ODOUR CONTROL EQUIPMENT-CARBON TYPE

9.1 GENERAL

9.1.1 Scope

1 This Part includes the requirements for the design, manufacture, construction, installation testing and commissioning of force ventilated and passive odour control equipment.

2 Related Sections and Parts are as follows:

This Section
Part 1, ... General

Section 1, General
Section 8, Drainage Works
Section 10, Instrumentation Works
Section 21, Electrical Works

9.1.2 References

1 The following standards or revised/updated versions are referred to in this part:

ASTM D2862.....Standard Test Method for Particle Size Distribution of Granular Activated Carbon

ASTM D3467.....Standard Test Method for Carbon Tetrachloride Activity of Activated Carbon

BS 848- .....Fans for general purposes –

BS 848-1 .....Fans for general purposes - Performance testing using standardized airways; (ISO 5801 Fans. Performance testing using standardized airways)

BS 848-2 .....Fans for general purposes - Methods of noise testing; (ISO 13347-1 Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 1: General overview; ISO 13347-2 Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 2: Reverberant room method; ISO 13347-3 Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 3: Enveloping surface methods; ISO 13347-4 Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 4: Sound intensity method)

BS 848-5 .....Fans for general purposes - Guide for mechanical and electrical safety;

BS 970 (ISO 683).....Specification for wrought steels for mechanical and allied engineering purposes (ISO 683 - Heat-treatable steels, alloy steels and free-cutting steels)

BS 2782 (ISO 174, 181, 307, 8618) Methods of testing plastic - ; ISO 1628-2 Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 2: Poly(vinyl chloride) resins; ISO 307 Plastics — Polyamides — Determination of viscosity number; ISO 3251 Paints, varnishes and plastics — Determination of non-volatile-matter content)

BS 3496 (ISO 1888)...Specification for E glass fibre chopped strand mat for reinforcement of polyester and other liquid laminating systems (EN 14118-1 Reinforcement - Specifications for textile glass mats (chopped strand and continuous filament mats) - Part 1: Designation; EN 14118-2 Reinforcement - Specifications for textile glass mats (chopped strand and continuous filament mats) - Part 2: Methods of test and general requirement; EN 14118-3 Reinforcement - Specifications for textile glass mats (chopped strand and continuous filament mats) - Part 3: Specific requirements; ISO 1888 Textile glass — Staple fibres or filaments — Determination of average diameter)

BS 3532 .....Method of specifying unsaturated polyester resin systems

BS 3749 .....Specification for E glass fibre woven roving fabrics for the reinforcement of polyester and epoxy resins systems

BS 5000 (IEC 60034, IEC 60072) Rotating electrical machines of particular types or for particular applications; (IEC 60034 Rotating electrical machines- ; IEC 60072 Rotating electrical machines - Dimensions and output series -)

BS 5345 (IEC 60079) Code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture); (IEC 60079- Explosive atmospheres)

BS 6105, (ISO 3506)..Specification for corrosion-resistant stainless steel fasteners; (ISO 3506- Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners)

BS 6339 (ISO 6580)...Specification for dimensions of circular flanges for general purpose industrial fans; (ISO 13351 Fans — Dimensions)

BS 6739 .....Code of practice for instrumentation in process control systems: installation design and practice

BS 7671, ...Requirements for Electrical Installations. IET Wiring Regulations

EN 779, ...Particulate air filters for general ventilation - Determination of the filtration performance; (ISO 16890-1 Air filters for general ventilation — Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM); ISO 16890-2 Air filters for general ventilation — Part 2: Measurement of fractional efficiency and air flow resistance; ISO 16890-3 Air filters for general ventilation — Part 3: Determination of the gravimetric efficiency and the air flow resistance versus the mass of test dust captured; ISO 16890-4 Air filters for general ventilation — Part 4: Conditioning method to determine the minimum fractional test efficiency)

EN 13923 .....Filament-wound FRP pressure vessels - Materials, design, manufacturing and testing

ISO 1888 .....Textile glass — Staple fibres or filaments — Determination of average diameter

