for a specific site where it would provide the general requirements for an OCU. Any additions, variations, or one-off requirements for that specific site would be included in the Contract document itself. Unless specifically required otherwise in the Contract document, this Specification must be complied with.

The contract document must provide for three hold points in the procurement process as follows:

- Sydney Water must be provided with design criteria and concept design. The Contractor must resolve with Sydney Water any issues of concern that Sydney Water may have as a result of its review of this information prior to proceeding with detailed design work.
- Sydney Water must be provided with the detailed design including details of any deviations from this Specification. The Contractor must resolve with Sydney Water any issues of concern Sydney Water may have as a result of its review of the detailed design prior to proceeding with ordering and manufacturing of the unit.
- In accordance with Sydney Water's Technical Specification D0001440 Commissioning - transitioning assets into operation, Sydney Water must be provided with all Work as Constructed (WAC) documents, such as detailed drawings, Installation, Commissioning and Start-up instructions including installation and quality checklist, troubleshooting guidelines and Operation and Maintenance (O&M) Manuals.

1.4 Standards

Equipment supplied and installed must be new and in accordance with the requirements of this Specification, Needs Specifications (if supplied), Drawings and job specific Technical Specification (where supplied) and the latest editions of the relevant Australian Standards and Technical Specifications, WSAA Codes of Practice, Water Industry Standards and Product Specifications.

Where there is no suitable Australian Standard available, an agreed international standard and/or industry current best practice must be adopted.

If an international standard is proposed in lieu of an Australian Standard, a detailed assessment to show that the proposed standard is equivalent or superior to the relevant Australian Standard must be provided to Sydney Water for acceptance.

The work must also comply with the requirements of all relevant bodies or codes, including but not limited to:

- SafeWork NSW
- NSW Environment Protection Authority (EPA)
- Power Supply Authorities
- Australian Communications and Media Authority
- Local Government Authority.

In the event of any ambiguity or discrepancy Sydney Water must be consulted as to the interpretation to be followed in carrying out the work.

1.5 Supplier experience and quality assurance

The Supplier must have a Competent Engineer with at least 5 years' experience in the design, fabrication, and supply of odour control systems similar to the type specified for this project.

The Supplier must have in place a dedicated quality system that conforms to ISO-9000/ ISO-9001. The Supplier's Quality Assurance systems must demonstrate traceability of materials back to the original equipment and material provider. Work procedures must be provided by the Supplier which comply with the original equipment provider's equipment warranty conditions.

The Supplier must provide a list of three (3) air treatment installations associated with the removal of hydrogen sulphide and other typical organic municipal wastewater odours for which they have been responsible. The list must include contact names, telephone numbers, system capacity (flow rates in m3/hr), removal efficiency of system in terms of odour and H_2S (ppmv in/out, % removal), and length of operation for each installation. Installations must be of comparable size to the type specified for this project.

The Supplier must have a local representation and the Supplier's place of business must be open for inspection upon request.

1.6 New Design and innovations

This document specifies the minimum requirements for the Works. The Contractor may wish to produce their own alternative design that will comply with these minimum requirements.

Any alternative materials, designs, methods of assembly, and processes that do not comply with specific requirements of this Specification, or are not mentioned in it, but give equivalent or improved performance outcomes to those specified, are not prohibited.

Written approval from Sydney Water must be obtained for any deviation from this Specification prior to ordering and manufacture of equipment affected by such deviation.

1.7 Style of this Specification

This document is written in the directive style. Where an obligation is given and it is not stated who is to undertake these obligations, they are to be undertaken by the Contractor.

Where a submission, request, proposal is required and it is not stated who the recipient must be, it is to be provided to Sydney Water representative for approval.

1.8 Responsibilities

Responsibilities relating to the contractual terms and conditions, including financial matters, and site issues are covered in the Head Contract documents. Specific responsibilities are noted in this document, but they do not necessarily describe all the activities required for the Works.

1.8.1 Contractor

The Contractor must be fully responsible for the detailed design, and construction to fully comply with the requirements in this document and provide a complete functional OCU, which meets all the necessary Standards, Codes of Practice, Industry Standards, and all statutory and regulatory requirements. Where necessary, relevant Dangerous Goods Regulations must be complied with. The complete systems must include all pipework, fittings, ducting, fans, filters, covers, instruments, and controls, from the point of foul air extraction to the point of treated air exhaust unless otherwise specified by Sydney Water.

In addition, the Contractor must provide the following, but not limited to:

- Additional equipment as may be necessary for the operation and maintenance of the odour treatment system being provided, or as recommended by Sydney Water, the Supplier and regulatory bodies.
- Stairs, ladders, platforms and walkways, where appropriate, to allow ease of access for changing of media, access sampling points and monitoring equipment, and all storage tanks and equipment. All such stairs, ladders, platforms and walkways must be constructed of appropriate corrosion resistant materials.
- Safety facilities such as safety shower, eyewash station, fire extinguishers, etc.
- Tags, labels, signs, and other markings, for all these systems which clearly indicate the individual system, chemical contents, hazards, warnings, asset numbers and any other pertinent information in accordance with the requirements of the relevant Standards, Codes of Practice and statutory authorities, and Sydney Water's Maintenance Management System (MAXIMO).
- O&M Manuals, Unit Process Guidelines (UPGs), Standard Operating Procedures (SOPs), WAC drawings, copies of Programmable Logic Controller (PLC) software programs for WRRF installations, P&IDs and any other documents necessary for the optimal operation and maintenance of the OCU.
- Any additional items/equipment requested by Sydney Water.

1.8.2 Sydney Water

Sydney Water, through its appointed representative/consultant, shall be responsible to provide input from the various internal stakeholders for the development of both the concept and detailed design required by this Specification. They shall include, but not be limited to:

- This document
- The concept purpose of the OCU (for example, ventilate sewer pumping station wet well, ventilate one of two sewers feeding the draw off point, prevent odour nuisance at a plant boundary)
- Location of the OCU
- OCU expected equipment life term at the location (fixed or temporary)
- Current and estimated future operational parameters, such as catchment population and development staging, sewage characteristics, flow levels, and gas level monitoring data as defined in the needs specification.

1.9 Reference documents

The design and construction of the OCU works must be in accordance with the requirements as contained in the following reference documents where applicable.

American Society for Testing and Materials

ASTM	American Society for Testing and Materials
ASTM D2854	Standard Test Method for Apparent Density of Activated Carbon
ASTM D2862	Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D3802	Standard Test Method for Ball-Pan Hardness of Activated Carbon
ASTM D6646	Standard Test Method for Determination of Accelerated Hydrogen Sulfide Breakthrough Capacity of Granular and Pelletized Activated Carbon

Australian Standards

AS	Australian Standard
AS 1324.2	Air filters for use in general ventilation and air conditioning - Methods of test
AS 1939	Degrees of protection provided by enclosures for electrical equipment (IP Code)
AS 3580.2.1	“Preparation of Reference Test Atmospheres – Permeation Tube Method”
AS 1345	Identification of the contents of pipes, conduits and ducts
AS 4254	Ductwork for air handling systems in buildings
AS 1657	Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation.
AS 1170.2	Structural Design Actions
AS 3735	Concrete Structures for Retaining Fluids
AS 3780	The Storage and Handling of Corrosive Substances

Australian and New Zealand Standards

AS/NZS	Australian Standard/New Zealand Standard
AS/NZS 4323.3	Stationary source emissions - Determination of odour concentration by dynamic olfactometry
AS/NZS 3580.2.2	Methods of sampling ambient air - Compressed Gas Method
AS/NZS ISO 9001	Quality Management Systems
AS/NZS 60079	Classification of hazardous areas

European Standards

EN	European Standard
BS EN 13121	GRP Tanks And Vessels For Use Above Ground

WSA 121	Industry Standard for Biofilters for Odour Control
WSA 201	Manual for Selection and Application of Protective Coatings
ISO 6141	Gas Analysis – Contents of Certificates for Calibration Gas Mixtures
ISO 6142	Gas Analysis – Preparation of Calibration Gas Mixtures – Part 1
ISO 6143	Gas Analysis – Comparison Methods for Determining and Checking the Composition of Calibration Gas Mixtures

"Air Pollution Measurement Manual" – A Practical Guide to Sampling and Analysis, Volumes 1 and 2, Clean Air Society of Australia and New Zealand (CASANZ)

"Handbook of Air Pollution Analysis", edit. Roy M. Harrison and Roger Perry. Chapman and Hall, printer/publisher: University Press, Cambridge 1986 ISBN 0412 244101

IEEE Standard 1349 – Guide for application of electric motors, Class 1 Division 2: Hazardous (Classified) locations

EPA Standards

EPA Noise Policy for Industry (NPfI) 2017

Sydney Water Standards (refer to Appendices of this Specification for P&IDs)

P&ID Drawing for Activated Carbon Unit (SEW1700-S1701)

P&ID Drawing for Chemical Scrubber Unit (SEW1700-S1702)

P&ID Drawing for Biotrickling Filter Unit (SEW1700-S1703 and S1703_A)

P&ID Drawing for Monitoring System (SEW1700-S1705)

P&ID Drawing for Treated Air to Stack (SEW1700-S1706)

P&ID Drawing for Biotrickling Filter Unit General Arrangement (SEW1700-S1708)

Deemed To Comply Drawing for Facility Fencing DTC-5000 and 5001 (Network OCUs where security fencing is required)

Health and Safety Procedure HSP-058: Risk Assessment in Design

Safety in Design Procedure (D0000653)

Technical Specification – Commissioning - transitioning assets into operation (D0001440)

Asset Creation Operational Readiness Guideline (D0000256)

Technical Specification - Instrumentation and Control - General (HSS0009)

IICATS Sewer Odour and Corrosion Control Standards TOG_TS08

Treatment Plant SCADA Standards D0000724

Technical Specification – Civil (CPDMS0023)

Technical Specification – Mechanical (BMIS0209)

Technical Specification – Electrical (CPDMS0022)

Sewerage Code of Australia (Sydney Water Edition) WSA 02-2002-2.2

Classification and Management of Flammable Gas Hazardous Areas (TG0502)

Sydney Water Fibre Polymer Composite Specification (Doc number not yet assigned)

Sydney Water Procedure for Odour Dispersion Modelling for SW Projects

2. Passive OCUs

2.1 Background

Passive OCUs offer a simple solution to odour complaints, installed on air valves, vent shafts and maintenance holes. They remove H_2S and other odorous gases through adsorption/chemisorption in the media and differ from active OCUs, as they don't have a fan and therefore, do not require a power supply. Consequentially, remote telemetry is not essential. However, as there is no active means of forcing air through the media, air will follow the path of least resistance and can leak from poorly fitting lids or other vent shafts. For this reason, they must be designed to keep the pressure losses low and are generally not suitable for use on pumping stations or other locations where lids are frequently lifted and subject to small gaps being present.

Passive OCUs are not standardised and are supplied by different manufacturers based on their performance criteria and maintenance requirements. In deciding the most suitable unit to utilise, site characteristics and nature of the odour complaint are considered, followed by a criteria selection which include:

Technical Feasibility

- Flowrate range
- Contact time
- Pressure losses
- Asset type
- Odorous gas removal characteristics

Ease of Operation and Maintenance

- Weight and dimension of unit
- Filter or carbon change-out period
- Vacuum truck or single person lift

Economics

- Life-cycle cost (over 30 years)
- CAPEX
- OPEX

2.2 Design requirements

2.2.1 Material Selection

- Materials must be suitable for installation in the proposed environment.
- Must be constructed from:
  - HDPE or uPVC
  - Glass-reinforced plastic (fibreglass)
  - Stainless steel grade 316
  - Any other material, equivalent to these materials in corrosion resistance and durability.
- All fibreglass vessels and components for OCU service must be designed and constructed to BS EN13121 for a 25 year service life and must consist of an internal corrosion barrier, a structural layer and an outer surface layer, as specified under relevant sections of BS EN13121.
- Where constructed from fibreglass, the internal corrosion barrier must be constructed from corrosion resistant vinyl ester resin, with a minimum backing layer of 900gsm of CSM. Vinyl ester resin must be used in both the corrosion barrier and structure to ensure corrosion protection throughout the vessel construction. The outer surface layer must comprise an Iso-NPG based pigmented topcoat/gelcoat system specifically formulated for the external protection of the FRP equipment, i.e. weather and UV resistant.
- Internal parts that may be in contact with odorous gas must be acid resistant.
- All adhesive, sealants and gaskets must be resistant to oil, water and acid and must be non-supportive of microbial growth and dimensionally stable.
- The colour for the OCU vessels can be either G66 Environmental Green or Black. Colour for housing cabinets is to be G66 Environmental Green.

2.2.2 General Requirements

- Designed for a minimum 25 years' service life without the need for major maintenance or renewals. This does not apply to consumable components such as filter media.
- The design life of the filters and carbon must be a minimum of 24 months.
- Lifting lugs must be fitted where necessary. If OCU is temporary or moveable, lifting lugs must be provided on the Unit.
- Duct connections shall as far as practicable be connected to OCU units at ground level to minimise support structures and exposure of ducting to additional loadings.
- A vent shaft may be required downstream of the passive OCU as advised by Sydney Water to disperse treated air and prevent exposure of workers and the public to unsafe or odorous levels of foul air when media is depleted.
- OCU structure, including vent shafts where installed, shall be designed to withstand all forces, including wind loads, operating pressures (positive or negative), loading and unloading of media, and other anticipated forces. Magnitudes shall comply with AS 1170 using building type with Importance Level 1.
- An inlet gas tight isolation valve must be provided to protect workers when undertaking maintenance including replacing media.
- Passive OCUs must be provided at ground level. The use of vent top filters is not acceptable.
- Please refer Clause 3.2.7 of ACP0004 regarding carbon requirements.
- Design must prevent caking, solidifying and blooming of media.

- Pre-filters are not required for passive OCUs.
- In-line heater/demisters are not required for passive OCUs.
- Must be designed to minimise pressure drop, prevent any short circuiting of gas flow, and provide easy access for maintenance.
- In ground units or units where media is partially buried are only acceptable where there is no risk of flooding or inundation.
- The passive OCU must have a contact time of at least 3 seconds at the design foul air flow rate.
- At the design foul air flow rate, the passive OCU must have a pressure drop of less than:
    - Air valves – 30% of the pressure required to open the air valve
    - Non-air valves – 50 Pa.
- The design foul air flow rate should be the greater of the following:
    - For air valves:
        - Upstream pump rate
        - Maximum rate at which the air valve releases foul air
    - For rising main discharge maintenance holes
        - 70% of the peak dry weather flow
        - When the upstream sewer pumps are variably controlled, 70% of the 95th percentile of measured upstream pump rates
        - When the upstream sewer pumps are fixed speed, 70% of the pump rates
    - For gravity branch and trunk sewers
        - The type of OCU that would be equivalent to the vent shaft diameter as follows:

Vent shaft diameter	McBerns units	Bioaction units
DN150	ZC1500	FV40
DN225	ZC3000	FV80
DN300	ZC3000	FV160

    - When vent shafts on gravity branch and trunk sewers are provided with passive OCUs, all vent shafts shall be provided with either passive OCUs or alternating passive OCU and induct cowls (with flap). This is to prevent the pressure loss associated with a passive OCU pushing foul air to an alternate location.

2.2.3 Housing requirements

- Drainage – OCU areas must be designed with appropriate containment measures to prevent any leaks or spills from entering the environment. The passive OCU must be provided with a drain line to direct condensate to a Sydney Water approved location, including a leachate tank where identified by operational requirements such as on pressure mains. Where leachate tanks are not required, all drains should have suitable rechargeable water traps to allow free draining. When the drain line is provided on a passive OCU connected to an air valve, the pressure of air valve opening needs to be considered when designing the drain line to ensure the water trap does not blow during operation. Manual valves for draining condensate are not acceptable.

- Where identified by Sydney Water, the security enclosure for any passive OCUs will be considered separately to the supply of the OCU unit.
- Ports are to be incorporated into the passive OCU design on the inlet and outlet to enable differential pressure monitoring or gas grab sampling for odour analysis. The diameter of the ports should be sufficient to enable insertion of a tube of to 10mm OD. The ports must be gas tight when not being used and easy to open to enable monitoring and sampling.
- H_2S monitoring ports (for deployment of portable H_2S monitors) are required before and after the passive OCUs. When a passive OCU is connected to a maintenance hole, the maintenance hole itself can be used for the H_2S monitoring before the passive OCU. When a passive OCU is connected to a vent shaft, the anemometer door in the vent shaft can be used for H_2S monitoring downstream of the passive OCU. When a passive OCU is connected to a vent shaft but there is no anemometer door in the vent shaft, a new H_2S monitoring location must be provided after the passive OCU.
- Where a passive OCU is connected to an air release valve, provision for H_2S monitoring at the inlet must be incorporated into the design to allow monitoring for performance assessment. The monitoring point should be suitably sized to house a standard mobile H_2S monitoring device such as offline OdaLog or Acrulog, while not restricting the ability of airflow into the passive OCU. Sydney Water reserves the right to reject any design that does not comply with this minimum requirement.
- No control methods are required for passive OCUs.

