SCANDINAVIAN ENERGY CONTRACTOR

Project	1017 **Newport energy from waste plant**	Document no.	Rev.no.
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Subject: **Environmental Agency**
CEMS Description

TECHNICAL SPECIFICATION

Rev.	Date	Description	Issuer	Reviewer	Approver
00	2022.12.13	Issue for EA application	PEJO		

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2. Introduction

A dual redundant (2 x 100 %) continuous emission monitoring systems will be installed for the measurement and monitoring of CO, NO (NOx), NH3, SO2, HCl, H2O, TOC and O2.
Exhaust gas will be continuously extracted (sampled) from the exhaust stack (two streams) and fed to the multiple gas analysers via a trace heated sample line/hoses. The gas analyser panel will be located indoors in a container solution. Autocalibration of the analysers is included from bottled calibration gases.
The exhaust stack will also be fitted with redundant (2 x 100 %) forward scatter laser devices for particulates (dust) measurement.
Additional HCL and SO2 gas analysers (one of each) will be installed between the boiler economisers and FGT system, to allow calculation of the RDF feedstock chlorine and sulphur content, and as an input signal to the FGT control system for the control of hydrated lime injection.

2.1. Description

The below description is the purchased CEMS equipment from the company CBISS.

a1-cbiss are an ISO accredited, environmental monitoring systems supplier, with expertise in the design, manufacture and integration of Continuous Emissions Monitoring Systems, Gas Detection & Analysis Instrumentation, Air Quality Monitoring Solutions, and Sampling & Filtration Equipment.

a1-cbiss provide a range of fixed MCERTS accredited Continuous Emissions Monitoring Systems which satisfy both operator and regulatory requirements including the Waste Incineration

Directive (WID) and Large Combustion Plant Directive (LCPD). These systems are currently operational in a number of key industries including power generation, combustion, pyrolysis, biomass, gasification, animal, clinical and hazardous waste incineration. 60% of the UK's Energy From Waste (EFW) facilities benefit from a1-cbiss CEMS installations.

Designed around legislative requirements the reporting packages provide all of the information required for compliance:

- The software can correct data to standard conditions, dry gas and apply O2 corrections and confidence interval adjustments.
- Data can be viewed in tabular format as a range of averages for each parameter.
- Recent historical data can be viewed graphically displaying any calculated averages.
- Up to four individual alarms can be configured for each average, thus allowing digital outputs to trigger warning beacons to alert users as limits are being approached.
- For WID applications the software encompasses all the data logging requirements stipulated in the QAL2 and QAL3 sections of EN14181.
- Digital signals can be provided to the DCS to indicate system status such as faults etc.
- Reports can be generated on a daily basis to indicate compliance with daily and half hourly limits.
- Monthly reports in standard EA format will also be generated for ease of submission.

Please refer to signal and cable diagrams in attachment 1 and overview diagram in attachment 2. Arrangement and layout of platforms to be found in attachment 3 and 4.

PID for the CEMS is included attachment 5 and for the CEMS in attachment 6.

Quality Control Plan (QCP) & Inspection Test Plan (ITP) is included in attachment 7.

Rev.	Date	Description	Issuer	Reviewer	Approver
00	31.01.2023	First issue. EA application/SOL Environment	PEJO	ALGU	JGP

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1. Attachments

No.	Doc.no.	Rev.no.	Description
1	Attachment 1. Grate Technical description		Grate Technical description
2	Attachment 2. Flue Gas Cleaning		Flue Gas Cleaning
4	Attachment 3. SNCR M&S		Selective Non-Catalytic Reduction

2. Introduction

The purpose of the project is to establish a net 20MWe RDF fuelled Energy from Waste (EfW) facility to be located in Alexandra Docks in the Port of Newport in accordance with the description **in this** Schedule and attachments.
The supply covered by this specification is intended for use in the New Port Energy from Waste plant, for which Scandinavian Energy Contractor (SEC) has entered a contract for the design, manufacturing, delivery to site, erection and commissioning. SEC is the principal contractor responsible for the complete plant.

