Facultatieve Technologies

Cremation & Incineration Equipment

Flue Gas Cooling and Filtration Equipment for Single Cremator Installation

UK Technical Specification

Date: February 2022 **Single Cremator Installation**

Facultatieve Technologies Ltd

Moor Road
Leeds LS10 2DD, England
Phone : +44 (0) 113 276 8888
Fax : +44 (0) 113 271 8188 Sales Direct 2774558
Email : info@facultatieve-technologies.co.uk

1.0 GENERAL SYSTEM DESCRIPTION

1.1 Introduction

Our proposed Flue Gas Treatment system is based upon tried and tested Dry Scrub Technology, and is designed to adsorb heavy metals, mercury, dioxins and furans, as well as reducing acid gases such as SO2, HCl and HF, which are found in the flue gases, to ensure compliance with the required emission regulations.

1.2 Cooling System

For optimum filtration, it is necessary to cool the flue gases exiting from the cremator, to ensure the correct process temperature for the filtration of the flue gases. In removing energy from the flue gases, there is scope for heat recovery. *(see section 3.2.6)*

The flue gases from the cremator enter the waste heat cooler and are cooled down to the filter operating temperature range of 120°C to 150°C. The heat removed from the flue gases is transferred by a water / ethylene glycol circulation system to a dedicated air blast cooler located externally from the filter equipment. Ethylene glycol is used to prevent the water circuit from freezing in cold climatic conditions.

1.3 Dosing Reagent System

Within the ductwork between the waste heat cooler and the fabric filter, fresh reagent additive ***Factivate*** is added to the flue gases. The flue gases and the ***Factivate*** are mixed within a reaction volume prior to entering the filter.

The premixed chemical reagent mixture will be supplied in easily manageable closed containers, which can be easily introduced into the automatic reagent feeding station.

The feeder station is a "loss in weight" device, able to automatically feed the correct dose/weight of reagent to the process.

1.4 Filtration System

The addition of the ***Factivate*** reagent into the flue gases makes a chemical reaction occur and as a consequence solid particles appear. These particles are filtered out by the filter bags when they pass through the filtration system. This absorbs the mercury, dioxins, furans and reduces the concentration of acidic gases such as SO_2 and especially HF and HCl. A second reaction occurs when the ***Factivate*** and the flue gases are in contact with the reagent layer that builds up on the outside of the filter media. The dust/reagent layer deposited on the media as well as being favourable for flue gas filtration, greatly increases the filter media lifespan and improves filtration efficiency.

1.5 Operation of Filter System

An induced draught fan draws the cleaned gas through the fabric filter, and passes it to atmosphere through the chimney stack. The automatic control of this fan, via a frequency controller (inverter), ensures the correct system underpressure (as continuously measured in the cremator). Furthermore, the induced draught fan is suitably sized to overcome all the resistances within the cremator, flue gas cooling and filter equipment.