3. Active OCUs

3.1 Design

3.1.1 Performance requirements

The active OCU must be designed to

- Be safe to construct, operate, maintain, and decommission in accordance with the Safety in Design Procedure D0000653.
- Provide reliable and effective odour removal to a level specified in the minimum requirements outlined in Clause 3.1.2.2 of this Specification.
- Have a minimum of 25 years' service life, i.e. no major maintenance or renewal required. This does not apply to consumable components such as filter media.
- Not cause interruption to the normal operation of the Sydney Water sewer system or treatment processes.
- OCUs located at treatment plants must be designed to treat air 100% of the time.
- Be capable of automatic operation via connection to Sydney Water's Integrated Instrumentation, Control, Automation, and Telemetry Systems (IICATS) for networks and Supervisory Control and Data Acquisition (SCADA) for treatment plants.

3.1.2 Design criteria and concept design

3.1.2.1 General

The designer must undertake investigations, including a desktop study, field testing and modelling to determine the specific requirements for the OCU. Refer Sydney Water "Procedure for Odour Dispersion Modelling for SW Projects."

The layout details of the system where the OCU is to be provided and its surrounds must be collected and documented. They must be used for the selection of the optimal locations of extraction and discharge points. All features that may affect the operation and maintenance of the OCU must be documented and considered in the design.

Data for the design of an OCU must be collected and clearly documented including all calculations and assumptions. It must be submitted to Sydney Water for written approval prior to commencement of detail design work.

Due consideration must be given to unforeseen operational problems and changes in odour loads related to future population projections for the operational life of the OCU. Due consideration shall also be given to non H_2S contaminant loads (e.g. Ammonia) and their impacts on the OCU performance.

No OCU shall be placed in a "confined space" such as a below ground pit without written approval from Sydney Water.

The submitted information must include, but not be limited to:

- Concept design showing the management of air inflows and extraction points to maximise removal of foul air to prevent corrosion and minimise the potential of gas escape leading to odour problems. This means air inlets must be one-way type made of corrosion resistant material (galvanised steel will not be sufficient in this case) located at the furthest point of the space to be ventilated and admitted as close to top water level as possible, with the extraction point as close as possible to the location with highest foul air concentration (e.g. riser main discharges, launders or weirs).
- Current, peak, and future quantity of foul gas required to be treated.
- Physical properties of gas such as pressure, temperature, and humidity.

- Current and future level of odorous gas component(s) and fluctuation during different time/season.
- Location of treated gas discharge.
- Assessment of corrosive substances in the gas and surrounds, which may affect the unit.
- Proposed type of OCU including P&ID and recommended spare parts list.
- General site layout concept to allow adequate space around the OCU (including roadway access) for its operation and maintenance, such as the changing of media, and removal of equipment.
- Electrical circuits and control panel layout and submit these drawings to Sydney Water for review prior to manufacture.

3.1.2.2 Minimum requirements

Unless otherwise specified by Sydney Water, the minimum requirements of the OCU are specified below.

ITEM	REQUIREMENTS
Outlet concentration as measured at the exit of the OCU or vent stack (if installed).	Hydrogen Sulphide (H_2S) $\leq$ 0.05 ppm_v Mercaptans (Thiols) $\leq$ 0.02 ppm_v Odour concentration $\leq$ 500 Odour Units (OU) Or otherwise, at a level that is demonstrated to achieve no odour nuisance at the nearest residence or public space.
Inlet envelope	Hydrogen Sulphide, VOCs* (where identified as high loads), dimethyl sulphide and methyl Mercaptan (particularly for sludge processing), and industrial loads for OCU and carbon sizing need to be considered.
Flow rate	Sufficient air extraction shall be provided to prevent fugitive odours or corrosion of ventilated assets. Minimum of 6 x airspace/headspace volume per hour for network (refer notes below **). For treatment processes, minimum airflows are based on Figure 1 below.
Fan(s)	Duty/standby. Centrifugal type with forward or backward curved impellers fitted with a flameproof motor Class 1 Division 2 ***
Noise level	Not exceeding 35 dBA under free field conditions, or 5dBA above the surrounding environment noise level measured at the boundary fence whichever is less (as per the EPA Noise Policy for Industry (NPfI) 2017.
Discharge vent stack	The discharge vent stack height must generally comply with the Sewerage Code of Australia for vent stacks (14m above ground level) unless otherwise agreed by Sydney Water. Typically, the vent stack must be designed to maximise the air velocity (>15m/s) out of the top of the stack to obtain maximum dilution with the surrounding air.
Removal Rate	Hydrogen sulphide >99% Where outlet H_2S is below requirements listed above, removal rate is not applicable.

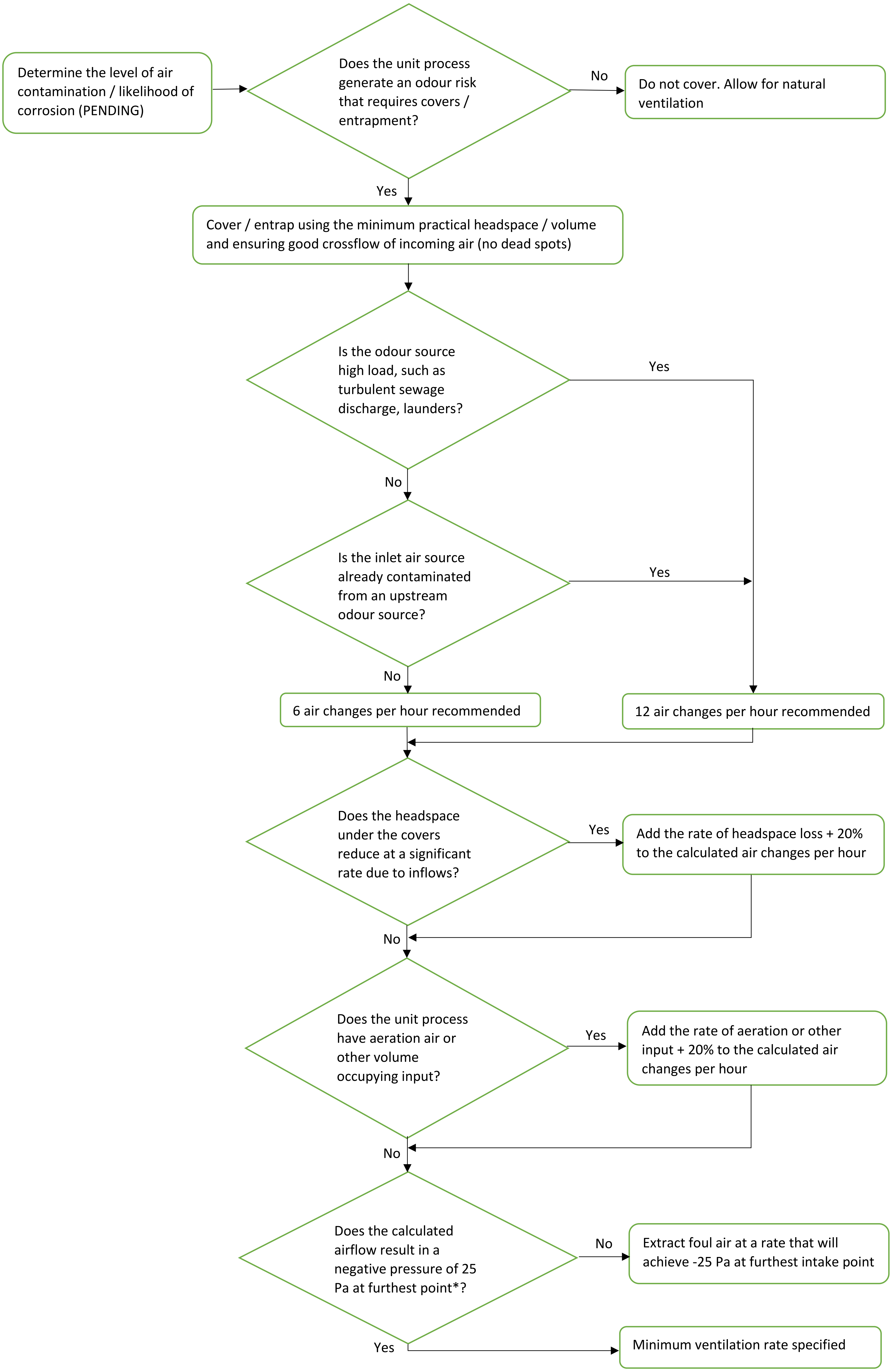
Notes

* VOC concentrations must be monitored on the inlet and outlet of the OCU when they have been incorporated into the design requirements.

** Volume examples:

- Sewage Pumping Station (SPS) wet well: if the volume of a SPS wet well at the lowest operating level is 10 m^3, then the required *minimum* flow rate is 60 m^3/hour.
- Sewer pipeline: if a pipeline has a cross sectional headspace at the low dry weather flow level of 1 m^2, and a sewer flow velocity of 1m/s (to which the gas velocity must be matched), then the *minimum* required flow rate is:
  (Headspace cross sectional area at low peak dry weather flow level) × (gas velocity down sewer)
  $$= (1m^2) \times (1 m/s) \times (3600 s/h)$$
  $$= 3600 m^3/h$$

*** In accordance with IEEE Standard 1349



Note: * Negative pressure monitoring under covers of extracted process units at furthest point from the OCU is required to prove capture rates have been achieved.

Figure 1 – Minimum Airflow Flowchart Treatment Processes

3.1.2.3 Selection of odour control unit type

Different types of OCU have different performance characteristics. These must be considered thoroughly when selecting the type of OCU that will perform best given the type, volume, concentration and variability of the foul air odorous components and other contaminants. Attention must also be given to operability, installation and maintenance requirements of the unit, particularly in terms of cost, availability of electricity, availability of critical spare parts, media or chemical replacements, requirements for any confined spaces entry, and ease of access. Where non hydrogen sulphide contaminants are the main odour concern, appropriate instruments will supplement H_2S sensors in this document for those units.

Soil bed odour systems will not be considered. Chemical Scrubbers must only be used in treatment plants, and not the networks. This is due to the hazardous nature of the chemicals used.

3.1.3 General detailed design requirements

3.1.3.1 General

All materials specified in the design must be suitable for installation in the proposed environment and be corrosion resistant for at least 25 years' service life without the need for major maintenance or renewals. This does not apply to consumable components such as filter media.

To allow easy installation and removal of equipment by lifting devices, suitably designed lifting lugs must be fitted where necessary. Where the OCU is specified as temporary or moveable, lifting lugs must be provided on the Unit.

All odour treatment facilities areas must be designed with appropriate containment measures to prevent any leaks or spills from entering the environment. These include liquid retaining bunds for delivery and storage of hazardous liquids such as those associated with Chemical Scrubbers and drainage type containment facilities for Biotrickling Filter and Activated Carbon installations. The drainage type containment facilities can either drain to sewer by gravity through a P trap or drain to a blowdown pump station as required. All containment facilities must be installed prior to tanks being used for storage of liquids. Secondary containment must be sized considering risks related to recharge/flow rate into tanks from external sources and storage volume of the tanks located therein.

3.1.3.2 Quality

The OCU system and its components must be manufactured under a quality management system certified to AS/NZS ISO 9001 – Quality Management Systems.

The contractor must supply a third-party certification of the manufacturer's quality system stating the scope of certification and the period of validity. All materials and products must have been supplied or manufactured within the period of validity of the certificate.

3.1.3.3 Documentation

The following information must as a minimum be submitted with the proposal. The accuracy and completeness of the submission of all the requested data will form part of the tender evaluation. All information must be submitted in both hard copy originals and as an electronic copy.

- Details of any non-conformances relating to this technical specification.
- Manufacturer's catalogue information including equipment type, model number/designation, operating characteristics, and relevant technical product brochures.

- Basic description of proposed OCU system, including process flow description.
- Details of expected odour removal performance and statement of performance guarantees offered.
- The Tenderer's Scope of Supply, including limits of contract and any assumptions made by the Tenderer.
- List of main equipment items, motor list, and instrument list.
- Details of media offered, including media life guarantee.
- Details of instruments proposed.
- Civil/Structural requirements (to be provided by others), e.g. preliminary footprint dimensions, dead weight, operating weight, and dynamic loading criteria.
- Drawings with the proposed layout complete with key dimensions, showing ductwork, access road and access platforms.
- P&ID drawings.
- Media, chemical and utility consumption based on design average and maximum conditions.
- Reference lists and relevant case studies demonstrating Supplier's previous experience.
- List of any special tools and lifting devices.

3.1.3.4 OCU Structure

The odour unit structure/vessel material and finish must be durable, resistant to corrosion and UV degradation in the proposed environment to achieve the nominated service life. The structure must be constructed from the following:

1. Glass-reinforced plastic (fibreglass)
2. Stainless steel grade 316
3. Any other material, being equivalent to item 1 or 2 in strength and durability, including HDPE which may be used subject to Sydney Water's acceptance.

The OCU structure must be suitably reinforced and supported to withstand all forces including wind loads, operating pressures (positive or negative), loading and unloading of media, and any other anticipated forces. The magnitudes of the imposed actions are to be determined using AS/NZS 1170 using building type with Importance Level 1.

3.1.3.5 Fibreglass

All fibreglass vessels and components for OCU service must be designed and constructed to BS EN13121:2016 for a 35 year service life and must consist of an internal corrosion barrier, a structural layer and an outer surface layer, as specified under relevant sections of BS EN13121:2016.

Vessels shall be designed against wind and seismic loading based on AS1170.0 Importance Level 2 structure with a 50 year recurrence interval. For wind loading the minimum terrain category shall be TC=2 (subject to project specification). Wind loading and seismic analysis shall be as per AS1170.2 and AS1170.4 respectively. All vessels shall use an aerodynamic shape factor C_{shp} for wind drag loading of 1.2.

Where the OCU system is temporary and has a limited life of service (i.e. due to planned replacement or closure) at the discretion of SWC the design life may be reduced, the minimum being 10 years.

The corrosion barrier must be constructed from corrosion resistant vinyl ester resin, suitable for the application, and must comprise a minimum backing layer of 900gsm of CSM subject to any additional requirement recommended by the resin Supplier.

All BSEN13121 (all parts) relating to pressure testing, inspection and material qualification testing requirements relating to the vessels and their construction must apply. All FRP OCU vessels shall have design calculations completed in accordance with BSEN13121 as appropriate.

Vessels, as a minimum, must be subject to a post cure of the internal corrosion barrier in accordance with the resin suppliers recommendations. The design factor used for vessels, ducts and stacks must include the non-post cure factor regardless of any post cure achieved.

The resin, veils and glass reinforcement selected for fabrication must be suitable for the chemical used. The resin used must have the minimum performance criteria as specified under relevant sections of BS EN13121:2016 including structural requirements, i.e. ductility and strength. The corrosion barrier must not be included in the structural strength or stiffness of any FRP equipment.

All ACF or BTF units with an internal diameter greater than 2.8m, or height greater than 8m, require design verification or where the units (regardless of size) provide total or partial support for an access platform.. The verifier must ensure that the method of construction and the design meet the requirements for the specified service conditions. The verifier must also verify the design method (BS EN1321 Table 8) is appropriate and that the necessary material testing to establish the minimum material properties (BS EN13121 Table 3). For filter vessels the Basic Design method must be used. To establish the influence factor of the laminate ply properties test data the minimum value of A1 must be 1.3. Vessel cut outs must not be used for material property testing and the A1 must be selected as per Table 8 based on the age of the material testing. When considering historic test data, the resin type and resin extension to failure must be the same. The overall design factors must be calculated based on the design conditions and specified minimums in this specification, the value of K must not be less than 8 and F must not be less than 4. The design must meet the requirements for both strength and strain limit criteria.

The fabricator must ensure that the FRP vessel is built to the correct requirements in accordance with BSEN13121 including all QA/QC testing and records. In addition, an independent third-party inspector must be appointed to assess the conformity of the fabrication, material testing, pressure testing and QA/QC requirements as required by the specification. The inspector must be sufficiently competent to conduct the inspection to the nominated specifications and must be approved by Sydney Water. The frequency of inspections must be agreed with Sydney Water and must comprise a minimum of one inspection per vessel or piece of equipment at the completion stage and must include the witnessing of the pressure testing. Ductwork does not require pressure testing. Designers, verifiers and inspectors must have direct experience across the design and manufacture of corrosion resistant FRP equipment. All designers, verifiers and inspectors must be registered in accordance with State and Federal requirements for practising Engineers. Inspectors shall be approved by Sydney Water..

The materials used for the construction of the OCU and ductwork must be nominated for approval prior to ordering the materials. Vinyl ester resin must be used in both the corrosion barrier and structure to ensure corrosion protection throughout the vessel construction. The outer surface layer must comprise an Iso-NPG based pigmented topcoat/gelcoat system specifically formulated for the external protection of the FRP equipment, i.e. weather and UV resistant and must have acceptable corrosion resistance against minor spills. This system must be capable of being pigmented to the project specific colour. Factory formulated topcoats are not permitted without the permission of Sydney Water. FRP Ductwork shall be designed as per Sydney Water Technical Specification – Mechanical (BMIS0209).