The expected average fuel Lower Calorific Value (LCV) for continuous operation is 11 MJ/kg, though the design range for the boiler is from 8 – 16 MJ/kg

2.1. Layout

2.1.1. Main Data

Subject	Details	Comment
Fuel type	Refuse Derived Fuel (RDF)	As per Specification section 22
Number of streams	One	Single Boiler, single turbine
Gross electricity output	24 MW at 100% boiler MCR	At 11 kV
Net electricity exported to the grid	20.0 MW	At 33 kV
Net electricity exported to potential future private wire	3.0 MW maximum	At 11 kV
Total electricity exported	20.0 MW at 100% MCR	
Fuel input rate at 100% MCR	28.8 t/h1 37.3 t/h	At design LCV 11 MJ/kg At min. LCV 8 MJ/kg

Subject	Details	Comment
	19.8 t/h	At max. LCV 16 MJ/kg
Fuel input rate average	28.8 t/h	For aggregate gross power generation of 24 MW At design LCV 11 MJ/kg
Steam conditions	41 bara, 415 °C	At steam turbine inlet
Steam boiler capacity	102.2 t/hr at boiler MCR	
Ambient air temperature	15 °C	Design -5 °C minimum 35 °C maximum
Exhaust gas emissions	Commission Implementing Decision (EU) 2019/2010 of 12 November 2019 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for waste incineration	Upper emission limits to be applied

Notes:

1) Design fuel specification:
   a. LHV 11.0 MJ/kg
   b. Chemical analysis (by mass): Carbon 29.99%, Hydrogen 3.73%, Nitrogen 0.47%, Oxygen 16.98%, Water 33.00%, Ash 17.0%, Sulphur 0.31%, Chlorine 0.52%, Fluorine 0.00%.
2) Gross power generation and net power output reduced at higher ambient temperatures.

The Plant will be designed to operate with an R1 factor above the 0.65 threshold for new installations after 31 December 2008, as defined in the R1 Energy Efficiency Formula for Incineration Facilities Dedicated to the processing of Municipal Solid Waste according to Annex II of Directive 2008/98/EC on Waste.

The overall Energy and Mass Balance is included in section 8 and the Firing Diagram in section 9 of this application

2.1.2. Operational Functionality

Plant cold start-up will be fully automated and require no operator intervention except for the initiation of such start-up process, and the opening/closing of manual valves, switchgear etc. that are normally not operated during normal online running. Start-up will require 5-6 operation staf Plant warm/hot restart will be fully automated and require no operator intervention except for the initiation of the re-start process.

The plant will safely shutdown following a trip or loss of grid at any level of power output without any damage to equipment by way of the 100% steam turbine bypass capability. The plant shutdown will be fully automated and require no operator intervention.

3. Waste Reception

3.1. Feedstock Reception

The waste reception hall is designed with 2 side-by-side storage bunkers, divided by a wall. Each storage bunker has 3 unloading lanes each, 6 in total.

Feedstock arrives from 7.00-19.00 Monday to Saturday and possibly 8.00-16.00 Sundays. There will be 1 – 6 mainly 90 m^3 walking floor types of lorries arriving each hour.

3.2. Treatment of raw waste

A mobile shredder will be installed for loosing bales or to shred oversized fuel in accordance with EPC contract schedule 33 attached in section 22 of this application and will be placed in one lane to directly conveying the shredded RDF into the storage bunker. Shredding is estimated to be <10% of the fuel throughput. Shredding is not normal pre-condition for the received fuel as it will frequently be used during long weekend and holidays.

The loose RDF from the lorries will be unloaded directly into one of the two storage bunkers. Feedstock unloading can take place as lorries reverse into one of six lanes. The sub-contractor shall consider crane grab design based on the waste characteristics as described in the feedstock specification.

3.3. Feedstock Storage Bunker

For design and arrangement of the waste fuel reception bunker, feeding bunker and the external bale storage please refer to 1017.S1.U00.000 "Plan E waste fuel handling conclusions" attached in section 24 of this application.

3.4. Waste Crane

At the lower level, 2 cranes ,1 for each bunker, will move, mix, and stack the pre-shredded RDF. When the RDF is stacked on the east side of the bunker, 2 redundant cranes will feed the stacked waste from the storage bunker into the boiler feeding hopper at the higher level. The feeding hopper will call the cranes for RDF when needed.

The cranes shall be designed for feeding the hopper as the priority and stacking and mixing as the secondary priority.

The cranes are designed for fully automatic mode for stacking in unloading-bunker and feeding the Feeding Bunker. It will be possible to operate the unloading cranes manually.