9.1.3 System Description

1 Performance Requirements

Concentration of hydrogen sulphide	:	500 ppm unless otherwise specified in project specification
Other Contaminants:		
Mercaptans	:	trace only
Amines (mono/di/tri)	:	10 ppm
Ammonia	:	50 ppm
Sulphide Concentration in Solution	:	50 mg/l
Removal of hydrogen sulphide gas and ammonia	:	99.8 % at a maximum of 0.5 ppm in outlet
Removal of amines	:	95 %
Removal of mercaptans	:	No requirement

2 The ventilation for force ventilated systems will operate continuously.

3 Air shall be supplied into the wet well to dilute the air/gas mixture via a fly screened inlet.

2 The deodorisation equipment shall operate continuously.

4 The sizing and design criteria for the system are given in the particular Project Specification.

5 The odour system shall be designed for indoor or door out installation as shown on the Contract drawings and as specified.

9.1.4 Submittals

1 In addition to the requirements of Part 1 of this Section, the Contractor shall provide information and data as described in the following paragraphs.

2 Design data providing the following information:

(a) calculations to justify the sizing and life of the carbon bed(s) at the concentrations given

(b) calculations to justify the sizing of the fan(s) if forced ventilated odour control equipment is used

(c) Calculations regarding chemical consumption and storage requirements

(d)

(e) user certificates

3 Shop Drawings providing the following information:

(a) product data

(i) fibreglass resin manufacturer's technical data on composition and characteristics of resin for fibreglass items including hydrostatic and burn tests

(ii) manufacturer's technical data on other equipment used

(iii) carbon specification including test reports

(b) dimensional layout of stack and all equipment used

(c) fan test data as BS 848.

4 Samples:

(a) vessel and duct GRP, pre-filter mesh, activated carbon.

5 Operation and maintenance and instruction manuals including:

(a) odour reduction site test report(s) as specified in Part 9.3.2

(b) the documentation in 3 and 4 above.

9.1.5 Warranty

1 The Contractor shall obtain from the Odour Control System manufacturer a warranty that his system meets the specified odour level reduction criteria, and life for the carbon bed. This does not in any way alter the Contractor's guarantee under the Contract.

9.2 PRODUCTS

9.2.1 General

1 All units shall be designed to operate continuously in temperatures up to 55 °C with 100 % condensing humidity and to reduce odours to an unobjectionable and unobtrusive level, and shall consist of one of the following types, as specified.

(a) passive deodoriser. This system will be used for totally enclosed areas without forced ventilation where positive displacement occurs. The passive deodoriser system shall operate as a free-standing unit suitable for outside use in the conditions prevailing at site and shall contain pre-filter cells, activated carbon filter cells or loose activated carbon and all necessary appurtenances. Access to the filters shall be quick and easy without the requirements of special tools for replacement of carbon, cells and pre-filters. The design of the entire unit shall be such as to ensure a minimum of maintenance time

(b) forced ventilation deodoriser system. The deodoriser shall contain pre-filter cells, activated carbon filter cells, or loose activated carbon, fan unit, a vent stack and all necessary appurtenances. Access to the filters shall be quick and easy without the requirements of special tools for replacing carbon, cells and pre-filters. The design of the entire unit shall be such as to ensure a minimum of maintenance and operating timing.

2 Activated Carbon Support System. This shall be one of these types

(a) removable carbon cell type filters. Carbon filters shall be of the rechargeable cell

(b) type with stainless steel or moulded GRP frames and perforated faces riveted together. The filter cells shall be arranged to give a counter current multiple pass system with the lowest filter taking the heavy load. When the lowest filter is spent it shall be removed and higher filters moved down to replace the one beneath and a new filter fitted in the highest position. Two additional complete sets of carbon filters shall be provided as a minimum

(c) bulk carbon system. The odour control unit forms a receptable for the granular activated carbon which is placed in, either manually or using a proprietary mechanical vacuum device.

9.2.2 Materials

1 Deodoriser Unit and Ducting: These shall be of chemical and ultraviolet light resistant GRP using water resistant 'E' glass chopped strand mat or woven glass fabric to BS 3496 and BS 3749. All surfaces and exposed edges shall be gel coat/flow coat covered using resin to BS 3532. Alternatively the deodoriser unit and ducting may be manufactured in uPVC or polypropylene/selmar and wrapped externally with G.R.P, generally as above. All fittings shall be stainless steel and sealing strips shall be neoprene. The units shall have smooth semi-gloss finish in white and shall be fully weatherproof.