Any internal structures, bracketry, spray headers, etc. must be designed in accordance with BSEN13121:2016 and have the same or greater factors of safety and the same or lower design strain as the OCU vessel itself. All internal structures, etc. must have an external corrosion barrier applied, and any voids sealed to prevent the build-up of liquids. The inclusion of pultrusion for beams or other components must be considered under BSEN13121 for design, however the pultrusion suppliers design methods must be followed where the allowable capacity of any design element (i.e. beam) is less than that calculated by BS EN 13121, in which case the same level of safety and strain limit must be maintained as the vessel. Pultruded FRP sections may only be used where the supplier has an acceptable dedicated design manual for their supplied sections. Structural sections made up of contact moulded FRP must follow standard engineering practice for structural elements. In all cases good engineering practices must be followed and all structural elements must be checked for buckling or adverse deformation.

The use of moulded or pultruded FRP grating may be used for the support of AC or BTF media beds. The grating must comprise vinyl ester resin confirmed by the grating fabricator as being suitable for the intended service. The structural capacity of the grating must meet the requirements of ANSI/AMCA/FGMC – Grating Manual. The grating must be selected and supported such that it has a minimum UDL load capacity equal or greater of the maximum operational or end of life media weight, or 2.5kPa whichever is greater. The grating must have the same minimum factor of safety as the filter vessel. The deformation of any grating shall be limited to 25% of the grating thickness.

Any fibreglass bearing surfaces must be protected from point loads by use of suitable compressible insertion material.

Vessels must not rely on any liquor to offset the effects of pressure (positive or negative) on design loading (i.e. wind loading or uplift of the filter base from vacuum). Permanent internal structures may be used to prevent base uplift under vacuum providing the design method is sufficiently detailed (i.e. Finite Element Analysis). Non-permanent uniformly distributed media support structures may be used to offset vacuum pressure but not over turning or positive pressures unless the base has been designed specifically stiff enough to transmit the load to the vessel shell and this has been demonstrated using a detailed design method such as Finite Element Analysis.

The design will allow for the periodic inspection and maintenance of the fibreglass structures in accordance with manufacturer's recommendations to ensure delivery of the required asset life. The supplier must consult with Sydney Water to ensure that safe access can be provided into the FRP equipment as far as practicable.

Any fibreglass walkways, stairs and ladders must be designed and installed as per the *Sydney Water Fibre Polymer Composite Specification (Doc number not yet assigned)*

Any FRP Chemical Storage Tanks must be designed and constructed as per the *Sydney Water Specification for FRP Chemical Tanks (D0000824)*.

3.1.3.6 FRP Odour Covers

All FRP covers shall be constructed with VE resin throughout unless used for covering clean water or clean air areas, where iso-polyester may be used for the structure.

Covers shall be assessed for fitness for service on the basis that the corrosion barrier is ignored for strength and stiffness. The corrosion barrier shall comprise a C Glass veil with a minimum backing layer of 900gsm of CSM subject to any additional requirement recommended by the resin supplier.

Minimum loads unless project specific loading are provided shall be:

- Vacuum (long term load) - 200Pa
- Access UDL (short term load) – 500Pa
- Point Load (short term) – 1.1kN

Location of connecting pipework, vents and access manways - Where manways are fitted specifically for access, then the structure in this area shall be robust enough to be subjected to the loads associated with access and rescue i.e. tripod load arrangement, equipment etc.

Covers are effectively un-trafficable. Where trafficable covers are required, the design shall minimize trip and slip hazards and shall meet the requirements of AS1657 for platforms. Project specific loading shall be given but shall not be less than 2.5kPa UDL and 1.99kN point load.

The strength and stability of the covers shall be assessed using the BS EN13121-3 method for determining laminate strength and stiffness unless actual laminate test results are available. These laminates shall not exhibit a strength or stiffness less than BS EN13121-3 Table 3 for their individual laminate properties, evidence of material property conformance shall be part of the verification of the covers. Cover design verification shall be as the discretion of the project for non-trafficable covers. Trafficable covers shall be 3rd party verified. Inspection requirements for compliance to the design and the fabrication standard i.e. BS EN13121-3 shall be at the discretion of the project and the covers shall have a minimum Factor of Safety (FoS) on strength of 6 and 4 on buckling stability.

The shape of the covers may be determined between the supplier and the project.

Cover design shall consider the self-weight of the cover and the method of anchoring.

Consideration of the covers ability to shed water is important and the cover should not permit the ponding of water. The deflection criteria of the cover shall be limited to span/360 for non-trafficable covers. Trafficable covers shall not exceed 9mm from the as installed deflection of span/360 when subject to live loading.

The cover design shall be tested for the specified UDL based on a single cover to demonstrate the deflection criteria can be met by loading under a UDL equal to the larger of the UDL loads specified by the project.

3.1.3.7 Parts

All internal parts that may be in contact with the odorous gas must be acid resistant, particularly sulphuric acid, and any other chemical used by the OCU.

All bolts, nuts, and washers must be made from stainless steel grade 316. Potential for galvanic corrosion must be minimised.

3.1.3.8 Adhesive, sealants, and gaskets

All adhesive, sealants and gaskets must be resistant to oil, water, and acid (mainly sulphuric acid). They must be non-supportive of microbial growth and dimensionally stable.

Where applicable, they must also be resistant to any chemicals used by the OCU.

3.1.3.9 Inlet Isolation valve

An easily operated positive shut off isolation valve must be provided on the extraction ductwork to the OCU to ensure a safe working environment during OCU maintenance over the life of the unit.

All valve spindles, bearings and ancillary components must be stainless steel grade 316, and suitable for operation in an atmosphere where saturated air and H_2S gases are present. Any components where galvanizing is used or where copper or brass components are used will not be accepted.

Each unit must be supplied for heavy-duty operation and must operate through 90 degrees of operation, from fully open to fully closed. Buried valves are not accepted.

Provision for safe isolation of filters for maintenance must be achieved using gas tight isolation valves or permanently installed blind/orifice plates located as close to the filter equipment as possible whilst allowing the isolation method to be fitted with ease. Blinds may be FRP or stainless steel. Isolation blinds must be fitted or be able to be fitted where semi-permanent bypass is required.

3.1.3.10 Intrinsically safe

At some locations, analysis of the sewer gases and upstream users may indicate a risk of high hydrocarbon levels that may give rise to flammable conditions. Sewer catchment areas with a known history of hydrocarbons linked to illegal discharges are considered to be high risk. In these situations, the Contractor must install a suitable monitoring system and design the unit to prevent ignition of the hydrocarbons when detected. This may take the form of automatic shutdown of the OCU, with an alarm to IICATS (Network) or WRRF SCADA (Treatment Plant) or use of appropriate equipment to prevent potential fire / explosion. The Contractor must carry out and document a risk assessment in conjunction with relevant Sydney Water personnel to assess the need for a flame arrestor or other such measures, and if required, where it is to be located, and to identify any other control measures which may be needed (for example, methane meter, alarms, operational interlocks, etc.).

Where it is deemed necessary, a flame arrestor must be designed and installed so that any liquid condensation must drain away and not pool.

FRP equipment may be required to be antistatic and built with suitable fillers, veils and earthing straps as required and specified by the project.

Also refer to Sydney Water's TG- 502 Classification and Management of Flammable Gas Hazardous Areas and CPDMS0022 Technical Specification – Electrical, Clause 2.5 Hazardous Areas.

3.1.3.11 Ductwork

All ductwork must be fabricated in fibreglass, stainless-steel grade 316 or PVC (subject to Sydney Water acceptance) to the relevant Australian Standards, unless otherwise specified in relevant Clauses of this Specification.

The design of the ductwork must prevent the pooling of any liquid. The duct must either rise steadily to the unit or have one high point only, such that any condensate water will flow into the unit or back to the air source (e.g., sewer, treatment processes). Where this cannot be achieved, drainage pipes with hydrostatic seals and directed back to the sewer/treatment process are required. The minimum drainage slope of ductwork is 1:100. An assessment of any sag in the ductwork shall ensure that the drainage of the ductwork is maintained, and pooling is minimised.

Design of FRP ductwork shall follow the requirements of Sydney Water Technical Specification – Mechanical (BMIS0209).

3.1.3.12 Vent stack

A vent stack must be provided to exhaust the treated air vertically from the odour treatment processes unless otherwise specified by Sydney Water.

It must be formed from stainless steel or fibreglass tubing and must be self-supporting (including stainless steel guy wires where necessary).

FRP Stacks must be designed to BSEN13121 and be subject to a full dynamic analysis in accordance with AS1170.2 and good engineering practice. Vinylester resin must be used through the stack. The corrosion barrier must be constructed from corrosion resistant vinyl ester resin, suitable for the application, and must comprise a minimum backing layer of 900gsm of CSM subject to any additional requirement recommended by the resin supplier. The overall design factors must be calculated based on the design conditions and specified minimums in this specification, the value of K must not be less than 6 and F must not be less than 4. The design life for the stack must be 35years for the purposes of BS EN13121 design.

The stack must be considered an importance level 2 structure with a 50 year return interval for wind loading.

FRP Stacks do not require seismic analysis at the discretion of the designer or design verifier. Strakes must be fitted unless agreed to otherwise by SWC and only when the Scruton No. is greater than 20. Buckling analysis relating to the influence of the inlet duct using Finite Element Analysis must be used where the inlet or any other nozzle or opening exceeds one third of the stack shell internal diameter at that location. The buckling factor must meet the minimum required by the standard and all factors of safety and buckling factors must be the same as the filter vessels. Stacks must not be directly connected to ductwork and shall have a suitable flexible connector. Stacks must be sealed at a location below the lowest inlet with provision for drainage. The maximum deflection of the stack under serviceability wind loads is 25% of the diameter of the upper most section of the stack excluding any reducer cone under serviceability windspeeds.

Co-joined multiple inlet ducts are not permitted on FRP stacks and an independent Y branch must be fitted to the inlet via a flexible joint.

Provision of bracketry for air sample pipework and lightening conductors etc must be made.

Stack anchoring must be of a single flange design, individual hold down lugs or clips are not permitted.

Detailed design for the vent stack must be provided to Sydney Water for written approval, along with calculations, prior to the fabrication of the stack.

FRP Stacks below 14m in height do not require third party verification or inspection. Stacks above 14m but less than 20m require third party verification only, all stacks above 20m require third party verification and third party inspection.

3.1.3.13 Fans

The fan(s) with variable speed drive (VSD) must provide exhaust ventilation of the odorous source. For network sites, a single fan arrangement with isolation valve for replacement is recommended. For larger critical sites like treatment plants duty/standby with automatic change-over is required. For all systems it is preferred that the fan(s) be installed after the contactor and draw air through the contactor under vacuum to remove the risk of gas leaks under pressure. For biotrickling filters combined with activated carbon polishing, it is preferred that the fans be installed after the biotrickling filter and before the activated carbon filter so that the inlet air into the activated carbon is not saturated with water.

The fan(s) must be selected to provide the designated airflow under the system head pressure. . Fan performance curves must be provided with the design documents.

The fan must be constructed from materials suitable for the environment in which it will operate. Materials of construction and clearances between impeller and fan scroll must always be provided to ensure that no spark potential is possible within the fan. The fan must be fitted with a 4-pole flameproof motor to satisfy the requirements of the relevant classification specified by AS/NZS 60079 and must be sized to be non-overloading over the range of operation.

Where required, the fan must be lagged and fitted with discharge and inlet silencers to ensure that the sound pressure level requirements are complied with.

Airflow monitors (one flow switch per fan outlet) must be provided to indicate whether a fan is running when called to operate. Failure of air flow must be used to lock out operation of the fan and any duct heater (and any other equipment of concern). The airflow monitor must be installed on the downstream side of any fan isolation damper valve.

The Contractor must provide a price for supply and lead time of an additional fan to be held as a critical spare. Sydney Water reserves the right to choose whether to take up this option or not.

3.1.3.14 Integrity of system

The complete ductwork system, through the main duct, adsorber inlet and outlet ducts, any bypass duct and stacks, must be completely gas tight and soap bubble tested at the operating pressure of the OCU. All ductwork and associated ventilation equipment must be fabricated and installed to the Standards specified in this document.

Any joints, ducts, bends, etc., that do not meet this requirement must be remade or replaced at no cost to Sydney Water.

3.1.3.15 Dampers

Dampers must be provided to perform the functions of diverting or modulating the airstream to the OCU as required and as directed by the monitoring and control system. Dampers that are intended for air diversion only must operate either in the fully open or fully closed position. Dampers used to modulate airflow and for balancing purposes must be fabricated and installed in accordance with the specified Standards in this document, and to materials standards as specified in these Clauses.

The dampers must be stainless steel or FRP, factory assembled units. UPVC dampers may be used for sizes ≤DN200 subject to Sydney Water acceptance. Each unit must be supplied for heavy-duty operation and must operate through 90 degrees of operation, from fully open to fully closed.

All FRP damper bodies, housings, bracketry and blades for OCU service must be designed and constructed to BS EN13121:2016 for a 25 year service life and consist of an internal corrosion barrier, a structural layer and an outer surface layer, as specified under relevant sections of BS EN13121:2016.

The corrosion barrier must be constructed from corrosion resistant vinyl ester resin, suitable for the application, and comprise a minimum backing layer of 900gsm of CSM subject to any additional requirement recommended by the resin supplier. The main structure must also be constructed from vinylester resin. The overall design factors must be calculated based on the design conditions and specified minimums in this specification, the value of K must not be less than 6 and F shall not be less than 4.

FRP damper bodies must be designed such that any mounted actuators are anchored to a bracket and not bolted directly through the FRP body. This bracket may be FRP or Stainless steel and be laminated directly to or bolted via a flange or spigot arrangement. The design must permit the access to the actuator mounting bolts for ease of maintenance or repair.

Dampers for non-intrinsically safe isolation and flow modulation must have a Class 1 leakage rate tested as per Air Movement and Control Association (AMCA) Standard 500-D.

All damper spindles, bearings and ancillary components must be stainless steel, and suitable for operation in an atmosphere where saturated air and H_2S gases are present. Damper/isolation valve bearings at installations with salt loaded atmosphere (marine environments) must be sealed and lubricated stainless steel journal or rolling element bearings (also consider PTFE or other shaft linings). Any components where galvanizing is used or where copper or brass components are used are not accepted.

Provision for safe isolation of filters for maintenance must not be achieved using dampers (refer *Inlet Isolation Valve* Clause above)

3.1.3.16 Air curtains

To minimise any short circuiting and/or to focus the draw of air from one direction an air curtain(s) may be required. The need for an air curtain must form part of the Needs Specification and Concept Design supplied by the Contractor and accepted by Sydney Water. If required, a suitable air curtain must be designed, fabricated and installed by the Contractor. All aspects of Sydney Water 'requirements for confined space entry must be complied with when installing the air curtain(s).

3.1.4 Mechanical works

The design and construction of the mechanical works must be in accordance with the requirements contained in Sydney Water's Technical Specification – Mechanical (BMIS0209), unless otherwise specified in this document.

3.1.5 Electrical

The design and construction of the electrical works must be in accordance with the requirements contained in Sydney Water Technical Specification – Electrical (CPDMS0022).

All equipment must be new and suitable for its purpose. They must comply with the Australian Standards and must be rated for continuous in-service condition within a switchboard.

All items of equipment must be designed, manufactured and installed to perform their required functions reliably and efficiently. Considerations must be made to ensure the designed system and selected equipment could be operated and maintained safely and efficiently. Particular attention must be given to equipment installed in an adverse environment and/or exposed to weather.

Live equipment and terminals must be located behind removable covers or doors, and shrouded, to prevent accidental contact when the control panel's front doors are open, including equipment mounted on doors.

Where more than one item of equipment is supplied and installed to perform a particular function, all such items of equipment must be identical and completely interchangeable.

Sites are subject to power failure. The equipment must be designed for automatic restart when the power returns.

The Contractor must develop electrical circuits and control panel layout and submit these drawings to Sydney Water for review prior to manufacture. The Contractor must resolve with Sydney Water any issues of concern Sydney Water may have as a result of its review of these drawings prior to proceeding with ordering and manufacture.

All controls will be placed in a free standing painted stainless-steel cubicle as used for Sewage Pumping Stations (IP65 rating to AS 1939).

3.1.6 Telemetry

3.1.6.1 Networks

The OCU must be designed for connection to the Sydney Water telemetry system in accordance with the latest *Sydney Water IICATS Sewer Odour and Corrosion Standards TOG_TS08*.

3.1.6.2 Water Resource Recovery Facility

The OCU must be designed for connection to the Sydney Water WRRF SCADA system in accordance with the latest *Sydney Water Treatment Plant SCADA Standards D0000724*.

3.1.7 Instrumentation and control

Instrumentation must be positioned to maximise their accuracy while remaining safe to maintain and must not be left exposed to sunlight, the elements, magnetic fields, vibration, or where local indicators are difficult to read, unless written approval is first obtained from Sydney Water.

3.1.7.1 Networks

All instrumentation must comply with Sydney Water's *Technical Specification – Instrumentation and Control (General) HSS0009* (to be read in conjunction with *TOG_TS08* for networks). If there is any discrepancy between this document and HSS0009/TOG_TS08, it must be raised to Sydney Water at the design phase. The Contractor must resolve any issues of concern with the Sydney Waters Instrumentation and Control Engineer and obtain written approval from Sydney Water prior to proceeding with ordering and manufacture.

Differential pressure transmitters must be provided to measure the head loss across both the pre-filters and the OCU media bed. These transmitters must be calibrated in Pascals and must have a local display as well as being connected to the IICATS Remote Terminal Unit (RTU) for alarms of high pressure.