3.4.1. Lower-level cranes

The feedstock reception building where walking floor lorries unload into the bunker at one side furthest from the boiler feed chute, there are 2 cranes. These runs on separate sets of rails side-by-side from the unloading end to the wall towards the boiler. These cranes can move, stack, and mix the raw feedstock in the bunker. The cranes will also be able to service the shredder with oversized waste. Feeding of bales into the shredder will be done by a front loader.

The grabs on the cranes can also be lowered down to the unloading deck on a grab trolley for servicing and maintaining.

One crane shall be able to supply 100% fuel to the feeding cranes/boiler.

3.4.2. Upper-level cranes

2 cranes operate on rails at the top of the feedstock building above and perpendicular to the two parallel lower cranes. The working area of these feeding cranes overlap that of the two lower cranes and can feed the boiler at the elevated boiler feed chute.

The cranes are able to clear the feeding hopper in case of blockage.

For service or maintenance of the grabs, a jib-crane is placed on the SE end of the building to hoist down the grab to ground level on a grab trolley.

The installed cranes are 2 x 100% (one duty one stand by).

3.5. Dust and Odour

To mitigate dust and odour in the fuel storage bunker and tipping hall, the combustion air will be taken from the storage bunker to facilitate a local negative pressure in the building. In case of an unforeseen stoppage, the building facility has an extraction ventilation system facilitating a local negative pressure. The plant will be equipped with source specific dust removal system based on individual filters for suppression of dust or similar. Furthermore, the equipment shall be equipped with odour-handling devices designed to meet the appropriate permit limits for dust and odour.

4. Grate Combustion System

4.1. From Storage to Combustion

4.1.1. Charging hopper

The hopper receives the waste from the grab and leads the waste down into the charging chute succeeding the hopper. The design of the upper opening is similar to the expected diameter of the grab in open condition.

4.1.2. Charging chute

The chute, leading the waste to the furnace feeding pusher, is constantly filled with waste during operation, thus creating a seal between the combustion chamber and the exterior atmosphere.

4.1.3. Charging pusher

The charging pusher placed under the charging chute slowly pushes the waste onto the first section of the grate.

4.1.4. Grate section

The main task of the grate is to transport and distribute the waste on the grate area in the furnace to obtain the best possible contact between combustion air and waste.

The incineration of the waste fuel at the grate and in the furnace convert the waste fuel to flue gas leading to the boiler.

4.2. Grate

4.2.1. Overview

The RDF combustion system will be a moving grate, both air and water cooled, to suit the RDF Specification set out in the Specification, including ranges of calorific value, water content, ash content and physical dimensions.

The grate combustion supplier is Mitsubishi Power Europe gmbh. Technical description and scope of supply can be found in Attachment 01 of this schedule.

The combustion grate system has feed control range of 70% to110% of the thermal design basis, achieved by speed and stroke length of the RDF pushers in the metering section. The range of the grate system is given in the Firing Diagram in section 09 of this application.

There are four sections of the moving grate. 2 sections are water cooled and 2 sections are air cooled. There is no "tipping point" or switch over as the cooling is in continuous operation.

The water-cooling system is sufficient for the maximum LCV of the feedstock.

Control of the combustion air (primary-air and secondary-air) is done by frequency (speed) controlled fans as well as motor driven dampers for each air zone.

The primary air enters the combustion chamber through the combustion grate. Its task is to control the main combustion and the thermal output out of the combustion.

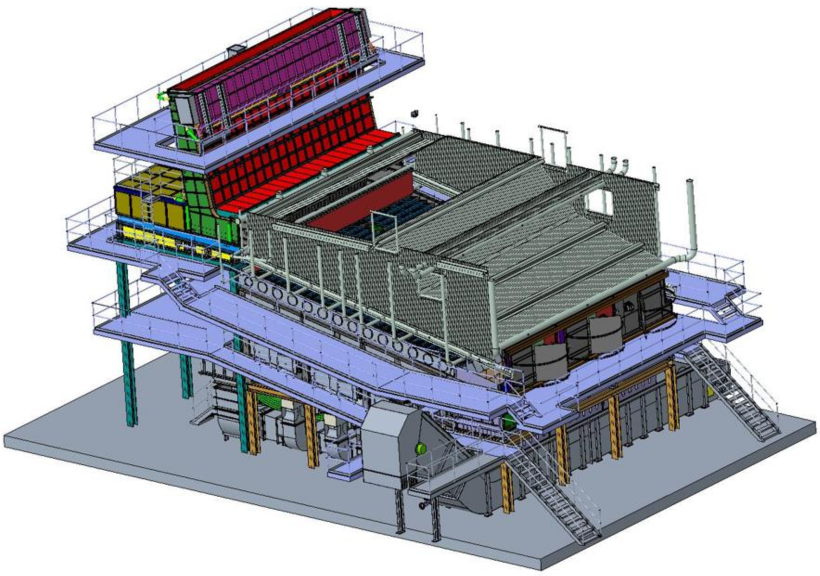
The secondary air enters the combustion chamber at the upper end of the combustion chamber. Its task is to ensure the complete burnout of the flue gas from the combustion chamber. The secondary air flow is controlled by the O_2 controller to keep the flue gas O_2 concentration constant.