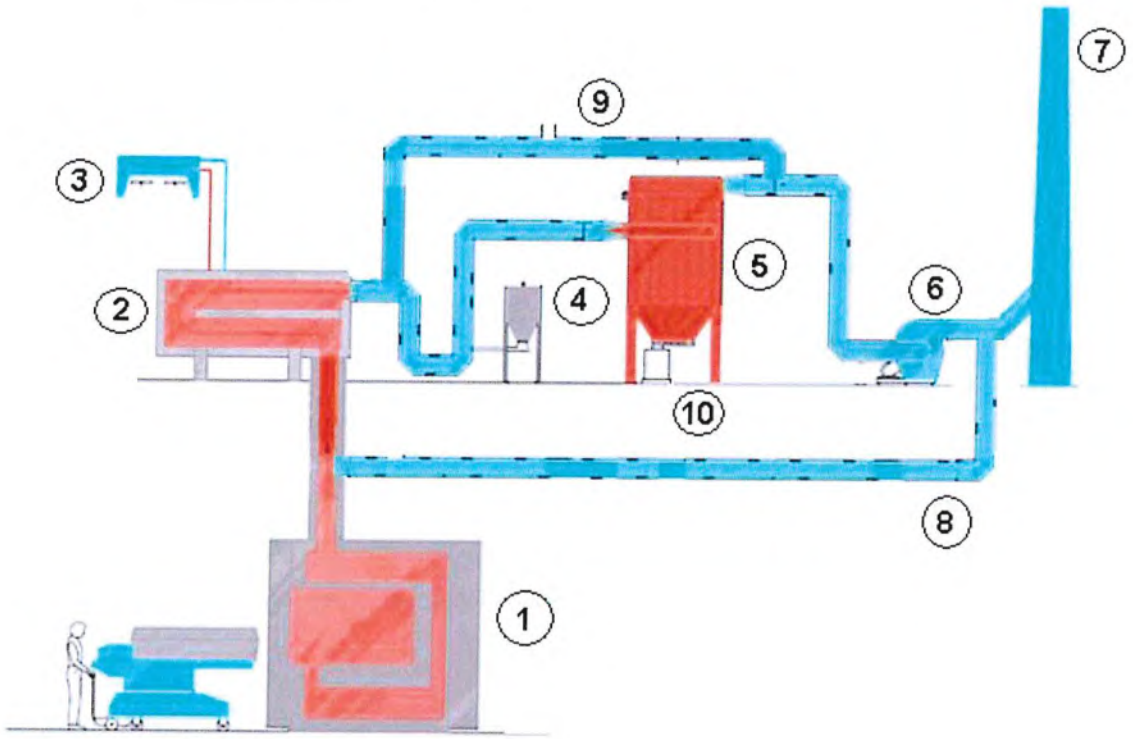
1.6 Filter Cleaning System

During the automatic cleaning process of the filter unit, the released waste materials falls into the filter hopper. A motorised mechanical screw conveyor transports the dust and spent reagent to a container for waste disposal.

Typically the automatic cleaning process occurs once a day – at shutdown, so ensuring that the filter is cleaned of "used ***Factivate***" at the end of every operational day, and so starts operation the following day using only fresh ***Factivate*** reagent. Such operation dramatically reduces the risk of filter fires, especially as the reagent selected has natural fire retardant capabilities.

This system includes an air compressor to supply the compressed air requirements of the filter cleaning.

1.7 General System Diagram



ITEM No	EQUIPMENT
1	Cremator
2	Waste Heat Cooler
3	Air Blast Cooler
4	Reagent Dosing System
5	Compact Filter Unit
6	Induced Draught Fan
7	Chimney Stack
8	Filter Bypass Valve
9	Filter Outlet Valve
10	Spent Reagent Storage Bin

2.0 TECHNICAL DATA

Technical Design Data		
Operating hours	8-12 (normally) Up to 23	hours per day hours per day
Temperature after cremator	Normal 800 (*) Max. 1100 Temporary 1200 (for up to 10 minutes)	°C °C °C
Volume flow waste heat cooler	1500	Nm^3/h

(*) Minimum of 850°C in the secondary combustion chamber when operating under emergency conditions without abatement.

Operational Information		
Temperature before filter	Approx.150 Peaks up to 180 (for max. 5% of the cremation)	°C °C

3.0 EQUIPMENT SPECIFICATION

3.1 Cremator Draught Control System

To ensure optimum process pressure conditions in the cremator, the under pressure (negative) in the cremator is constantly measured by pressure transducer controlling instruments. These control signals are used to constantly modulate the speed of the filter system's induced draught fan during the filter system operation.

3.2 Flue Gas Cooling

The flue gas cooling plant is sized to accept the flue gases from the cremator and is designed to accept the wide thermal load variation of the flue gases exhausting from the cremator. The flue gas cooling consists of:

- Waste Heat Cooler
- Automatic Soot Cleaning System
- Water Circulation Pumped System
- Air Blast Cooler
- Water Control System

As an option, if required, a heat recovery module can be provided. *(see section 3.2.6)*

3.2.1 Compact Waste Heat Cooler

The compact gas cooler is designed as a conventional waste heat cooler, of multi-pass design. The design of the waste heat cooler is such that the flue gases pass up the inside of the cooler tubes and water-based coolant is pumped through the shell on the outside of the tubes.

Technical Data		
Maximum Flue Gas Volume	1500	Nm^3/h
Gas Temperature inlet	800 (normal)	°C
Gas Temperature outlet	150	°C
Convective power	450 (design) 600 (max thermal)	kW kW
Water Temperature inlet	75	°C

Technical Data *(continued)*		
Water Temperature outlet	95	°C
Cooler pressure Design	6.0	Bar
Water volume	20.0	m³/h
Differential Pressure gas	410 (normal)	Pa
Differential Pressure gas	1170 (max.)	Pa
Differential Pressure water	400 (normal)	mbar

3.2.2 Automatic Soot Cleaning System

This system relies upon an automatic shock blast system to clean the inside of the flue gas tubes of solid deposits and is often referred to as a "soot blowing system".