Air Flow switches must be provided for fans installed for OCU operation and be connected to the IICATS RTU for generating a no flow alarm and causing the fan to be shut off automatically.

If a heater is required, then temperature transmitters must be provided on the inlet and outlet of the heater unit. These transmitters must be calibrated in degrees Celsius (ºC) and must have a local display as well as the outlet transmitter being connected to the IICATS RTU for generating a high alarm and causing the heater to be shut off automatically.

If a flame arrestor or biotrickling filter followed by an activated carbon polishing unit are installed, then additional differential pressure indicators are required.

Hydrogen sulphide meters must be supplied to monitor the inlet and outlet OCU performance. These meters must be calibrated in ppm_v H_2S and will have a local display as well as being connected to the IICATS RTU. Refer to Clause 3.6 of this Specification for more detail.

3.1.7.2 Water Resource Recovery Facility

All instrumentation must comply with Sydney Water's *Technical Specification – Instrumentation and Control (General) HSS0009* (to be read in conjunction with *Sydney Water Treatment Plant SCADA Standards D0000724*). If there is any discrepancy between this document and the HSS0009/SCADA Standards, it must be raised to Sydney Water at the design phase. The Contractor must resolve any issues of concern with Sydney Water's Instrumentation and Control Engineer and obtain written approval from Sydney Water prior to proceeding with ordering and manufacture.

If local PLC control is required, then the Contractor must comply with the relevant Clauses of Sydney Water's Treatment Plant SCADA Standards D0000724 including Appendix J – PLC Hardware.

Differential pressure transmitters must be provided to measure the head loss across both the pre-filters and the OCU media bed. These transmitters must be calibrated in Pascals and must have a local display as well as being connected to the WRRF SCADA system for alarms of high pressure.

Flow switches must be provided for fans installed for OCU operation and be connected to the WRRF SCADA system for generating a no flow alarm and causing the fan to be shut off automatically.

An airflow meter shall be provided for continuous airflow reading of OCU operation and be connected to the WRRF SCADA system for fan speed control.

Where multiple OCUs units are installed in parallel to allow operation 100% of the time, an airflow measurement point shall be included for each unit to detect any single unit blockage. Thermal anemometer technology shall be applied for air flow measurement. Refer to the Sydney Water standard instrument list for approved suppliers.

If a heater is required, then temperature transmitters must be provided on the inlet and outlet of the heater unit. These transmitters must be calibrated in degrees Celsius (°C) and must have a local display as well as the outlet transmitter being connected to the WRRF SCADA system for generating a high alarm and causing the heater to be shut off automatically.

If a flame arrestor or biotrickling filter followed by an activated carbon polishing unit are installed, then additional differential pressure indicators are required.

Hydrogen sulphide meters must be supplied to monitor the inlet and outlet OCU performance. These meters must be calibrated in ppm_v H_2S and will have a local display as well as being connected to the WRRF SCADA system. Refer to Clause 3.6 of this Specification for more detail.

3.1.8 Access and auxiliary services

Adequate access must be provided to allow all expected operational and maintenance activities to be carried out in a safe and efficient manner.

Suitable road access must be provided for large vehicles required for media and equipment (such as fans, pre-filters or pumps) removal and installation (such as vacuum tankers, HIAB trucks or cranes).

Platform access must be provided for media removal and replacement. It must be large enough to hold two people and a pallet of media unless otherwise agreed by Sydney Water.

Platforms where required must be supported from the ground rather than from the adsorber and ductwork.

A Residual Current Device (RCD) protected 240V General Purpose Outlet (GPO) for general use must be provided in close proximity to the OCU.

A water supply with backflow prevention must be provided in close proximity to the OCU for process use. The Reduced Pressure Zone (RPZ) valve must be installed in a standard lockable cage.

A safety shower and eyewash station must be provided in close proximity to the OCU, which is supplied separately from the RPZ protected process water supply. Safety showers and eyewash stations are not required for activated carbon type OCUs.

Where a pre-filter is used, suitable cleaning facilities must be provided.

A suitable lockable location must be provided beside the OCU to provide storage of plant documentation (such as O&M manuals, Hazard ID list, plant diary, calibration records, , etc.)

3.1.9 Civil related

The design and construction of the civil works must be in accordance with the requirements contained in Sydney Water Technical Specification - Civil, and Sydney Water's Protective Coating Specification WSA 201.

3.1.9.1 Foundation

The OCU must be located on a concrete slab. The slab must be constructed on a suitably prepared ground. Its thickness and compressive strength must be adequate to bear the load of the unit. Rubber mats must be used for fibreglass tanks.

3.1.9.2 Drainage

The OCU must have gravity drainage facilities to remove condensate. The material of construction must be sulphuric acid resistant. Drains from the heater/demister must also be heat resistant. The drainage must be directed to a permissible disposable location, such as a wet well or sewer and no potentially basic/chlorine laden waste streams are to be mixed.

Each drainage point must be from the lowest point in the item being drained. and sufficient drainage points must be supplied to prevent any condensate from collecting in the OCU.

Drains may only be combined for gases of like quality. No drain from downstream of the media bed is to be connected to any drain from upstream of the bed.

All drain discharge points must have a water seal, which can be easily checked/refilled and removed for cleaning by the operator. The diameter of the water trap needs to be minimal 40mm and a height needs to sufficient to overcome the pressure difference and is typically at least 200mm. Where possible water traps are to be shaded to minimise evaporation from water seals.

3.1.9.3 Fencing

When nominated in the Contract as being required, depending on security risk, a chain-link wire fence must be supplied and installed as per Sydney Water Standard drawings DTC-5000 and 5001, with a gate at the perimeter of the network OCU area. It must be at least 2.0 m in height. It must be located so as not to interfere or restrict operational and maintenance activities.

3.1.10 Facility and equipment identification and labelling

All equipment must have a unique identification number. Sydney Water designates unique identification number for all its asset and associated equipment, and Sydney Water will assign these.

The facility and equipment identification and labelling must be in accordance with Sydney Water's Technical Specification D0001440 Commissioning - transitioning assets into operation.

A standard Sydney Water Facility Asset sign must be mounted on the OCU structure.

3.1.11 Critical spares

The Contractor must provide a list of any critical spares they consider necessary, including the cost of provision and their source, with their detailed design submission. Sydney Water will review the list and advise those items that the Contractor must provide under the contract. Refer D0001440 for more details.

3.1.12 Operating and maintenance manual

An Operating and Maintenance (O&M) manual must be provided for the OCU. An acceptable O&M manual is considered a key requirement for successful contractual handover. It must be provided in both paper form (2 copies) and electronic form (on CD-R/DVD/USB, in both Word and PDF formats for every component) and equipment FMECAs must be in Excel format. In addition, editable file copies must also be provided where created by the Contractor in a format suitable for Sydney Water (for example, Microsoft Word and Excel documents, AutoCAD for drawings, etc.).

The manual must be in accordance with Sydney Water's Technical Specification D0001440 Commissioning - transitioning assets into operation.

The manual must include, but not limited to:

- Overview of the OCU conceptual design and how it fits into the local management of odour and corrosion control, with reference to general location drawing.
- Detailed description of the unit and its components, process, and performance criteria.
- Detailed P&IDs, complete list of all equipment items (including electrical items) and a cross reference to Sydney Water's asset numbers where relevant.
- Detailed information for each supplied piece of equipment (Manufacturer, Supplier, model number , etc.).
- A list of Suppliers and their current contact details.
- Pump and fan curves where relevant (including any test data).
- Pressure drop data through media and (pre-) filters at design airflows.
- Standard operating instructions covering all routine work requirements (for example, system start up, shut down, routine monitoring, changing of media, etc.).
- Process optimisation and troubleshooting guide.
- Where relevant, a copy of the PLC functional description, Input/Output listings, electronic copies of PLC programs, details of the programming software used (including version details) and where it can be obtained.
- Reference listing of all monitoring and alarm signals both locally and transmitted to IICATS (network) or WRRF SCADA system (Treatment Plants). For each alarm, this must include detail of how the alarm generates (primary device, condition, relevant relays, etc.).
- Reference listing of all interlocks and system timers (their values, allowable ranges and where these are set).
- Recommended routine inspection and maintenance schedule including replacement schedule of treatment media.
- List of any recommended spares to be held.
- Instructions on storage, loading/unloading, and MSDS of treatment media and any other chemicals (e.g. nutrients) required.
- A drawing register of all drawings supplied (such as drawing number, title, revision number, etc., grouped by type)

- WAC drawings covering all aspects of the OCU installation
- Complete program settings for all programmable equipment (for example, Differential Pressure Transmitters).
- Supplier equipment manuals for all items provided (including electrical equipment).

3.2 Activated carbon type OCU

A generic P&ID of this system is provided in Appendix A.

3.2.1 General

The activated carbon adsorption units must be capable of continuously treating odorous air at 100% relative humidity at specified flow rates.

The units must be designed to meet the required efficiency. Outlet conditions for the clean air discharge must meet discharge odorous gas limit concentration (see Clause 3.1.2.2 *Minimum requirements*).

The activated carbon adsorption system must be supplied complete with all auxiliary equipment required for system operation. The activated carbon media must also be supplied unless Sydney Water has exercised its right to free supply the activated carbon.

The activated carbon filter system must generally consist of an inlet isolation valve, pre-filter, flame arrestor (where required), heater, activated carbon housing and activated carbon media, extraction fan(s), discharge stack, control equipment panel, and monitoring equipment.

The minimum activated carbon design bed life must be 24 months based on the agreed maximum gas contaminant loading rate. The bed life is defined as the length of time between replacements of the activated carbon media based on breakthrough of gas contaminants above the target design levels. The Contractor must submit calculations to Sydney Water, substantiating the amount of carbon to meet the carbon bed life specified.

The activated carbon adsorption units must have a minimum empty bed gas residence time (EBRT) of three (3) seconds with the activated carbon media at the maximum design airflow.

Design of the activated carbon adsorption units must employ methods to prevent caking, solidifying and blooming of the impregnated activated carbon.

The activated carbon adsorption units must be designed structurally to withstand both the operating gas pressures (whether operating under a vacuum as preferred or under positive pressure) as well as any other stresses that might be expected during loading and unloading of the media (for example, people standing on top with carbon).

3.2.2 Pre-filter(s)

One easily removable and cleanable pre-filter assembly must be installed downstream of the inlet isolation valve and upstream of all other OCU equipment. This pre-filter is intended to remove fats, greases, particulate matter, and aerosols from the airstream and hence protect the flame arrestor (if required) and the activated carbon media from contamination. Platform ladder or scissor lift access for cleaning is not acceptable.

The pre-filter must be easily obtainable and of the honeycomb type designed to remove particulate matter and must have a removal efficiency of 96% based on No.3 dust to AS 1324.2, and of corrosion resistant construction materials. The pre-filter design must be sufficient to provide consistent flow to the unit for a period of one month between cleaning events, whilst not creating a manual handling issue for cleaning.

The filter(s) must be mounted in a frame and be constructed to prevent bypassing of the filter by inlet air.

One spare set of filter(s) must be supplied (with an appropriate storage enclosure where no onsite storage is available) as well as a suitable wash bay adjacent to the pre-filter for cleaning the filters on site. The cleaning container must be able to be drained back to the sewer. A suitable container for transporting the filters offsite for cleaning must also be provided.

The design of the pre-filter must facilitate easy removal of the pre-filter for cleaning/replacement without creating a source of gas leaks.

The filter housing must have a graded floor to a drain (minimum 40mm) connected back to the sewer via a visible water seal. The water seal must be able to be easily checked/filled manually. The pre-filter, filter housing and drain must be resistant to condensate attack.

3.2.3 In-Line Heater/Demister

In-line duct heating must be provided on the inlet side of the adsorber unit to ensure that the temperature of the saturated air to the OCU can be raised to achieve reduced humidity to prevent moisture entrainment and optimal adsorption in the activated carbon bed. The capacity of the heater must be sufficient to reduce the relative humidity to less than 70% for the design inlet airflow with a relative humidity of 100% at 20 degrees Celsius. The in-line heater must be of the black body type and must be hard wired over temperature cut out if fan failure or similar prevents air movement over the heater elements. The in-line heater must not operate unless the fan is running and airflow through the inlet ducting is ensured. Temperature measurement and indicators must be provided on the inlet and outlet of the heater. These must be used to switch on/off the heater to maintain a temperature difference between inlet and outlet of about 5 degrees Celsius.

The heater box must be adequately drained to the sewer to ensure the heater elements do not become immersed in condensate. The drain must be both resistant to condensate attack as well as high temperatures in case the heater overheats.

A humidity sensor must be provided at the inlet to the heater to control heater operation. The humidity sensor type must be agreed with Sydney Water as a hold point.

An in-line heater will be provided at all times, even when an activated carbon product is used that is not susceptible to moisture entrainment, and therefore would not require an in-line heater. Alternative activated carbon types that are more cost effective might be used in the future and might require pre-heating.

3.2.4 Adsorber unit

The activated carbon vessel, internal components, and structural components must be made of fibreglass or equivalent corrosion resistant material as specified in Clause 3.1.3.4 Where fibreglass is used, the suitability of this material with resins selected for resistance to activated carbon, the products of reaction and the general sewage environment must be required. The colour of the odour adsorber unit must be in accordance with WSA 201.

The effective volume of the activated carbon vessel will be such that 20% extra bed depth can be added if necessary, in the future when additional activated carbon is required or when a different type (e.g. lower density) of activated carbon will be used.

The design must include lockable access hatches for loading and removal of spent carbon, and for inspection of any other ancillary equipment. The hatches must be of sufficient size to allow both removal of carbon by suction hose through the top, and by manual shovelling through the side. The hatches must allow the easy removal of any internal components such as screens for maintenance purposes.

The adsorber and associated ductwork must be designed to minimise pressure drop, prevent any short circuiting of gas flow, and provide easy access for maintenance.

3.2.5 Monitoring

Monitoring systems must be provided, as detailed in Clause 3.6 of this Specification. of this Specification. Three additional permanent sampling ports must be provided on the adsorber, each at increasing depths across the activated carbon media bed (for example, at 25%, 50% and 75% of the bed depth). These must be terminated in 12mm full bore stainless steel ball valves and be designed to withdraw a representative gas sample at that depth without blockage or escape of the carbon media.

3.2.6 Control system

The activated carbon system must be designed for unmanned remote operation fully automated with allowance for manual operation.

The activated carbon system unit must be installed with the following additional sensors and monitors as a minimum:

- Air flow monitoring (flow switch after fan) – interlocked to shut down the heater and connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Differential pressure transmitter over the pre-filter – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Differential pressure indicator over the activated carbon filter – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Temperature transmitters before and after the heater – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Where required, Lower Explosive Limit (LEL*) – interlocked to shut down the unit at >5%** and connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).

*NOTE: * LEL is defined as the concentration of flammable gas, vapour or mist in air below which an explosive gas atmosphere will not be formed. For methane, the LEL is 5% (by volume) in air.*

*** Where the LEL has the potential to be >5% there will need to be an assessment on whether the installation is in a Zone 2 classified area. The definition of a Zone 2 classified area is a place in which an explosive gas atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only. If so, appropriate requirements are to be included (refer TG0502 – Classification and Management of Flammable Gas Hazardous Areas).*

3.2.7 Adsorptive media

The Contractor must include information including details and price of the activated carbon intended to be supplied in the concept design for review. Sydney Water may agree to proceed with this intended carbon, however, reserves the right to specify the carbon to be used for detailed design purposes. In this case, Sydney Water will provide performance information of the carbon to the Contractor, to facilitate the detailed design of the OCU.

Sydney Water reserves the right to free supply the activated carbon for the OCU and not use the media offered by the Contractor. Where Sydney Water agrees to use the Contractors carbon, it must comply with the following requirements:

- The adsorptive media must be either impregnated activated carbon or other similar proprietary media that is predominantly an activated carbon material, chemically treated to adsorb the constituent gases from the collected airstream.
- The carbon must be extruded, steam activated and impregnated with sodium hydroxide or potassium hydroxide, potassium iodide or copper oxide. Details of the selected adsorptive media, and its performance characteristics, particularly moisture ingress must be provided. Peat, coconut shell or high-grade coal must be used as the base material for manufacture of the carbon.
- The depth of media must be such that the minimum contact time for the airstream in the OCU is at least 3 seconds at maximum design airflow without exceeding the manufacturer recommended gas velocity through the activated carbon (typically maximum 25-30 cm/s). The adsorptive media must be evenly distributed in the bed so that no bypassing or short circuiting of foul air occurs within the OCU.
- The activated carbon must also be required to absorb levels of hydrocarbons that may be present at times.
- The design life of the adsorptive media must be a minimum of 24 months. The activated carbon must have an odour removal efficiency of not less than 99% for all sewer based odours and meet discharge odorous gas limit concentration.

The carbon media must meet the following minimum specifications.