4.3. Summary Description of Grate

The combustion grate incorporates staged combustion with primary air and secondary air. Air suction will be from strategic areas of the feedstock handling/storage hall (shredder discharges, push-floors) to minimise and extract dust and any odour and to induce a negative pressure in the feedstock hall.

Heat will be recovered from the grate cooling system. The grate will be integrated to the boiler, sited beneath the first vertical path.

In below drawing the grate and combustion arrangement is shown:



The lower section of the boiler first pass radiation room will incorporate two auxiliary start-up / support burners firing diesel oil. Compressed air will be used as the fuel oil atomizing medium during the short and infrequent periods of diesel oil firing operation.

5. Riddling, Slag and Boiler Ash

Riddling, slag, and boiler ash will be mixed in the slag bunker.
Riddling from the grate is led by the riddling conveyors beneath the grate system to the slag conveyor which will collect the slag as-well and transport the mix of riddling and slag to the chain conveyor which deliver the slag/riddling to the slag/ash bunker.
The riddling conveyor and slag conveyor are water filled.

Under the 2/3erd pass water cooled screw conveyors are located. Boiler ash from the hopper beneath the 2/3rd pass is led by the screw conveyors and duct to the above-mentioned slag conveyor to be transported to the bunker together with the mix of the wet slag/riddling. Due to the moisture of the mix of slag and riddling no dust is foreseen. The chain conveyors will be covered by plates.

Boiler ash from the 4th pass (horizontal) is collected in hoppers below the pass and lead to the chain conveyor beneath the hoppers. Rotary valves are installed below the hoppers to provide an airtight connection. The chain conveyor leads the boiler ash to another chain conveyor which transports the boiler ash to the slag /ash bunker. The chain conveyors will be covered by plate to ensure safety. The boiler ash will be led into a humidifier before entering the bunker to prevent dust emission.

In a similar way, the boiler ash is collected in the economizers in the lower hoppers to be led down to a chain conveyor. The (inclined) chain conveyor lead the boiler ash to the bunker. Rotary valves prevent falls air inlet to the economizer hopper. The chain conveyor is covered by plates. Likewise, the ash from the horizontal pass, the boiler ash from the economizers will be lead into a humidifier before entering the bunker to prevent dust emission.

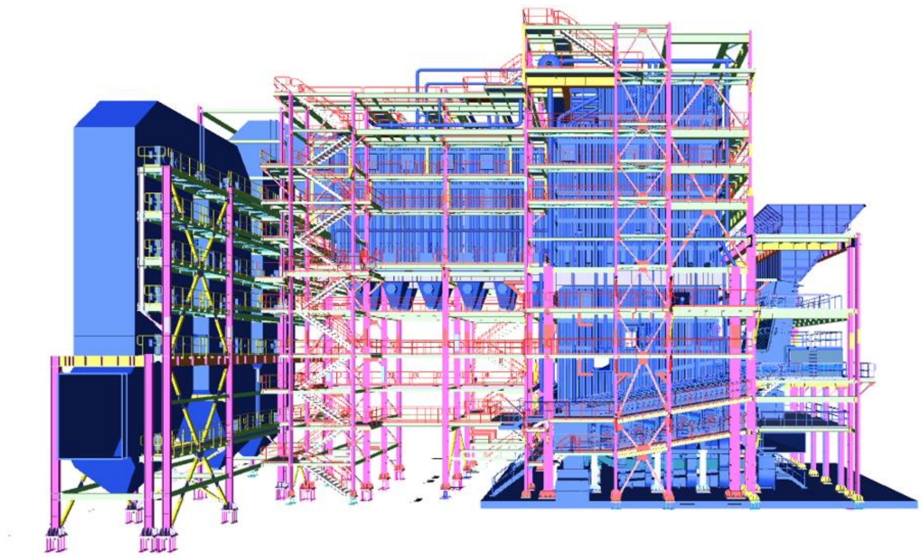
The slag/ash bunker is concreted lined bunker with effective storage volume of at least 400m^3 providing approx. 4-6 days storage, to be located on the SE end of the boiler building, to allow drive through loading of the slag and ash removal lorries by mobile telehandler or overhead crane. The clockwise circuit of the site for the ash removal lorries includes weighing on entry and exit.