This system utilises a supply of compressed air, at a pressure of 8-bar maximum, which will be supplied from the air compressor system supplied in conjunction with the flue gas filter installation.

The process of soot cleaning is **automatically** controlled by the dedicated PLC control system. As part of the cremation plant's automatic shutdown sequence at the end of the operational day, the waste heat cooler will be automatically cleaned, this sequence typically lasting 30 to 60 minutes.

The soot and dirt removed from inside the waste heat cooler tubes would pass onto the filter unit entrained in the moving flue gases being drawn through the equipment by the filter's induced draught fan.

Essentially this system removes the requirement to **manually clean** the waste heat cooler, on a frequent basis.

3.2.3 Water Circulation Pump System

The water circulation system allows the flow of hot coolant from the waste heat cooler to be pumped to the air blast cooler by using a suitably sized recirculation pump. Then the cool coolant is pumped back into the waste heat cooler.

The recirculation circuit will also be fitted with a thermal expansion system comprising a vessel fitted with a pressurised diaphragm, system fill connections and safety pressure relief equipment.

3.2.4 Air Blast Cooler

To remove heat from the system, the coolant, a mixture of water and glycol, passes to the air blast cooler, normally located externally to the process equipment. Ambient (cool) air is force ventilated over the tubes by fans located on the air blast cooler, while the hot water / glycol mixture passes inside the finned cooling pipes. Control of this system is fully automatic.

Technical Data		
Finned pipe material	Aluminium finned copper tubes	
Max. Temperature (design)	120	°C
Max. Excess pressure	6	bar
Number of Axial-fans	4 placed on the inlet side withprotective grating.	
Electric Motors	400 50 0.5	V Hz kW
Cooling power	450 (design) 600 (Max Thermal)	kW kW
Coolant Media	25% v/v ethylene glycol in water	
Coolant Water Volume	20.0	m^3/h
Temperature inlet	95	°C
Temperature outlet	75	°C
Differential Pressure	Approx. 68	kPa
Sound Pressure Level axial fans	44 (at 10 m)	dB_A

3.2.5 Water Control System

The system will be complete according to the relevant country standards. The water circulation pipework will include duty and standby circulation pumps, all necessary valving, insulation, and two (valved) connections to enable heat recovery from the water circuit as necessary. *(see section 3.2.6)*

3.2.6 Heat Recovery System (Additional Cost – Optional System)

Should heat recovery be required, a dedicated plate heat exchanger will be integrated within the cooling system circuit to enable heat recovery.

Typically, the plate heat exchanger, complete with manual isolation valves on both primary and secondary circuits, will be as follows:

Technical Data	
Type of Heat Exchanger	Plate Exchanger
Supplier	HRS Coolers or similar
Design Rating	100 kW
Flow rate	Designed to suit clients' requirements
Temperature of Water	
Pressure Drop	

PLEASE NOTE: *Connection into the crematorium's central heating systems is expressly charged by the crematorium's owner.*

3.2.7 Piping

The cooling system's recirculating pipework, connects the waste heat cooler to the externally located air blast cooler. All pipework is included within our scope of supply and will be thermally insulated and covered with a protective cladding.

3.3 Dosing System

The dosing system consists of:

- ***Factivate*** Reagent Station:

Including a charge unit with support structure to accept easily manageable ***Factivate*** reagent **15**kg containers. Each container is lifted into the charging station via the dedicated door which is closed and sealed before reagent transfer, so ensuring the automatic addition of reagent under controlled clean safe conditions.

- ***Factivate*** Dosing unit:

Consist of a "loss in weight" feeding system, including a frequency-controlled dosing screw conveyor and an injection piece to inject reagent additive into the flue gas ductwork.

Technical Data		
Dosing range	0.2 – 2.0 (per cremator)	kg/h

3.4 Reaction Volume

For a thorough mixing of the gas stream and additive, a reaction volume is designed within the interconnecting ductwork, between the waste heat cooler and the filter. This reaction volume is complete with a reagent distribution pipe, and inspection openings.