Sodium Hydroxide/Potassium Hydroxide (Caustic) Impregnated Activated Carbon (NaOH/KOH)

PARAMETER	REQUIREMENT	TEST METHOD
Potassium Hydroxide or Sodium Hydroxide content	up to 10%	
Apparent Density	0.45 to 0.62 g/mL	ASTM D2854
Ball-Pan Hardness	95 minimum	ASTM D3802
Particle Diameter	4 mm	ASTM D2862
Particle Length	6 mm	ASTM D2862
Mean Particle Diameter	3.6 to 4.7 mm	ASTM D2862
Surface Area	1000 m^2/g minimum	N_2 BET Method
Hydrogen Sulphide Breakthrough Capacity	0.06 H_2S g/cm^3 Carbon minimum	ASTM D6646

Potassium Iodide Impregnated Activated Carbon

PARAMETER	REQUIREMENT	TEST METHOD
Potassium Iodide content	1.8% minimum	
Apparent Density	0.40 to 0.60 g/mL	ASTM D2854
Ball-Pan Hardness	90 minimum	ASTM D3802
Particle Diameter	3 to 4 mm	ASTM D2862
Particle Length	6 to 8 mm	ASTM D2862
Mean Particle Diameter	3.6 to 4.8 mm	ASTM D2862
Surface Area	1000 m^2/g minimum	N_2 BET Method
Hydrogen Sulphide Breakthrough Capacity	0.09 H_2S g/cm^3 Carbon minimum	ASTM D6646

Copper Oxide Impregnated Activated Carbon

PARAMETER	REQUIREMENT	TEST METHOD
Copper Oxide content	5% minimum	
Apparent Density	0.40 to 0.55 g/mL	ASTM D2854
Ball-Pan Hardness	90 minimum	ASTM D3802
Particle Diameter	2 to 3.5 mm	ASTM D2862
Particle Length	3 to 5 mm	ASTM D2862
Mean Particle Diameter	2.25 to 3.89 mm	ASTM D2862
Surface Area	1000 m^2/g minimum	N_2 BET Method
Hydrogen Sulphide Breakthrough Capacity	0.07 H_2S g/cm^3 Carbon minimum	ASTM D6646

An analysis sheet must accompany each batch of carbon media. Random sampling may be carried out by Sydney Water for product quality testing. The testing may be made by any laboratory approved by Sydney Water. All costs associated with the test work must be borne by the Contractor.

3.3 Biotrickling filter with carbon polishing type OCU

Generic P&ID of stand-alone activated carbon and biotrickling filter are provided in Appendices A and B.

3.3.1 Pre-filter

A pre-filter will not normally be required. However, if a flame arrestor is required upstream of the biotrickling filter, then a pre-filter will be required. For details, see Clause 3.2.2 of this Specification.

3.3.2 Biotrickling filter unit

The biotrickling filter units must be capable of continuously treating odorous air at the specified flow rates and be designed to meet the minimum required removal efficiency of 99% H_2S following commissioning.

The biotrickling filter must be supplied complete with all auxiliary equipment required for system operation. The biotrickling filter unit must generally consist of an inlet isolation valve, one or more contactors containing a suitable bio growth media and support frame, a liquor recirculation system, if part of the Suppliers' design, to maintain the media in a moist state, a liquor decant and makeup (water and nutrients where required) system, extraction fan(s), discharge stack, control equipment panel, and monitoring equipment.

One or multiple layers of media will be of a design such that it provides sufficient surface and contact time (EBRT of 10 seconds is required under normal operation and an EBRT of 8 seconds when one tower is offline, or as specified) to treat agreed contaminant loads to the agreed discharge quality whilst being open enough to not suffer from blockage or short circuiting over its operational life span. The number of media layers and treatment stages are as specified by the Supplier. The Contractor must submit calculations to Sydney Water, substantiating the choice of media to meet the required performance and life span. The media must be guaranteed for at least 10 years without the requirement of media change-out, without pressure drop increase (no increase after start-up period) nor shrink or compact (maximum 5% compaction of the original bed depth). Examples or specific tests illustrating that the media can be guaranteed must be provided as part of the proposal.

The biotrickling filter must be designed structurally to withstand both the operating gas pressures (whether operating under a vacuum as preferred) as well as any other stresses that might be expected during loading and unloading of the media. Where the roof of the unit is to be used for refilling the OCU and personnel access is required the roof must be flat and designed for 2.5kPa (in addition to any vessel operating loads i.e. vacuum) and have a suitably designed area for the landing of media. This area must be a minimum of 1.5m x 1.5m to accommodate a standard pallet. The design of this area must be a minimum of 4kPa. The area must be marked according to identify the landing spot and marked "max load 4kPa". Compliant handrail must also be fitted. Where personnel access is not required for maintenance, the roof may be any other shape. For any roof design pooling of water must be minimised. The location of any nozzles must be as far as practicable below the roof or where absolutely necessary at the edge of the roof to permit ease of access. Centrally located nozzles or other items or equipment are to be avoided and will require justification and will only be permitted by written approval of Sydney Water.

The biotrickling filter shell, internal components, and structural components must be made of fibreglass or equivalent corrosion resistant as specified in Clause 3.1.3.4. Where fibreglass is used, the suitability of this material with resins selected for resistance to biological attack, the products of reaction and the general sewage environment must be demonstrated.

The design must include access hatches for loading and removal of support media, and for inspection of any other ancillary equipment. The hatches must be of sufficient size to allow both removal of bio growth media through the side, and inspection and maintenance of the distribution sprays at the top. The inspection hatch(es) must be designed to allow visual inspection by operators of the sprays and the top of the media during normal operation. The hatches must allow the easy removal of any internal components such as screens for maintenance purposes. Guardrails must comply with the requirements of AS 1657: Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation.

For activated carbon type filters, it is required that the fans be installed after the treatment component and draw air through the unit under vacuum, in order to remove the risk of gas leaks under pressure. For biotrickling filters combined with activated carbon polishing, it is required that the fans be installed after the biotrickling filter and before the activated carbon filter. Operation under vacuum will have implications on the structural design of the various elements and on the operation of the various monitors, and these must be considered in the concept design.

The biotrickling filter and associated ductwork must be designed to minimise pressure drop, prevent any short circuiting of gas flow, and provide easy access for maintenance. The colour of the odour adsorber must be in accordance with WSA 201.

3.3.3 Adsorber unit

The adsorber shell, internal components, and structural components must be made of fibreglass or equivalent corrosion resistant material as specified in Clause 3.1.3.4. Where fibreglass is used, the suitability of this material with resins selected for resistance to activated carbon, the products of reaction and the general sewage environment must be required. The colour of the odour adsorber unit must be in accordance with WSA 201.

The design must include access hatches for loading and removal of spent carbon, and for inspection of any other ancillary equipment. The hatches must be of sufficient size to allow both removal of carbon by suction hose through the top, and by manual shovelling through the side. The hatches must allow the easy removal of any internal components such as screens for maintenance purposes.

The adsorber and associated ductwork must be designed to minimise pressure drop, prevent any short circuiting of gas flow, and provide easy access for maintenance.

The minimum activated carbon design bed life must be 24 months based on the agreed maximum gas contaminant loading rate. The bed life is defined as the length of time between replacements of the activated carbon media based on breakthrough of gas contaminants above the target design levels. The Contractor must submit calculations to Sydney Water, substantiating the amount of carbon to meet the carbon bed life specified.

The activated carbon adsorption units must have a minimum empty bed gas contact time (EBRT) of two (2) seconds with the activated carbon media at the maximum design airflow.

The effective volume of the activated carbon vessel will be such that 20% extra bed depth can be added if necessary in the future when additional activated carbon is required or when a different type (e.g. lower density) of activated carbon will be used.

The Contractor must include information including details and price of the activated carbon intended to be supplied in the concept design for review. Sydney Water may agree to proceed with this intended carbon, however, reserves the right to specify the carbon to be used for detailed design purposes. In this case, Sydney Water will provide performance information of the carbon to the Contractor, to facilitate the detailed design of the OCU (see also Clause 3.2.7).

Sydney Water also reserves the right to free supply the carbon to be used from its own store.

3.3.4 Monitoring

Monitoring systems must be provided, as detailed in Clause 3.6 of this Specification. The Contractor must provide any additional sampling points at the inlet and outlet ductwork necessary to adequately monitor the performance of the OCU or its key components.

3.3.5 Control system

The biotrickling filter with activated carbon system must be designed for unmanned remote operation fully automated with allowance for manual operation.

The biotrickling filter with activated carbon system unit must be installed with the following additional sensors and monitors as a minimum:

- Water flow rate to nozzles – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Water usage – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Free Chlorine – connected to IICATS (Networks) or WRRF SACDA system (Treatment Plants).
- Nutrient flow (flow switch) – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Level and/or low-level switch of the liquid in the nutrient storage tank – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Air flow monitoring (flow switch after fan) – connected to IICATS (Networks) or airflow reading from anemometer connected to WRRF SCADA system (Treatment Plants).
- Differential pressure indicator over the BTF and activated carbon unit with local readout and connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Where required, Lower Explosive Limit (LEL) – interlocked to shut down the unit at >5% and connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Where required, pH and or electrical conductivity level for the sump liquor – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants). In addition, provision for taking a sample of the drain or sump liquid must be provided.
- Where required, level of liquor in contactor sump – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants). In addition, a manual sight glass must be provided to allow visual checking.

Both the biotrickling filter and activated carbon unit must have a local differential pressure indicator. Three additional permanent sampling ports must be provided on the adsorber, each at increasing depths across the activated carbon media bed (for example, at 25%, 50% and 75% of the bed depth). These must be terminated in 12 mm full bore stainless steel ball valves and be designed to withdraw a representative gas sample at that depth without blockage or escape of the carbon media.

3.3.6 Liquor recirculation system

A minimum of two pumps with automatic change-over must be provided to recirculate the sump liquor. They must be in duty/standby arrangement. The pumps must be centrifugal pumps and mechanically sealed. The pump head and seals must be suitable for the corrosive nature of the sump liquor.

A sump purge valve must be provided to flush out contaminant build up within the reticulation system. This must be automatically controlled and allow for operator adjustment.

Flow indication must be provided for each component flow on the recirculation system including flows to the humidifier (if present), to the spray in each contactor, and to monitoring instruments.

A no flow alarm must be provided in case the recirculation of sump liquor fail. Similarly, a low liquor sump level alarm must stop the recirculation pumps. Failure of the reticulation system must be connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).

Any automated valves must be provided with a manual by-pass.

A single-pass type system must provide all flow indications and alarms to ensure that proper water flows is provided for each component flow on the system including flows to the humidifier (if present), to the spray in each contactor, to monitoring instruments. A single-pass system must be provided with a separate recirculation tank, associated equipment, and instruments (refer Appendix B) for the purposes of seeding on start-up and reseed as required.

3.3.7 Nutrient dosing system

Where potable water is used as process input, a nutrient dosing system must be provided to dose the sump liquor during purge makeup sequence. The dosing system must consist of storage tank, duty dosing pump, low level indicator, calibration tube, backpressure valve, pressure gauge and dosing lines. It must comply with the relevant sections of Sydney Water's Technical Specification - Mechanical, Clause M37: Chemical Systems. For network OCU nutrient dosing, ACP0002 does not apply.

A standby pump is not required for nutrient dosing at treatment plants.

3.4 Biotrickling filter type OCU

A generic P&ID of a stand-alone biotrickling filter is provided in Appendix B. Stand-alone biotrickling filters are not preferred by Sydney Water and will not normally be accepted in built up areas or where they would be close to neighbouring residents unless the Supplier can prove reliable long-term operations with sufficient performance. A combination of biotrickling filter with an activated carbon polishing filter will be accepted and the technical specifications of a biotrickling filter combined with a carbon polishing unit are provided in Clause 3.3.

3.4.1 Pre-filter

A pre-filter will not normally be required. However, if a flame arrestor is required upstream of the biotrickling filter, then a pre-filter will be required. For details, see Clause 3.2.2 of this Specification.

3.4.2 Biotrickling filter unit

The biotrickling filter units must be capable of continuously treating odorous air at the specified flow rates and be designed to meet the minimum required removal efficiency of 99% H_2S and 95% of the odour concentration as measured according to AS/NZS 4323.3. Outlet conditions for the clean air discharge must meet discharge odorous gas limit concentration as specified in Clause 3.1.2.2.

The biotrickling filter must be supplied complete with all auxiliary equipment required for system operation. The biotrickling filter unit must generally consist of an inlet isolation valve, contactors containing a suitable bio growth media and support frame, a liquor recirculation system, if part of the Suppliers' design, to maintain the media in a moist state, a liquor decant and makeup (water and nutrients) system, extraction fan(s), discharge stack, control equipment panel, and monitoring equipment.

Different layers of media will be of a design such that it provides sufficient surface and contact time to treat agreed contaminant loads to the agreed discharge quality whilst being open enough to not suffer from blockage or short circuiting over its operational life span. The number of media layers and treatment stages are as specified by the Supplier, providing at least one stage with an acidic pH to provide optimal conditions for the autotrophic micro-organisms and at least one stage with a neutral pH (pH 6-8) to provide optimal conditions for the heterotrophic micro-organisms. The Contractor must submit calculations to Sydney Water, substantiating the choice of media and the number of stages to meet the required performance and life span. The media must be guaranteed for at least 10 years without the requirement of media change-out, without pressure drop increase (no increase after start-up period) nor shrink or compact (maximum 5% compaction of the original bed depth). Examples or specific tests illustrating that the media can be guaranteed must be provided as part of the proposal.

The diameter and height of the biotrickling filter must be properly sized to meet the specified performance requirements. The biotrickling filter must have a minimum contact time (EBRT of 10 seconds is required under normal operation and an EBRT of 8 seconds when one tower is offline, or as specified) sufficient to provide 99% removal efficiency of H_2S and 95% removal efficiency of all odours during normal operation and meet discharge odorous gas limit concentration as specified in Clause 3.1.2.2.

The biotrickling filter must be designed structurally to withstand both the operating gas pressures (whether operating under a vacuum as preferred or under positive pressure) as well as any other stresses that might be expected during loading and unloading of the media. Where the roof of the unit is to be used for refilling the OCU and personnel access is required the roof must be flat and designed for 2.5kPa (in addition to any vessel operating loads i.e. vacuum) and have a suitably designed area for the landing of media. This area must be a minimum of 1.5m x 1.5m to accommodate a standard pallet. The design of this area must be a minimum of 4kPa. The area must be marked according to identify the landing spot and marked “max load 4kPa”. Compliant handrail must also be fitted. Where personnel access is not required for maintenance, the roof may be any other shape. For any roof design pooling of water must be minimised. The location of any nozzles must be as far as practicable below the roof or where absolutely necessary at the edge of the roof. Centrally located nozzles or other items or equipment are to be avoided and will require justification and will only be permitted by written approval of Sydney Water.

The biotrickling filter shell, internal components, and structural components must be made of fibreglass or equivalent corrosion resistant as specified in Clause 3.1.3.4. Where fibreglass is used, the suitability of this material with resins selected for resistance to biological attack, the products of reaction and the general sewage environment must be demonstrated.

A demister may be required to prevent any carryover of liquid droplets with the outlet gas stream.

The design must include access hatches for loading and removal of support media, and for inspection of any other ancillary equipment. The hatches must be of sufficient size to allow both removal of bio growth media through the side, and inspection and maintenance of the distribution sprays at the top. The inspection hatch(es) must be designed to allow visual inspection by operators of the sprays and the top of the media during normal operation. The hatches must allow the easy removal of any internal components such as screens for maintenance purposes and access to the hatches must be provided. Guardrails must comply with the requirements of AS 1657: Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation.

The biotrickling filter and associated ductwork must be designed to minimise pressure drop, prevent any short circuiting of gas flow, and provide easy access for maintenance. The colour of the odour adsorber must be in accordance with the WSA 201.

3.4.3 Monitoring

Monitoring systems must be provided, as detailed in Clause 3.6 of this Specification. The Contractor must provide any additional sampling points at the inlet and outlet ductwork necessary to adequately monitor the performance of the OCU or its key components.

3.4.4 Control system

The biotrickling filter must be designed for unmanned remote operation fully automated with allowance for manual operation.

The biotrickling filter unit must be installed with the following additional sensors and monitors as a minimum:

- Water flow rate to nozzles – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Water usage – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Nutrient flow (flow switch after dosing pump) – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Level and/or low-level switch of the liquid in the nutrient storage tank – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Air flow monitoring (flow switch after fan) – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).

- Differential pressure indicator over the BTF – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Where required, Lower Explosive Limit (LEL) – interlocked to shut down the unit at >5% and connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).
- Where required, pH and or electrical conductivity level for the sump liquor – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants). In addition, provision for taking a sample of the drain or sump liquid must be provided.
- Where required, level of liquor in contactor sump – connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants). In addition, a manual sight glass must be provided to allow visual checking.

3.4.5 Liquor recirculation system

A minimum of two pumps per stage with automatic change-over must be provided to recirculate the sump liquor. They must be in duty/standby arrangement. The pumps must be centrifugal pumps and mechanically sealed. The pump head and seals must be suitable for the corrosive nature of the sump liquor.

A sump purge valve must be provided to flush out contaminants build up within the reticulation system. This must be automatically controlled and allow for operator adjustment.

Flow indication must be provided for each component flow on the recirculation system including flows to the humidifier (if present), to the spray in each contactor, to monitoring instruments.

A no flow alarm must be provided in case the recirculation of sump liquor fails. Similarly, a low liquor sump level alarm must stop the recirculation pumps. Failure of the reticulation system must be connected to IICATS (Networks) or WRRF SCADA system (Treatment Plants).