2 Moisture Eliminator. These shall be incorporated in each duct. They shall be manufactured from corrosion resistant materials and shall incorporate drain facilities and access panels for cleaning. They shall incorporate a baffle arrangement with air cooling.

3 Prefilters. Prefilters shall be of washable urethane or polypropylene knitted wool to EN 779 designed as a particle and moisture barrier. The unit shall have an access plate for easy removal of prefilters. They shall be fabricated such that:

(a) maximum efficiency is not less than 95%, based on test dust No. 2

(b) maximum air velocity is 2.5 m/s at the design airflow

(c) the clean filter resistance does not exceed 90 Pa

(d) filters do not sag, flutter or be obstructed by contact with other filters or duct surfaces

(e) the size shall be not less than 600 mm x 600 mm x 45 mm thick

(f) corrosion resistant drain valves are provided

(g) there are no void areas or short-circuiting

4 Activated carbon.

(a) This shall be bulk carbon filters. The activated carbon shall be virgin granular, derived from bituminous coal, vapour-phase type, H_2S removal capacity of the media can be restored simply by washing with water and suitable to treat sewage odours. No chemical impregnates are used in the production of media nor are any required to regenerate the media. The carbon shall have the following specifications

Carbon Substrate	
CC1 4 Number	percentage by weight (ASTM D3467), 60
Iodine number, minimum	1000
Mean particle diameter	3.7 mm
Percent ash maximum	8 percent
Impregnated Carbon	
Apparent density(1) minimum	(to be check)
Hardness number, minimum	95
Moisture, maximum(2)	15 percent
Maximum head loss (Pa) at 0.254 m/s linear velocity (through a dense packed bed)(3)	1450 Pa/bed of 900 mm
H_2S breakthrough capacity, minimum(4)	25 g H_2S removed/100 g of carbon

notes:

(1) as determined by ASTM D2862 on a dry basis. The delivered apparent density shall range from 0.55 to 0.64 g/cu cm

(2) calculated on a total product basis

(3) dense packing as defined by procedure for apparent density determination where a glass 100 ml graduated cylinder is filled through a funnel with 24 mm inside diameter stem at a uniform rate not exceeding 1 ml/s. Pressure drop is measured across a 900 mm deep carbon bed, at least 125 mm in diameter

(4) the determination of H_2S breakthrough capacity shall be made by passing a moist (85 % R.H.) air stream containing 1 % H_2S at a rate of 1450 m^3/min through a 20 mm diameter by 230 mm deep bed of uniformly packed activated carbon and monitored to 50 mg/l breakthrough. Results are expressed in g H_2S removed per g of carbon

(5) the carbon supplied shall be water regenerable activated carbon type.

5 Fittings and fasteners. Fittings shall be stainless steel BS 970 Grade 316 S31, fasteners shall be stainless steel BS 970 Grade 316 S31 and BS 6105.

9.2.3 Fabrication

1 Carbon adsorbers shall be fabricated such that the vessel walls are not used to transfer any vertical loads to the foundations or vertically support any portion of the carbon support system. The carbon support system shall be removable for vessels of 1 m diameter or less and shall be constructed of materials resistant to corrosion or deterioration under the service conditions specified.

2 Four bed activated carbon units shall be horizontal, cylindrical vessels utilizing vertical media beds and provided complete with supports and anchoring system, all nozzles, and access hatches. Units shall be complete with access platform and ladder, support saddles, flanged inlet and outlet nozzles, grounding rods, carbon bed monitoring system, and manways and sample ports as specified.