3.5 Compact Filter Unit

Filter Type:

- Nederman FD 3 / 2.5 / 30 (or similar)

The filter is supplied complete with compressed air cleaning system configured for operation on the dirty gas side, and is delivered fully functional, with filter fabric elements and compressed air cleaning system installed.

The filter unit consists of:

- A filter housing in fully welded sheet steel construction with separate dirty gas and clean gas compartments.
- Inspection doors to allow easy access for maintenance and inspection work.
- Cleaning system with pressure reducer, compressed air tank, electromagnetic actuated diaphragm valves, injector nozzle and jet tubes.
- Connecting flanges for dirty gas connection and dust collecting hopper.

Technical Data		
Designed for negative pressure up to	60	mbar
Maximum number of filter cassettes	60	pcs.

Technical Data *(continued)*		
Averaged compressed air consumption (During cleaning cycle)	12	Nm^3/h
Filter Element(s) (Consisting of filter bag and spacer mat.)	30	off
Filter media	Aramid	
Temperature resistant up to	190	°C
Self ignition temperature	>485	°C
Overall installed filtering area	55	m^2
Overall effective filtering area	55	m^2

3.5.1 Filter Dirty Flue Gas Inlet Transition

Arranged above the fabric filter elements, manufactured as a fully welded sheet steel construction with baffles for guiding the dirty gas flow, inspection doors and the connecting flange for the dirty gas ductwork.

3.5.2 Dust / Spent Product Collecting Hopper

Arranged under the fabric filter elements for the collection of the separated dust. Manufactured as a fully welded sheet steel construction with connection flanges to both the filter housing and the screw conveyor. Supplied with integral support structure in suitably designed structural steel section.

3.5.3 Spent / Reagent System

Consisting of a screw conveyor arranged under the filter for the conveyance of the separated dust in fully welded sheet steel construction with connecting flanges to the dust collecting hopper and to the discharge valve.

Technical Data		
Gear motor screw conveyor	0.3 11.0	kW rpm

Support structure in suitably designed structural steel construction.

3.5.4 Spent Reagent Storage Bin

Arranged under the waste product screw conveyor, to store the spent product from the filter hopper (above).

Technical Data		
Capacity of storage	Supplied 6 bins of 60	litres
	or (depending on site conditions)	
	Supplied 2 bins of 200	litres

3.6 Induced Draught Fan (for total Filter/Cremator Plant)

For the conveyance of the cleaned gas through the total integrated cremator and filter installation.

Fan Type:

- Single-stage, one-sided suction.
- Impeller mounted directly on the fan shaft, overhang type, with two bearings.

Fan Design:

- Industrial fan in heavy-duty fully welded sheet steel construction.
- Housing with cleaning opening and drainhole for condensate
- Impeller with backwards inclined or radial blades.
- Electrodynamically balanced in two planes.

Technical data (Design point)		
Flow rate	3800	Am^3/h
Total pressure at 150 °C	70	mbar
Power requirement at 150 °C	18.5	kW
Impeller speed	2930	rpm

Induced Draught Fan supplied with cooling disc for shaft cooling of the fan, arranged between fan housing and motor including protection against accidental contact.

Anti Vibration Mounts – 1 set for vibration-free erection on the fan including fastening plates.

Electric motor for induced draught fan:

- Set up according to IEC norms.
- Designed for Frequency control via separate inverter system controlled using the system underpressure in the cremator.

3.7 Compressed Air Station

As an integral part of the filter installation, an air compressor is supplied, and will be of the rotary screw design type. The compressed system will be supplied complete with compressed air reservoir (pressure vessel), and necessary valving, automatic oil / moisture separators and interconnecting pipework from the installation to filter installation, soot blowing system and other compressed air users supplied as part of the filter installation.

Air Compressor Type:

- Screw Compressor – Atlas Copco GA 5 (or similar)

Technical Data		
Effective Air Volume by 7 bar	1 x 0.24	m³/min
Max. Pressure	8	bar
Electric Motor	2.2 400 50	kW V Hz
Compressed Air Receiver/Tank	1	off
Capacity	250	litres
Max. Pressure	11	bar
Max. Temperature	50	°C

3.8 Ductwork and Valves

3.8.1 Hot Flue Gas Ductwork

To convey the hot flue gases from the **single** cremator flue gas offtake, refractory lined ducting will be supplied, fabricated from mild steel, internally lined using 1400°C grade castable refractory further insulated with calcium silicate insulation.