Any automated valves must be provided with a manual by-pass.

A single-pass type system must provide all flow indications and alarms to ensure that proper water flows is provided for each component flow on the system including flows to the humidifier (if present), to the spray in each media layer and monitoring instruments. A single-pass system must be provided with a separate recirculation tank, associated equipment and instruments (refer Appendix B) for the purposes of seeding on start-up and reseed as required.

3.4.6 Nutrient dosing system

Where potable water is used as process input, a nutrient dosing system must be provided to dose the sump liquor during purge makeup sequence. The dosing system must consist of storage tank, duty dosing pump (plus standby for network installations), low level indicator, calibration tube, backpressure valve, pressure gauge and dosing lines. It must comply with the relevant sections of Sydney Water’s Technical Specification - Mechanical, Clause M37: Chemical Systems. For network OCU nutrient dosing, ACP0002 does not apply.

A standby pump is not required for nutrient dosing at treatment plants.

3.5 Chemical scrubber type

A generic P&ID of this system is provided in Appendix C. Chemical Scrubbers must only be used in treatment plants, and not the networks. This is due to the hazardous nature of the chemicals used.

3.5.1 Chemical scrubber unit

The chemical scrubber units must be capable of continuously treating odorous air at the specified flow rates and be designed to meet the minimum required removal efficiency of 99% H_2S and 95% of the odour concentration as measured according to AS/NZS 4323.3. Outlet conditions for the clean air discharge must meet discharge odorous gas limit concentration as specified in Clause 3.1.2.2.

The chemical scrubber unit must be supplied complete with all auxiliary equipment required for system operation.

Each scrubber must be a counter-current, packed-bed tower design with bottom gas inlet, top recirculation flow inlet. A mist eliminator must be installed at the scrubber outlet to prevent venting of entrained droplets. The mist eliminator must be sized to remove entrained droplets from the scrubbed gas stream and prevent fogging at the outlet of the vent stack.

The scrubber packing must either be a randomly packed or structurally packed type. The diameter and height of the packed bed must be properly sized to meet the specified performance requirements whilst being open enough to not suffer from blockage or short circuiting over its operational life span. The Contractor must submit calculations to Sydney Water, substantiating the choice of media to meet the required performance and life span. The media must be guaranteed for at least 10 years without the requirement of media change-out, without pressure drop increase (no increase after start-up period) nor shrink or compact (maximum 5% compaction of the original bed depth). Examples or specific tests illustrating that the media can be guaranteed must be provided as part of the proposal.

The chemical scrubber must be designed structurally to withstand both the operating gas pressures (whether operating under a vacuum as preferred or under positive pressure) as well as any other stresses that might be expected during loading and unloading of the media (for example, need to provide support for at least two people standing on top).

The tower, internal components, structural components and where applicable the sump tanks must be fabricated of fibreglass reinforced plastic or approved equal which is resistant to the chemicals used in and removed by the scrubbing process and must be fabricated in accordance with the requirements specified in BS EN13121 and as detailed in Clause 3.1.3.4 of this Specification.

The design must include access hatches for loading and removal of support media, and for inspection of any other ancillary equipment including the inspection and maintenance of the distribution sprays at the top. The inspection hatch(es) must be designed to allow visual inspection by operators of the sprays and the top of the media during normal operation. The hatches must allow the easy removal of any internal components for maintenance purposes and access to the hatches must be provided. Guardrails must comply with the requirements of AS 1657: Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation.

The chemical scrubber and associated ductwork must be designed to minimise pressure drop, prevent any short circuiting of gas flow, and provide easy access for maintenance. The colour of the odour adsorber must be in accordance with the WSA 201.

Each scrubber must be mounted on a sump tank integral with the scrubber shell. The sump tank must be sized to match with the design and operation of its associated scrubber. The tank must be a vertical, flat bottom storage tank, and must be fabricated with flanged nozzles, including the following:

- Scrubber (top)
- Access hatch/es, as far as practicable (top)
- Recirculation pump suction (side)
- Chemical make-up inlet(s) into recirculation line
- Make-up water inlet (side)
- Overflow (side)
- Drain (bottom).

The tank nozzles must be located as recommended by the Contractor to provide easy access and to minimise piping. All nozzle locations must be clearly labelled and located on the Shop Drawings. Required structural supports, hold down and lifting lugs must be installed. The size and configuration of access points must be designed to minimise the severity of the confined space within the scrubber.

3.5.2 Monitoring

Monitoring systems must be provided, as detailed in Clause 3.6 of this Specification. The Contractor must provide any additional sampling points at the inlet and outlet ductwork necessary to adequately monitor the performance of the OCU or its key components.

3.5.3 Control system

The chemical scrubber must be designed for unmanned remote operation fully automated with allowance for manual operation.

The chemical scrubber unit must be installed with the following additional sensors and monitors as a minimum:

- Water flow rate to nozzles – connected to WRRF SCADA system.
- Water usage – connected WRRF SCADA system.
- Chemical flow (flow switch after dosing pump) – connected to WRRF SCADA system.
- Level and/or low-level switch of the liquid in the chemical storage tanks – connected to WRRF SCADA system.
- Air flow monitoring (flow switch after fan) –connected to WRRF SCADA system.
- Differential pressure indicator over the chemical scrubber – connected to WRRF SCADA system.
- Where required, Lower Explosive Limit (LEL) – interlocked to shut down the unit at >5% and connected to WRRF SCADA system.
- Where required, pH, ORP and or electrical conductivity level for the sump liquor – connected to WRRF SCADA system. In addition, provision for taking a sample of the drain or sump liquid must be provided.
- Where required, level of liquor in contactor sump – connected to WRRF SCADA system. In addition, a manual sight glass must be provided to allow visual checking.

3.5.4 Liquor recirculation system

A minimum of two duty/standby pumps with automatic change-over must be provided to recirculate the sump liquor. They must be in duty/standby arrangement. The pumps must be centrifugal pumps and mechanically sealed. The pump head and seals must be suitable for the corrosive nature of the sump liquor.

A sump purge valve must be provided to flush out contaminants build up within the reticulation system. This must be automatically controlled and allow for operator adjustment.

Flow indication must be provided for each component flow on the recirculation system including flows to the spray in each contactor.

A no flow alarm must be provided in case the recirculation of sump liquor fail. Similarly, a low liquor sump level alarm must stop the recirculation pumps. Failure of the reticulation system must be connected to IICATS.

Any automated valves must be provided with a manual by-pass.

3.5.5 Chemical dosing system

A chemical dosing system must be provided to dose the recirculation line. The dosing system must consist of storage tank (at least 14 days of storage capacity), duty/standby dosing pumps, calibration tube, low level indicator, backpressure valve, pressure gauge and dosing lines. It must comply with the relevant sections of Sydney Water's Technical Specification – Mechanical, Clause M37: Chemical Systems.

An access point must also be provided to allow dosing of citric acid or equivalent for an acid wash on the scrubber to be carried out.

3.6 Monitoring system

These specifications relate to the monitoring of H_2S gas, as this gas is usually the predominant gas in sewer systems. Hence H_2S will be used as the online indicator gas for sewage odours that are present in the airstream at the inlet and outlet of the OCU. In some cases, Sydney Water will specify that there are more than one odorant of interest, or different target odorants. Where these odorants can be monitored online, the above also holds for these gases.

3.6.1 Standards and recognised practices

The standards that will be referred to and that are to be followed in the procurement, installation and maintenance of both high and low-level monitoring systems are as follows:

- "Air Pollution Measurement Manual" – A Practical Guide to Sampling and Analysis, Volumes 1 and 2, Clean Air Society of Australia and New Zealand (CASANZ).
- ISO 6141, ISO 6142, ISO 6143 – Gas Analysis
- AS 3580.2.1 "Preparation of Reference Test Atmospheres – Permeation Tube Method"
- AS/NZS 3580.2.2 – Preparation of Reference Test Atmospheres – Compressed Gas Method"
- "Handbook of Air Pollution Analysis", edit. Roy M. Harrison and Roger Perry. Chapman and Hall, printer/publisher: University Press, Cambridge 1986 ISBN 0412 244101

3.6.2 On-line monitoring system

A generic P&ID of this system is provided in Appendix D.

The complete monitoring system will consist of the following:

- H_2S analysers
- Sample port arrangement (draws sample away from duct wall)
- Sampling Pumps
- Condensate traps
- Flow Control Valves
- Flow Meters
- Differential Pressure sensors
- Pipework, Tubing and Ancillary Fittings
- Monitoring cubicle
- Data logging and display equipment
- Any other monitoring equipment as required by the specific site application to ensure reliable operation of the OCU (e.g., pH probes, chlorine analysers (dissolved and gas), LEL monitors, etc.)
- Where odour control is being maintained by a negative pressure -25Pa, the pressure under the covers of extracted process units at furthest point from the OCU is required to be monitored to prevent fugitive releases of odour.

The Supplier who must provide all the services, equipment, fixtures and fittings required to achieve a complete, fully integrated and operational monitoring system meeting all of the design conditions, testing requirements and warranty conditions as specified herein.

The monitoring system must comply with Sydney Water's Technical Specification - Instrumentation and Control (General) HSS0009 and Sydney Water's IICATS Sewer Odour and Corrosion Standards TOG_TS08 (for Networks) or WRRF Treatment Plant SCADA Standards D0000724 (for Treatment Plants).

The equipment supplied must be suitable for the specified operating conditions and must be designed and constructed for a minimum of 10 years. Electrochemical cell life must be of a minimum of 12 months at the specific operating condition.

3.6.2.1 H_2S monitors

H_2S monitors must be provided on the inlet and outlet of each unit process of the OCU. For example, a 7-tower bio trickling filter unit followed by a 2-cell activated carbon unit must have as a minimum an inlet H_2S monitor, a mid-point H_2S monitor and a discharge H_2S monitor to assess the performance of each unit process. As a minimum, H_2S monitors must be provided on the inlet and outlet of every individual OCU.

The H_2S monitors must provide accurate (see below at Clause 3.6.3.1 Electrochemical Cells) and reliable on-line monitoring of H_2S in the monitored gas stream at the required accuracy. The required accuracy will be determined by the designed output concentration.

It is recommended that the H_2S analyser be installed near (a maximum of 6 m) to the sampling port. This is to prevent the decomposition of sampled gases before presentation to the analyser.

3.6.2.2 Sampling lines and ports

Gas sampling arrangements must consist of sampling ports into the ductwork to allow the gas flow to be sampled away from the duct wall. Each of these sample ports must terminate in 12 mm full-bore stainless-steel ball valve. The outlet from the sampling port isolation valve is then piped to the condensate trap located in the monitoring cubicle. This line must either rise steadily to the condensate trap or have one high point only. There must be no low points that would act as water traps. Lines must meet the requirements set out in Clause 3.6.3.2 of this Specification. Hatches suitable for installing manual Odaloggers on both inlet and outlet must be provided and must be lockable.

3.6.2.3 Condensate trap

A high volume (in the order of 150 mL) condensate trap must be used. The trap must have a clear bowl to visually check its performance and must contain a suitable media to promote condensation. The trap will be connected to the suction side of the sample pump.

3.6.2.4 Sampling pump

A sample pump must be provided to withdraw gas from the sampling port (and the condensate trap if applicable) and provide a sufficient gas sample volume to the analyser. The pump is to be of the positive displacement, diaphragm or high-speed graphite vane types or other suitably approved type, which provide a gas sample stream at constant flow and constant pressure to the analyser. The pump is to be capable of withstanding system back pressure and must provide a minimum flow of 1 L/min to the sensor, at commissioning.

3.6.2.5 Flow control valves

From the outlet of the sampling pump the flow must be split to two (2) flow control valves, one to control the flow to the H_2S analyser, and the other controlling a side waste stream that is piped back to the ductwork. One of these valves is typically incorporated into the flowmeter going to the H_2S analyser.

All flow control valves must be of the high tolerance needle type valve, with stainless steel fittings and accessories. The valves must be suitable to operate in the conditions of the online monitoring system and must be sized to suit the required flowrate at midrange of the valve performance characteristics.

3.6.2.6 Flow meter

The flow meter must be of the rotameter type, with a full-scale deflection of 1 L/min. The meter will be selected to ensure that all internal surfaces are suitable for the gases present in the sample airstream. The flow meter will be installed upstream of the analyser.

3.6.2.7 Manual sampling ports

Manual sampling ports must be provided on the inlet sample line as well as on the discharge of the sample pump, to allow manual gas testing. The sampling port must terminate in 12 mm full-bore stainless-steel ball valve pointing upwards.

3.6.3 Analysers

Acrulog or equivalent.

3.6.3.1 Electrochemical Cells

Electrochemical cell type sensors, such as Acrulog, must be of proven design and capable of operating within the performance parameters and conditions described below.

ITEM	SPECIFICATION
Sampled Air Relative Humidity	15% to 90%
Temperature Range	-5°C to +40°C
Repeatability	2% of signal
Drift	Less than 5% per month
Operating Pressure	± 10% ambient
Output Signal	4 to 20 mA
Service Life	1 to 2 years
Response Time	Zero to +95% in 60 seconds
Recovery Time	1 to 5 minutes
Minimum Detection Limit	0.1 ppm_v
Maximum Range (inlet)	0 to 100 ppm_v

3.6.3.2 Pipework, tubing and ancillary fittings

All pipework, tubing and ancillary fittings (nominal internal diameter at least 6 mm) within the sampling and monitoring systems must be as scheduled in the table below in order to be resistant to corrosion and chemical absorption.

ITEM	SPECIFICATION
Pipework (rigid pipe)	All rigid pipework will be in stainless steel grade 316.
Tubing (Flexible)	All flexible tubing to be used only within the cabinet and will be PTFE (Teflon®) or equivalent and be connected to barbed hose fittings.
Ancillary Fittings	All fittings that provide connection will be stainless steel grade 316 of the highest-grade compression type, providing proper seals to prevent low level gas escape.

All internal lines and surfaces are to be subjected to a passivation gas treatment in order to minimise chemical absorption.

All lines must be graded to prevent capture of moisture and pressure drops due to moisture entrapment. Pipework must provide a steady rise (preferred) or a maximum of one high point - no low points will be acceptable.

All rigid sample lines are to be fixed where applicable by proper clamps that are similar or equal to ‘Stauff’ type. Mechanical protection of sample lines will be provided in those areas where potential damage to the line may occur. All sample lines are to be kept to a minimum length.

Materials of construction for the pipework that has not been specified will not be accepted.

3.6.3.3 Monitoring cubicle

All electronic components of the monitoring system must be mounted in a full-length free-standing cubicle similar to those used for SPS control cubicles (IP65 rating to AS 1939). The cubicle must be:

- Painted stainless steel grade 316 with double opening doors (no centre pillar and secured top and bottom)
- Fitted with recessed/internal hinges to present a clean external face when the cabinet doors are closed
- Have a lift out weather shield with wind resistant clips
- Have suitable vents for natural convection
- Suitable for locking with a padlock.

The cubicle must include a power distribution board of suitable IP rating with circuit breakers for each instrument, an RCD protected 240V GPO, and auxiliary cubicle items (for example, exhaust fans, light).

The cubicle must be fitted with a suitable light that is activated by opening the doors, an exhaust fan, and thermostatically controlled heater to prevent condensation during cold periods.

All equipment must be mounted on full size backboard made from a suitable non-metallic material.

The cubicle must nominally contain all required H_2S monitors and possibly others such as LEL and differential pressure transmitters. Careful layout of this cubicle is required with regard to levels to achieve steady grading of all sample tubing while also achieving a practical layout that allows both easy reading of displays and easy access for maintenance.

3.6.4 Calibration

Calibration will be provided on all equipment supplied within the sampling and monitoring system and will be carried out in accordance with the guidelines stated in Clause 3.6.1 of this Specification.

The calibration of all analysers will be carried out in accordance with either of the approved methods as detailed in the following:

- AS 3580 Method 2.1 – "Preparation of Reference Test Atmospheres – Permeation Tube Method"
- AS/NZ 3580 Method 2.2 – "Preparation of Reference Test Atmospheres – Compressed Gas Method"

Where proprietary calibration methods are used in checking the calibration of an analyser, the complete unit will be required to undergo calibration checks on a scheduled basis, to ensure that the total unit, and not simply the equipment electronics, is in full calibration.

4. Installation

4.1 Approval

Prior to installation, statutory approval from the local authorities must be obtained where required.

4.2 Installation practice

Written approval from Sydney Water and the designer must be obtained for any deviations from the accepted design.

4.3 Materials and equipment inspection

Prior to transportation to site, materials and equipment must be checked for compliance with the appropriate Specification or Standard by conducting a Factory Acceptance Test (See Clause 5.1 of this Specification). On site, prior to installation, materials and equipment must be checked to ensure that they are free from damage caused during transportation and are fit and suitable for use.

5. Commissioning (not applicable to passive OCUs)

Following installation, the OCU must be tested and commissioned in accordance with Sydney Water's Technical Specification - Commissioning - transitioning assets into operation D0001440. The commissioning plan as shown in the Appendices of D0001440 must be used by the Commissioning Coordinator to ensure all Sydney Water's requirements for asset commissioning are met.

The commissioning plan developed by the Contractor must be submitted to Sydney Water for review. Written approval from Sydney Water must be sought prior to commissioning.