3 Vessels shall be constructed in accordance with EN 13923 category III or equivalent.

9.2.4 Accessories

1 Each carbon adsorber vessel shall include the following accessories:

(a) manometer: This shall be provided to continuously monitor the pressure drop across each carbon bed

(b) sample probes: each vessel shall have three 40 mm diameter sample probes per bed which shall extend into the bed a minimum of 300 mm. The sample probes shall be adequate to provide suitable extraction of carbon samples from the carbon bed. The sample probes shall extend outside the vessel wall and shall be isolated with a uPVC ball valve

(c) grounding rod: a stainless steel rod shall be provided to adequately ground each carbon bed

(d) H_2S monitor: one portable hydrogen sulphide monitor shall be provided for each adsorber vessel to detect hydrogen sulphide concentration via a colour coded detector card. The housing shall be a weatherproof enclosure which also allows easy replacement of detector cards

(e) PVC-u drainage valves and 20 mm diameter pipework routed back to the wet well to drain off any condensate/regeneration liquid from the prefilters

(f) PVC-u drain valve and 20 mm diameter pipework routed back to wet well to drain off any condensate/regeneration liquid from the deodoriser unit

(g) airtight covers with gaskets to facilitate easy removal of carbon cells or loose carbon

(h) three PVC-u air sample probes which extend outside vessel walls and are fitted with PVC-u isolating valves

(i) gaskets: 3 mm thick full face constructed of neoprene or equal

(j) lifting and holding down lugs

(k) H2S analyzer in both inlet & outlet of OCU system to monitor the performance.

2 An inlet shall be fitted to the wet well to allow fresh air to be drawn in. This shall be of GRP or PVC-u construction with an insect screen.

9.2.5 Centrifugal Fan

1 Duty and standby fan shall be provided for each OC unit. The fan shall be centrifugal, belt-driven type constructed from corrosion resistant fibreglass reinforced plastic or stainless steel with vibration free mountings. The fan shall be capable of the performance specifications as shown below:

(a) unit capacity : as designated

(b) static pressure : 3000 Pa, or as required

(c) operating temperature : 0 - 70 °C

(d) Motor : high efficiency, 415 V, 3 phase, 50 Hz IP 55;1500 rpm, power as required, rated for zone 2 use with methane gas (BS 5345), to BS 5000.

2 Exhaust fans shall be suitable for continuous 24-hour operation and shall be non-overloading. Each fan shall operate such that no point on the fan curve requires more than the rated motor power. Fan performance curves shall be provided.

3 The fan housing, flanges and backward curved impellers shall be constructed of flame retardant GRP laminate or stainless steel, capable of resisting continuous fume temperatures of 70 °C. The manufacturer shall state the type of resin used and confirm that it shall perform satisfactorily under the operating conditions. All interior surfaces exposed to the corrosive air stream shall be resin rich.

4 Wheel and shaft assemblies shall be statically and dynamically balanced to a maximum of 0.5 μm displacement prior to assembly and every fan test run prior to shipment.

5 Fans shall comply with BS 848 and be provided with the following standard features:

(a) drive assembly: belts shall be oil, heat and static resistant type, sized for continuous duty. Shafts shall be constructed of heavy duty steel turned, ground and polished, keyed at both ends

(b) bearings: heavy duty, self-aligning, pillow block bearings, with grease fittings

(c) shaft seal: a fibreglass and neoprene shaft seal shall be placed where the shaft leaves the housing along with a viton shaft slinger between the seal and wheel on belt drive units

(d) bases: heavy gauge hot rolled steel, epoxy coated.

(e) the fan shall be provided with the following accessories:

(i) flanged and drilled inlet and outlet to BS 6339

(ii) drain

(iii) access door

(iv) vibration isolation system

(v) belt and shaft guard as Part 1

(vi) earthing as QGEWC (KAHRAMAA) requirements and BS 7671

(f) flexible connectors:

(i) flexible connectors shall be installed on the fan inlet and outlet to dampen axial, lateral, and vibrational duct movement

(ii) the flexible connector shall be resistant to the corrosive gases being processed and shall be able to withstand ± 3750 Pa. The flexible connector shall be minimum 30 mm long.

6 Dampers:

(a) (a) suitable sized dampers shall be provided as follows:

(i) balancing damper between the fan outlet and the carbon adsorber inlet

(ii) isolation dampers at each carbon adsorber outlet.