To ensure safe operation during emergency situations the above refractory duct is supplied with a bypass duct, fitted with a pneumatically actuated (fail open) damper, which on the detection of emergency condition opens. The duct is fitted with a device to cool the gases prior to direct entry to the chimney stack.

3.8.2 Cool Flue Gas Ductwork

To convey the cooled flue gases from the waste heat cooler to the filter installation and finally to the chimney, ducting is supplied from 3mm thick mild steel, of welded fabrication, supplied with flanged connections, designed for good flow characteristics.

The ducting will be supplied with all necessary flanges, fittings, connection pieces, screws and seals.

Flue Gas Ducting consisting of:

- Connecting duct from waste heat cooler to filter.
- Filter Preheat Bypass connecting duct.
- Connecting duct from filter to induced draught fan.
- Connecting duct from induced draught fan to chimney.

3.8.3 Filter Bypass Valve

Placed in the ductwork to allow the flue gases to bypass the filter system, generally used during system preheat prior to cremation, to protect the filter system against condensation caused by wet flue gases.

Comprising pneumatically actuated twin butterfly valve arrangement, complete with system vent damper.

3.8.4 Filter Outlet Valve

Placed in the ductwork at the outlet of the filter, to ensure that the filter is isolated from the flue gases during bypass condition.

Comprising pneumatically actuated butterfly valve arrangement.

3.9 Thermal Insulation

For the exterior surfaces of the filter plant, thermal insulation is to be installed for personnel protection and to avoid the cooling of the plant parts during short standby periods.

Technical Data		
Mineral wool Insulation thickness	50 to 100	mm
Mineral wool Insulation density	100	kg/m³

Thermal Insulation areas addressed:

- Insulation of the waste heat cooler.
- Insulation of the filter housing, hood, and screw conveyor.
- Insulation of the ductwork.

3.10 Exterior Surface Treatment - Filter Unit

The exterior surfaces of the filter unit receive a single layer of two component epoxy resin prime coating, layer thickness at least 40 µm. These exterior surfaces are treated with a supplementary top coating on alkyd resin basis, layer thickness at least 40 µm.

The application of different types of paint may cause colour variances.

Any filter components supplied in special steel, galvanised steel or insulated surfaces are excluded from the above surface treatment.

3.11 Filter System Control and Electrical System

A dedicated control system is supplied for the automatic and integrated operation of the cremator, the waste heat cooler and filter system.

The control system will comprise of the following:

- Control Enclosure
- Electric cabling

3.11.1 Control Enclosure

The enclosure will be designed conforming to European regulations; and comprise of a sheet steel cabinet, protected to IP 54. The enclosure will house power and control section, as well as wiring of devices in cable ducts. The control cabinet is designed with a minimum of fuses, completely wired on outlet clamps.

The control system will be based upon a "Mitsubishi" Programmable Logic Controller

The control enclosure also includes:

- 1 off Main Switch.

As well as the following components:

- 1 off Control of the Induced Draught Fan utilising Frequency Inverter.
- 1 off Negative pressure control in connection with speed dependent induced draught fan.
- 1 off Screw Conveyor control.
- 1 off Control of the reagent dosing system.
- 1 off Measurement of flue gas temperature after waste heat cooler.
- 1 off Control of the water control system.
- 1 off Control of the cooling fans from the air blast cooler.

The operator interface for the filter system will be via the SCADA based computer interface preloaded onto an standard PC, supplied complete with a 17" TFT Flat Screen monitor.

3.11.2 Electric Cabling

The cabling between the plant and our control cabinet has been calculated with a medium cable length of 20 m. The electric cabling consists of:

- Cable
- Cable glands
- Galvanised cable tray
- Fastening material
- Accessories

The incoming power supply to the control panel is to be provided by the client. For actual Power requirements please refer to our electric motor schedule as listed within our engineering documentation / information package.

3.12 Chimney System

To convey the cooled flue gases from the ducting exhausting from the induced draught fan, a specially designed chimney flue lines are supplied, for installation within the specific requirements of the crematorium. Generally, it is fabricated with 3mm stainless steel, of welded fabrication, supplied with flanged connections, designed for good flow characteristics.