The Contractor must provide the necessary expertise and resources for successful commissioning of the unit.

5.1 Pre-commissioning (Factory Acceptance Test)

Pre-Commissioning of the OCU must be carried out at the factory in the presence of relevant personnel from Sydney Water, prior to transportation to the relevant sites. The pre-commissioning work must include the following*:

- Running of the OCU and the testing of each fan's operation against its performance curve and design operating point.
- Testing of the control logic, sensors and programming.
- Testing of fail-safes and IICATS/SCADA alarms.
- Testing of dosing units, including pipe work, if pre-constructed.
- Structural integrity of OCU vessels.
- The whole structure of each OCU must be examined for any fugitive emissions that may be the result of leaks.
- Air flow rates and designed retention times are to be confirmed.
- Noise testing using certified testing equipment.

The OCU must not be transported to site until Sydney Water has accepted the tests*.

*Note * For some large WRRF installations (e.g. Malabar, North Head, Bondi, etc.) it may not be possible to carry out all the pre-commissioning factory tests as listed above due to the size of the OCU system (i.e. only Site Commissioning can be carried out). If this is the case then Commissioning works will include all Pre-Commissioning and Site Commissioning works as described in Clauses 5.1 and 5.2 once site installation is complete.*

5.2 Site commissioning

Following installation, the OCU must be test run for a minimum period of one (1) month. The Contractor is responsible for conducting on site performance tests to Sydney Water's satisfaction, to prove compliance with the guarantees. At a minimum, the following must be checked or carried out:

- Odorous gas component(s) removal rate
- Pressure, relative humidity, and flow rate of inlet and outlet gases
- Equipment operation and adjustment checks.
- Casing and insulation joint testing, for example, using soap bubble test at operating pressure.
- Noise testing using certified testing equipment.

- Structural inspection by a certified Structural Engineer.
- Controls and Alarms

During the test run period, the Contractor must maintain the OCU in a proper working manner. The unit must be used to demonstrate system performance to Sydney Water's satisfaction. The Contractor must carry out any work necessary to ensure the OCU is working correctly. At the end of this period, the Contractor must issue a certificate to verify that the unit is working properly.

The Contractor must supply all WAC Drawings, O&M Manuals along with trouble shooting guidelines and these must be verified during the commissioning period. The O&M Manuals must be in accordance with Sydney Water's Technical Specification D0001440 Commissioning - transitioning assets into operation and as described in Clause 3.1.12.

5.3 Performance testing

(i) General

Performance testing applies to all OCUs, unless specified by the purchaser.

Field performance tests must be carried out by the Supplier after installation and commissioning of the plant. The Supplier must undertake performance and systems tests to demonstrate acceptable performance, as defined by:

- Successful operation of each item of equipment.
- Overall system operation meets the performance criteria described in this specification, including correct operation in all control modes, e.g. in manual, local, and auto control.
- Inlet gas contaminant removal performance meets the criteria provided in this specification.

The Purchaser will give notice in writing of final acceptance to the Supplier following the successful completion of the performance testing.

The Supplier is to supply all test materials, temporary test equipment, consumables and experienced personnel required to demonstrate compliance with the specification.

Before performing any tests, the Supplier must arrange with the Purchaser to inspect the installation. When the following prerequisites are completed, the Purchaser will confirm a time for conducting the performance tests:

- The Purchaser has inspected the plant after commissioning and is satisfied with the installation and its function.
- All documentation associated with commissioning have been received and approved by the Purchaser.
- All test equipment used during tests must have a current calibration certificate (issued within the preceding 12 months) verifying its accuracy.

The Supplier must operate and be responsible for test equipment used during performance testing. Before making any changes to the odour system that could affect equipment or processes external to the odour control system, the Supplier must advise the plant operators of the intended change.

The Purchaser must have the right to observe, sample, and carry out any tests in parallel during performance testing.

The Supplier must include in their scope of work all sampling and laboratory analysis tasks. A Performance Testing Plan will be submitted to the Purchaser 4 weeks prior commencing the testing for approval.

Laboratory analyses must be done by an independent NATA accredited testing group. The testing group proposed by the Supplier must be reviewed and accepted by the Purchaser.

The Performance Testing Plan must include the verification of the guaranteed utilities (water, energy and nutrients consumption including pressure drop) and guaranteed removal of odour concentration and H_2S as outlined below to demonstrate the odour and H_2S removal efficiency of the equipment. Removal efficiency for both H_2S and odour is defined as:

% removal = (inlet – outlet concentration)/inlet concentration x 100

The performance tests must not be carried out until the Supplier is satisfied that the equipment has reached its optimum operational performance. The performance testing is to be carried out between the month of November to April and not within 1 week of a significant rain event resulting in STP flow rate greater than 4xADWF for longer than 2 hours. In the situation where commissioning is planned for the period May until October a practical completion preliminary testing can be carried out, but the official performance testing still will need to be completed during summer conditions.

The Supplier must carry out the odour and H_2S performance assessment during dry weather, and when plant unit processes are operational under normal conditions. The Purchaser must approve of proposed performance assessment time frame.

The collection and analysis of the odorous air samples must be carried out in accordance with the requirements of the local environmental authority and AS/NZS 4323.3.

No manual adjustment of valves or instrumentation associated with the OCU will be allowed during the test period.

The odour control system must be operated, to the satisfaction of the Purchaser, for seven (7) consecutive days without any major faults or alarms requiring attendance on site.

The gas flow rate and the OCU inlet gas pressure must be maintained as close as practical (+/- 5%) to the design conditions. The Supplier must be satisfied that the air flow rate through the scrubbing system is in accordance with the design gas flow rates and conditions before commencing the performance tests.

Within 10 working days of the completion of the test period, the Supplier must provide a written test report showing all laboratory and field test results. The report must state the conclusions of the tests with reference to the performance criteria.

The methods to obtain all measurements and make calculations must be included in the Performance Test Procedures and must be carried out to the satisfaction of the Purchaser.

At the completion of the performance tests copies of the performance test data log sheets must be provided by the Supplier to the Purchaser.

If OCU system fails to meet the performance requirements, the Supplier must rectify the problems immediately. The Supplier must, at no extra cost to the Purchaser, carry out all work necessary to ensure and prove that the equipment achieves the specified performance. When rectification work is complete, the equipment must be retested to verify that the specified performance has been achieved.

If after two re-tests the performance requirements are still not met, then at the Purchaser's discretion only, the Purchaser may elect to accept the system as is, require the Supplier to make system modifications at the sole expense of the Supplier, or obtain a replacement at the expense of the Supplier. If system modifications are deemed necessary, additional tests must be performed by the Supplier until performance requirements are proven to be met. All costs associated with re-testing must be borne by the Supplier.

The maximum time between each re-test will be 30 days.

(ii) Odour Sampling and Testing for OCUs at WRRFs

- Two odour samples on the gas inlet and outlets of each OCU must be taken per day. The inlet and outlet samples must be taken at approximately the same time to allow removal efficiency performance to be calculated and each set of inlet/outlet samples must be taken at greater than 1-hour intervals to reflect the peak odour load notionally from about 9 am till 12 pm.
- The tests must be repeated on two (2) consecutive days, such that a minimum of 4 inlet and 4 outlet odour samples are taken, i.e. a total of 8 samples.
- Care must be taken to prevent the contamination of the sampling and analysis equipment of the low odour samples by the high odour samples.
- The odour samples must be analysed within 24 hours of collection and must not be exposed to direct sunlight before analysis.

(iii) H_2S Sampling and Testing

Continuous H_2S monitoring instruments for the OCU inlet and two outlet gas streams are required for the test period. The inlet and outlet readings are to be recorded for the seven (7) consecutive days corresponding with the test period described above in section (i). The H_2S monitoring instruments will be Odalog instruments or equal (provided with a recent calibration certificate showing proper calibration of the Odalog instrument). For the inlet airstream, a 0-50 ppmv range and for the outlets a 0-5 ppmv range will be used.

(iv) Analysis of Results

Odour removal efficiency for each of the inlet/outlet sample sets of each of the two consecutive test days must be calculated using each individual odour concentration as determined by the NATA accredited lab.

- At least three out of the four daily outlet readings meet the removal efficiency performance criteria as specified in the Clause 3.1.2.2; and
- The average of all the daily inlet/outlet results meet the removal efficiency performance criteria as specified in the Clause 3.1.2.2; and
- At least three out of the four OCU outlet odour concentration readings meet the maximum concentration criteria as specified in Clause 3.1.2.2; and
- The average of all the daily OCU outlet odour concentration readings meet the maximum concentration criteria as specified in Clause 3.1.2.2.

H_2S removal efficiency must be calculated from the H_2S monitoring instruments results. The performance tests must be successful if, for each day of the seven (7) day test period:

- The calculated removal efficiency, based on averaging all results, meets the removal efficiency performance criteria as specified in Clause 3.1.2.2.
- The OCU outlet H_2S readings, based on averaging all results, meet the maximum level performance criteria as specified in Clause 3.1.2.2.
- The minimum instantaneous H_2S removal efficiency doesn't drop below the performance criteria as specified in Clause 3.1.2.2.
- The maximum H_2S concentration leaving the OCU does not exceed the maximum guaranteed concentration as specified in Clause 3.1.2.2.

5.4 Records

All tests and inspections must be documented identifying the date of the test, inspector's name, equipment used, results, and any adjustment action taken.

Fully detailed written reports must be provided to Sydney Water following a successful commissioning.

5.5 Handover

The Asset Commissioning SAP must be followed to ensure all issues are finalised before handover of the OCU to Sydney Water's Operations Division.

Ownership

Role	Title
Group	Asset Life Cycle
Owner	Engineering Modernisation Senior Manager, Engineering and Technical Solutions
Author	Jason Smith, Senior Mechanical Engineer, Engineering and Technical Solutions
BMIS No.	ACP0004

Change history

Version No.	Prepared by	Date	Approved by	Issue date
7	Jason Smith	4/4/2025	Norbert Schaeper	4/4/2025
6	Jason Smith	28/2/2022	Norbert Schaeper	28/2/2022
5	Jason Smith	18/05/18	Ken Wiggins	18/05/18
4	Louisa Vorreiter	7/9/2016		7/9/2016
3	Jeff Scott and José González	22/6/12		22/6/12
2	Sally Rewell and José González	18/1/11	Janssen Chan	18/1/11
1	Sally Rewell and José González	13/12/10	Janssen Chan	13/12/10

Appendices

Appendix A – ACTIVATED CARBON P&ID

P&ID drawing for activated carbon unit (refer to drawing SEW1700-S1701) and where applicable P&ID for treated air to stack (SEW1700-S1706).

Appendix B – BIOTRICKLING FILTER P&ID

P&ID drawing for biotrickling filter unit "Recirculation" type (refer to drawing SEW1700-S1703) and "Single-Pass" type (refer to drawing SEW1700-S1703A), and where applicable, P&ID for activated carbon unit (SEW1700-S1701) and P&ID for treated air to stack (SEW1700-S1706).

Appendix C – CHEMICAL SCRUBBER P&ID

P&ID drawing for chemical scrubber unit (refer to drawing SEW1700-S1702) and where applicable P&ID for treated air to stack (SEW1700-S1706).

Appendix D – MONITORING SYSTEM P&ID

P&ID drawing for monitoring system (refer to drawing SEW1700-S1705).

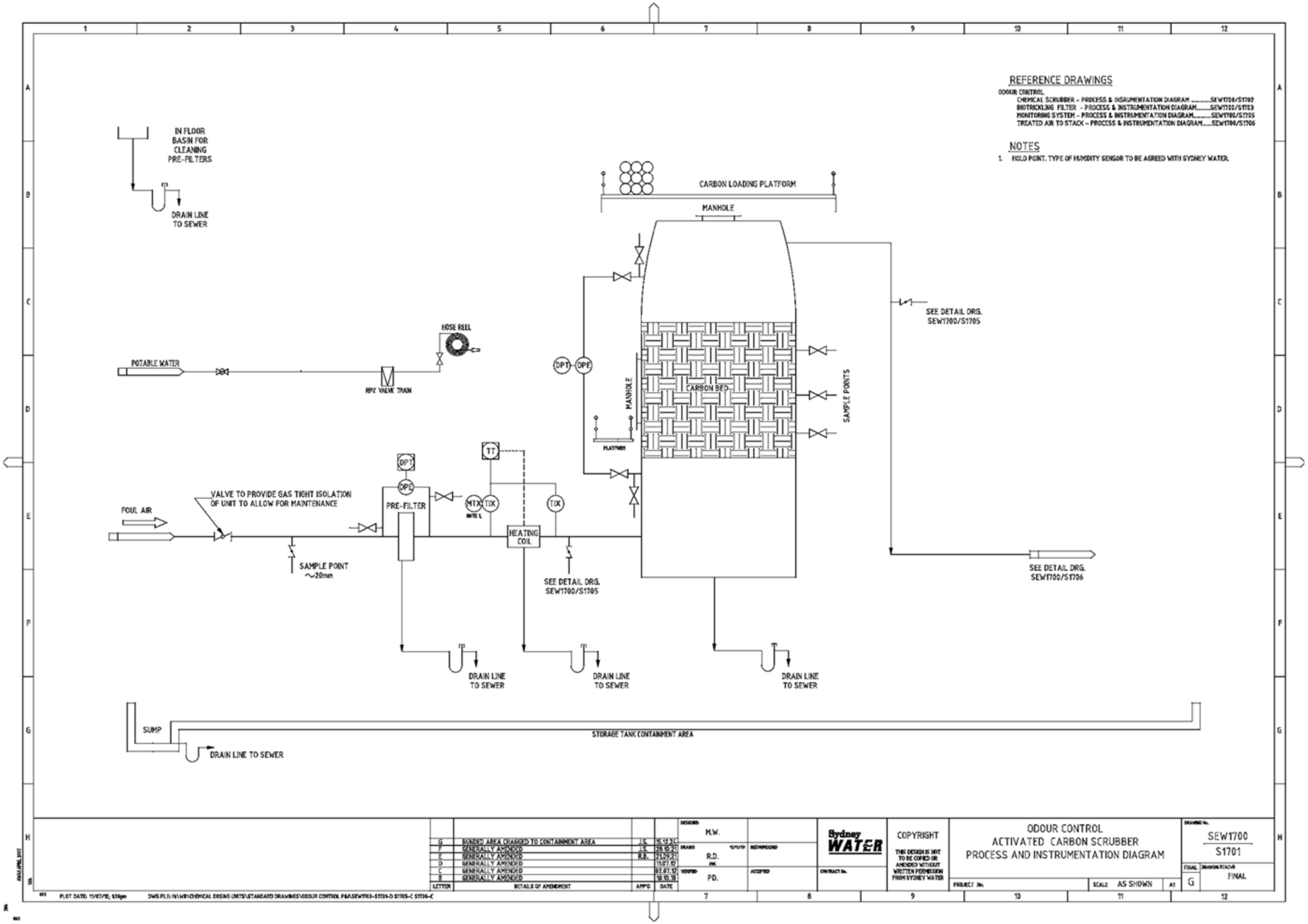
Appendix E – TREATED AIR TO STACK P&ID

P&ID drawing for treated air to stack arrangement (refer to drawing SEW1700-S1706).

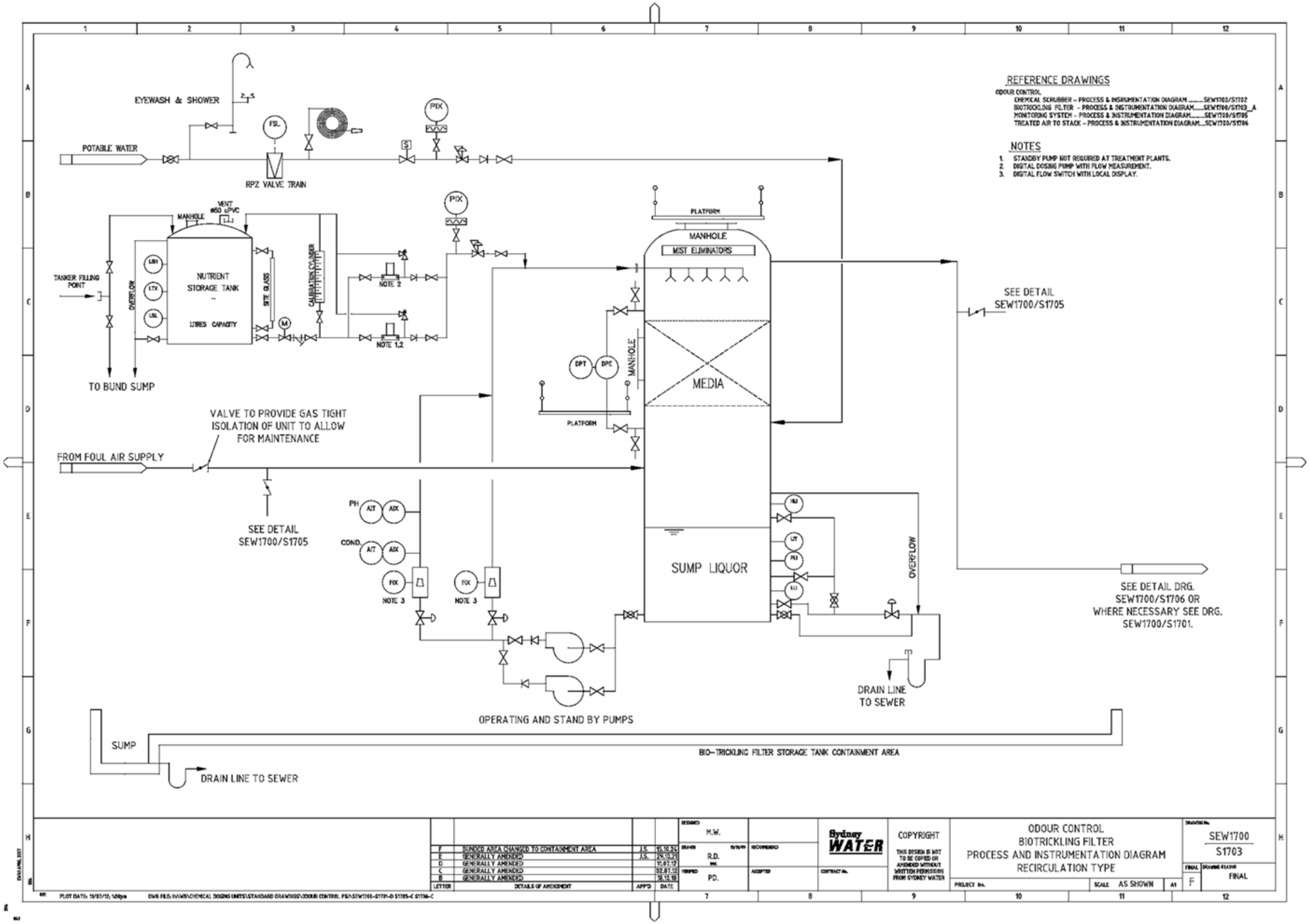
Appendix F – BIOTRICKLING FILTER GENERAL ARRANGEMENT

Site drawing for biotrickling filter general arrangement (refer to drawing SEW1700-S1708).