(b) (b) the dampers shall be provided in accordance with the following specifications:

(i) the dampers shall be flanged and drilled to withstand 3000 Pa

(ii) flange mount channel frame shall be vinylester with reinforced bearing pad

(iii) the blade thickness shall be as required by the damper manufacturer

(iv) the bearings shall be moulded plastic material

(v) fibreglass axles shall extend full length of blade and 150 mm beyond frame

(vi) the unit shall be equipped with a full circumference blade seal to limit leakage to less than 1 m^3/m^2 min at 3000 Pa

9.2.6 Electrical Control Panel

1 A prewired, preassembled electrical control panel shall be provided for the odour control system as specified in the Project Specification. The control panel shall contain pushbuttons, indicating lights, fan motor starters, alarms, and other controls for a complete automatic system. The panel shall be wired suitable for connection to 415 V a.c., 3 phase, 50 Hz source. The panel shall comply with Part 1 of this Section and Section 21.

9.2.7 Factory Inspection and Testing

1 The Contractor shall secure from the equipment manufacturers certification that the following factory tests have been carried out, and submit to the Engineer prior to shipment. Fibreglass vessels shall be tested as follows:

(a) hydrostatically tested prior to shipment, with water to the top of the vessel for a minimum of 24 h

(b) the water must be contained with no visible signs of leaks or excessive wall deflection

(c) a minimum of two burn tests of cutouts, from areas where access doors or piping cutouts are required, to verify glass resin ratio.

2 Activated carbon shall be tested as Part 9.2.2.4

3 Fans shall be tested as required by BS 848, Part 1 and 2.

9.2.8 Spare Parts and Tools

1 The Contractor shall provide from the equipment manufacturer's all the spare parts and tools required during the commissioning and maintenance periods as specified in Part 1, including those below. In addition, sufficient activated carbon shall be provided for the complete operation of the odour removal system for two years of operation.

2 The following tools and shall be provided in addition to any others required:

(a) sampling tool

(b) plastic container for shipping carbon samples.

3 The following spare parts shall be furnished as a minimum requirement, in addition to any additional spare parts required for two years of operation.

Item	Quantity	
Complete Centrifugal Fan	(1)	
Sets of V-belts	(2)	
Sets of bearings	(2)	
Shaft seals	(2)	(if fitted)
Carbon	(1)	Supplies guaranteed for two years operation
Prefilter set	(2)	

9.3 INSTALLATION AND COMMISSIONING

9.3.1 General

1 If required by the Project Specification, the Contractor shall furnish from the odour control system supplies the services on site of a factory trained service technician or engineer. He shall inspect the equipment installation, advise and assist with commissioning and train the Employer's operations and maintenance personnel.

2 The odour control system shall be installed in accordance with manufacturer's written instructions, by suitably qualified and experienced personnel.

9.3.2 Site Inspection and Testing

1 Vessel Test. The above water test shall be repeated on site after installation.

2 Fans shall be tested as required by BS 848 Part 1 and shall be installed in accordance with BS 848 Part 5.

3 Odour Vessels Test: The Contractor shall test as follows:

(a) the odour control system to certify that it meets requirements after completion of the installation

(b) all odour testing conducted by the Contractor in the presence of the Engineer

(c) the odour control system test shall be conducted after all the air systems are tested and balanced. Separate H_2S tests shall be conducted on each odour control system

(d) the H_2S tests shall be repeated at the end of the maintenance period with the equipment in full operation during the time of year determined by the Employer to have greatest odour problems, using the actual gas levels.

(e) the hydrogen sulphide test shall comprise as follows:

(i) hydrogen sulphide (H_2S) concentrations shall be measured using a calibrated portable H_2S analyser

(ii) if instructed by the Engineer, bottled H_2S gas shall be used to determine if the specified H_2S performance requirements are met

(iii) each test: three sets of samples shall be taken over an 8 h period:

- each test shall consist of an inlet and outlet H_2S test
- the supplier shall be responsible for supplying the H_2S for the bottled H_2S testing
- the three H_2S levels to be tested shall be selected by the Engineer.

(f) if the odour control system fails to meet the performance criteria, it shall be the Contractor's responsibility to make all the modifications necessary to improve performance at no cost to the Employer. The Contractor shall pay for all additional testing required to verify that performance criteria are being met

(g) final acceptance of the system will only be possible after successful completion of this testing

(h) documentation for all the testing shall be submitted to the Engineer.

END OF PART