The specific design of the chimney may enable double liner design to be supplied (subject to local regulations), enabling the cremation equipment to benefit from the connection of unabated flue gases to the chimney liner, and allowing the continuous operation of the cremator in an emergency unabated mode, by use of bypass operation driven by the cremator's ejector draught generator and associated bypass ducting.

4.0 EQUIPMENT DOCUMENTATION

Documentation will be supplied in the English language Two copies of the following will be supplied:

- Plant description
- Operation description
- Maintenance - and lubrication instructions
- Spare parts list

The information signs on the plant will be supplied in the English language.

5.0 OPERATIONAL PERFORMANCE

5.1 Dust Emissions in Flue Gases

The residual dust content in clean gas is typically max. 10 mg/Nm³, referred to 11%O_2 v/v, measured according to VDI 2066.

5.2 Gaseous Emissions

The concentration of the gaseous acidic and metallic pollutants will be abated by the flue gas treatment system. Based upon the inlet concentration of pollutants (as detailed in section 2.0 – Technical Design Data) and a ***Factivate*** reagent dosing rate of 600 grammes per hour for each operational cremator, the flue gas emissions will be within the limits set down in the Process Guidance Note 5/2 (12) Issued September 2012: -

Typical Measured Emissions	PG5/2 (12) Typical Concentration	
Hydrogen Chloride excluding Particulate Matter	<10	mg/Nm³
Total Particulate Matter from Cremator	< 5	mg/Nm³
Carbon Monoxide	<15	mg/Nm³
Organic Compounds excluding Particulate Matter expressed as total carbon	<1	mg/Nm³
Mercury	<20	µg/Nm³
Dioxins & Furans	<0.02	ng/ Nm³

Concentration values stated at standard gas reference conditions of 273 K, 1.013 Bar,11 % O_2, dry gas.

5.3 Sound Emissions from the Filter Equipment

The sound pressure level LAeq according to DIN 45635 - part 1 - at the plant is max. 75 dB_A in a distance of 1m. This is only valid for free field conditions without reflections.

The indicated sound pressure levels are valid for the non throttled operation of the plant, i.e. 100 % fan output.

Attenuation materials will be applied to the main ventilation fan to ensure compliance with the required 75 dB_A at 1metre distance, during normal operation hours.

PLEASE NOTE *that the other noise generating equipment will be supplied in normal (non silenced) format, both the Waste Heat Cooler Auto Cleaning System and the filter cleaning produce noise during the shutdown process. This is after normal operating hours, and as such not considered for noise within our normal operational hours.*

Facultatieve Technologies reserves the right to amend the above dosing rate if the inlet flue gas pollutant concentration is found to differ from the values detailed in the design data to maintain the stability plant's pollutant emissions.

6.0 GUARANTEE

The filter installation, and its component parts (with the exception of those consumable items necessary for operation), are guaranteed for a period of **12** months from the date of hand over and a 3-year design liability, excepting fair wear and tear, subject to entering into a Service Contract with Facultatieve Technologies.

This guarantee is dependent upon the equipment being operated and routinely maintained in accordance with supplied written instructions and operated by trained personnel in possession of a Facultatieve Technologies Training Certificate. Replacement of all spares and consumable parts within such time must be with genuine components as approved by Facultatieve Technologies.

The above design life is offered in good faith, however Facultatieve Technologies cannot be held responsible for any changes within relevant legislation that may impact upon the above design life.

Conditions for unrestricted validity of our guarantee:

- The plant has to be operated according to our operating and maintenance instructions and operated by trained personnel.
- The plant has to be operated within the established design parameters.
- The plant has to be commissioned by FTL nominated commissioning engineers.

Exclusion from guarantee:

- Mechanical destruction of the equipment caused by handling malpractice.
- Failure to supply or support an ADSL / Broadband connection so as to enable FTL to remotely support and diagnose the cremation installation.

The cleaned flue gas emission limits can only be assured, if sufficient addition of reagent is made to the system and is in full accordance with the equipment's operating instructions.

In case of altered site conditions, the addition of the additive quantity may only be adjusted to the respective new requirement by agreement with FTL.

Consumable items are excluded from the scope of the guarantee

Proof of clean gas values:

The actual proof of achieving the required emission values of clean gas of the proposed filter plant can only be carried out by an authorised measuring institute.