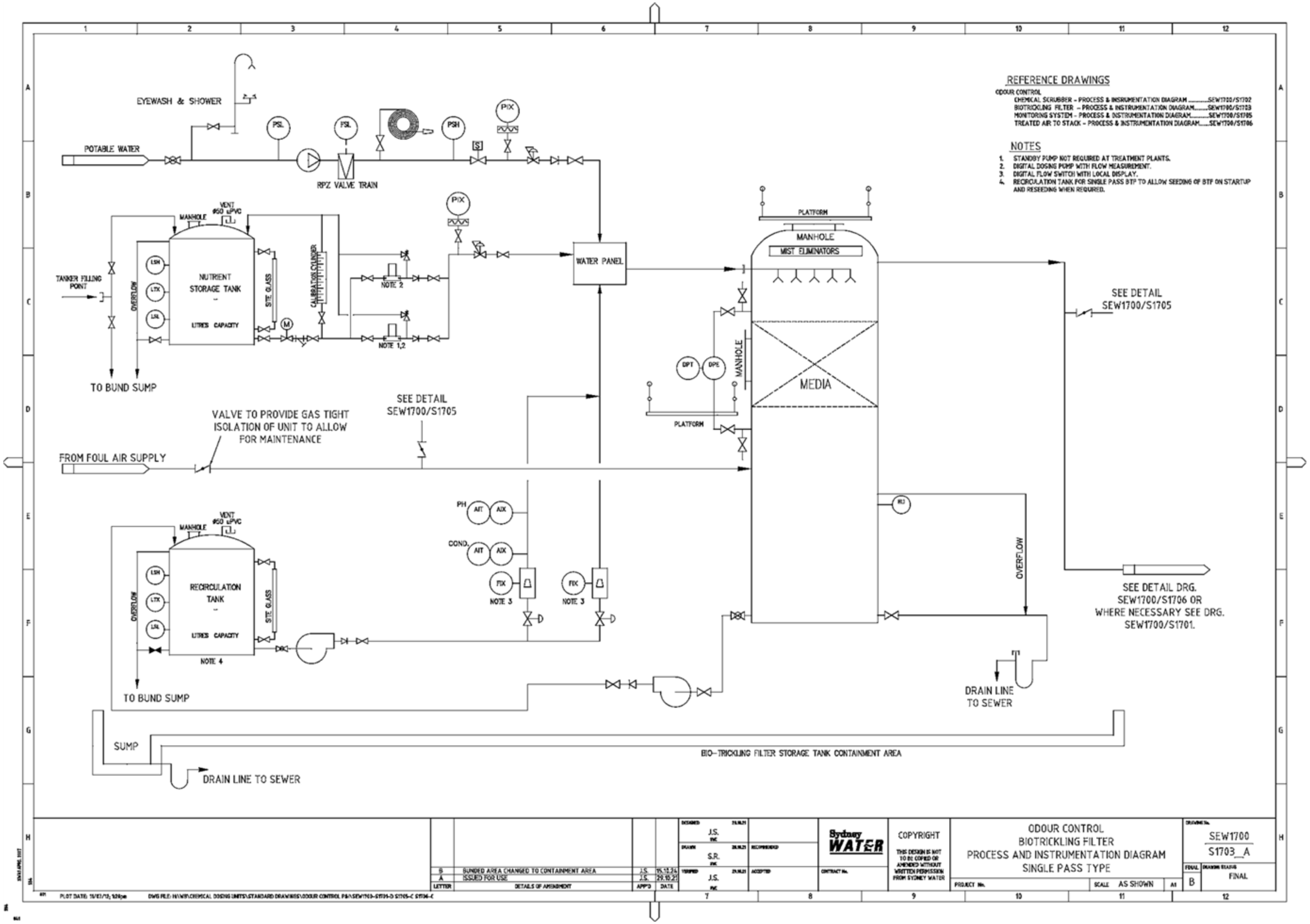
Appendix A - Drawing SEW1700-S1701



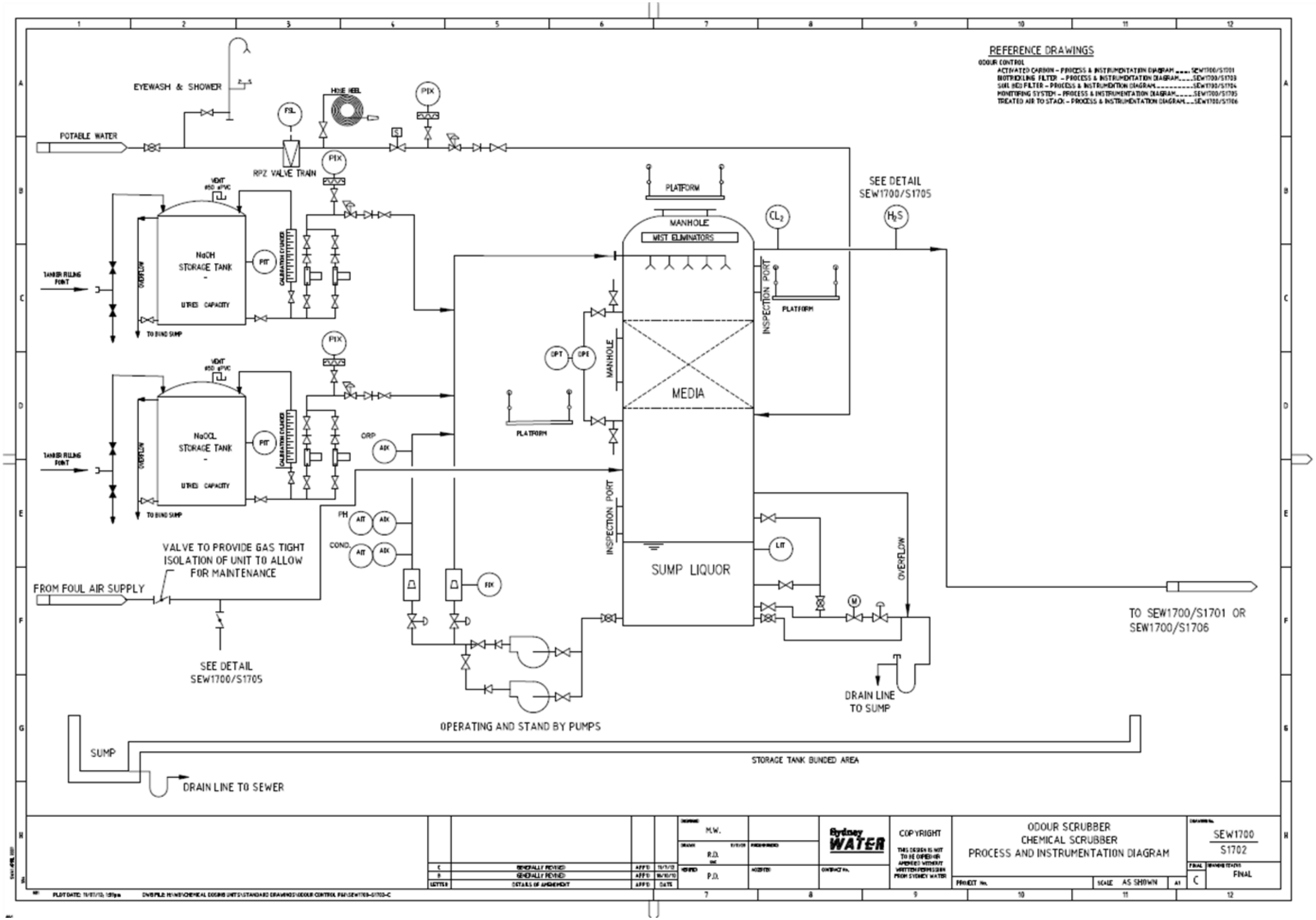
Appendix B - Drawing SEW1700-S1703



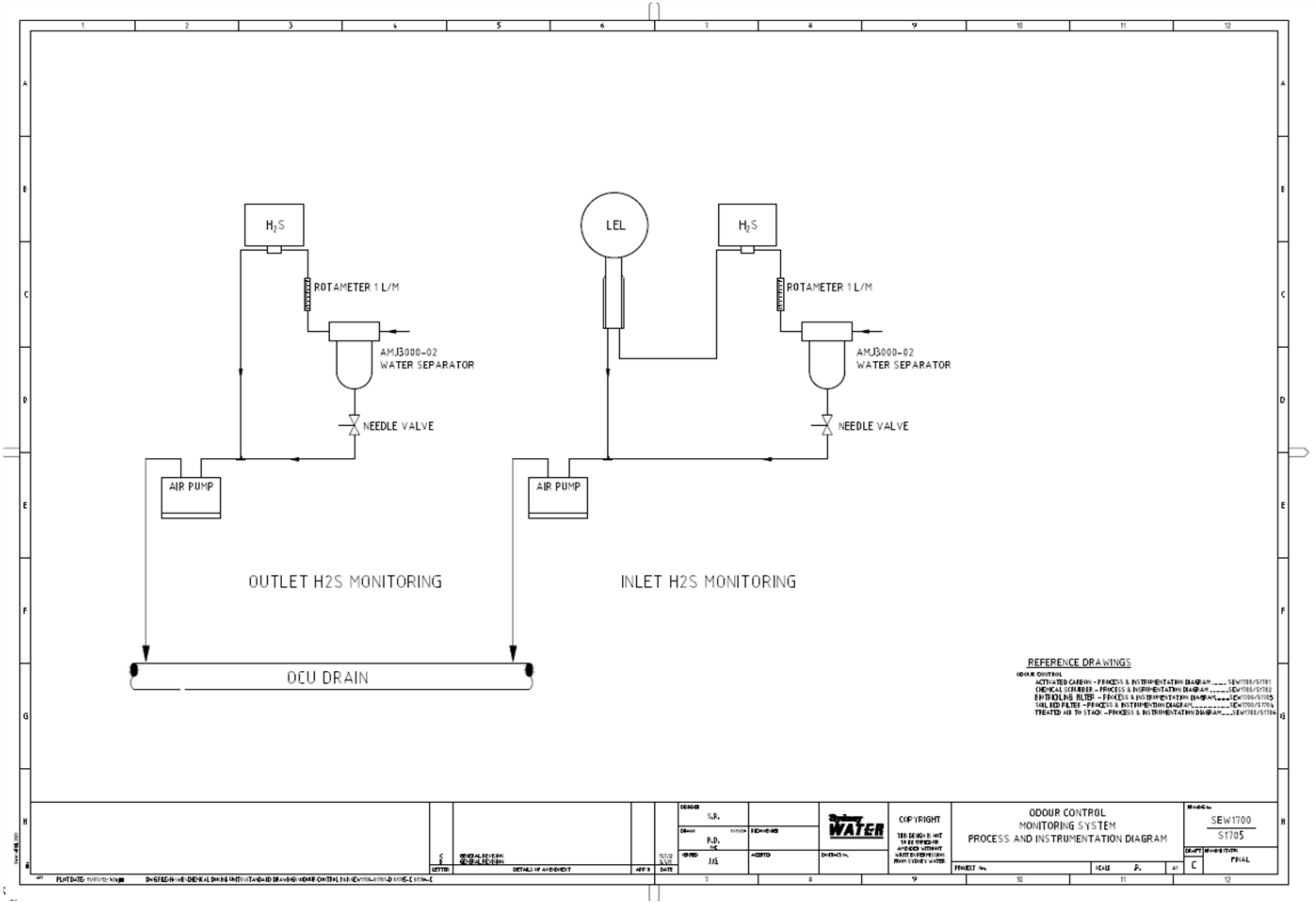
Appendix B - Drawing SEW1700-S1703_A



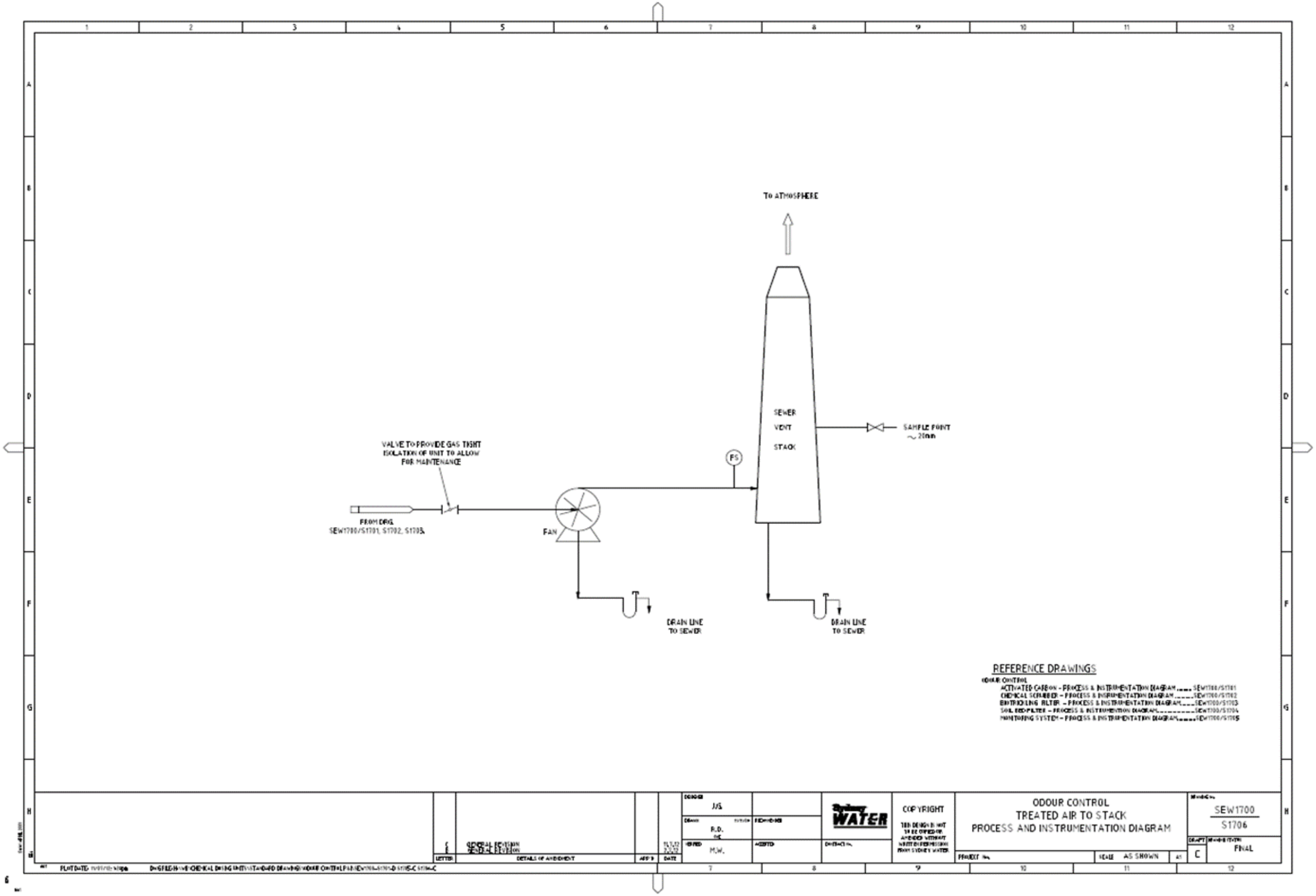
Appendix C - Drawing SEW1700-S1702



Appendix D - Drawing SEW1700-S1705



Appendix E - Drawing SEW1700-S1706



Appendix F - Drawing SEW1700-S1708