6. Boiler Description

6.1. Introduction

The boiler would be a Corner Tube, single drum, water tube boiler with vertical and horizontal passes.

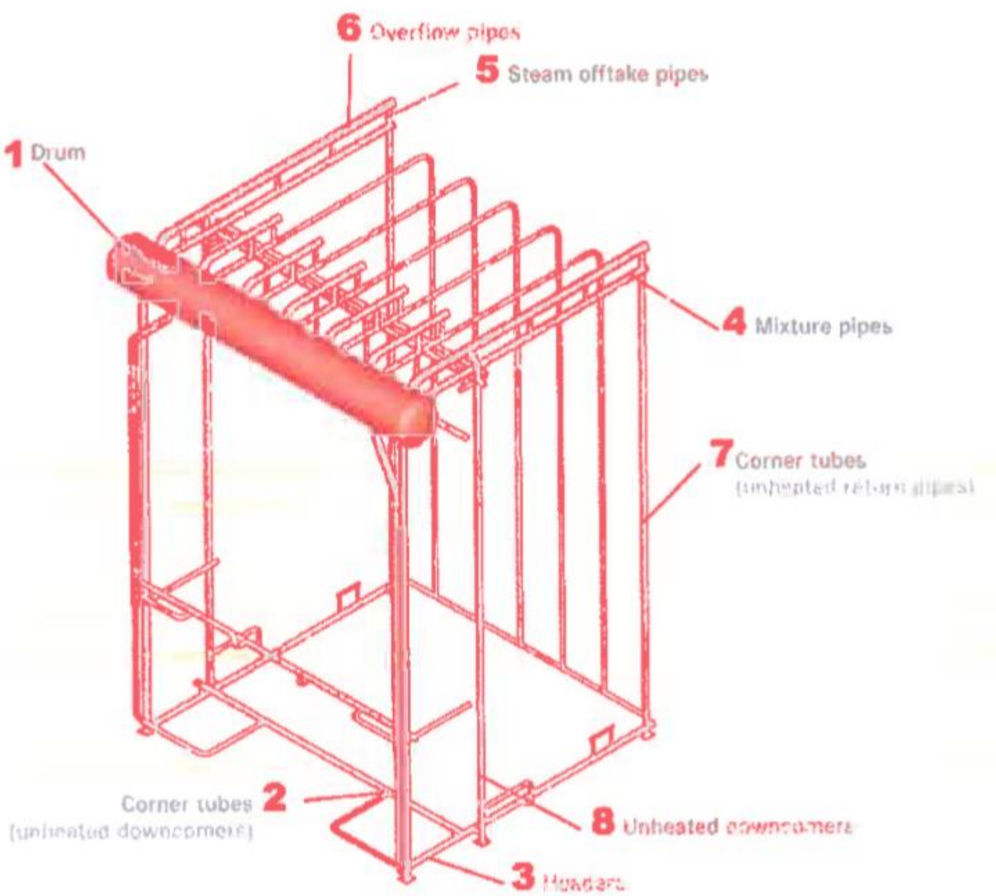
Below pictures shown the overall arrangement of the grate and boiler.



The boiler will comply with the minimum 2 seconds at >850 °C residence time requirements under all boiler operation conditions included in the full extent of the firing diagram. The boiler tube panel walls for the first two vertical passes will include multiple openings for thermal temperature mapping instruments to be fitted to enable proof of this requirement, with velocity and residence time being calculated from the boiler thermal design model.

The boiler is self-supporting with a fully welded construction, designed for extended service life and reduced maintenance requirements for minimum down time.

The ERK Corner Tube Boiler are a single drum natural circulation water tube boilers characterised by the following attributes:



- Pre-separation of steam: The steam generated in the boiler is separated through the overflow pipe (6) as shown in the figure above before it enters the steam drum (1). The steam is separated through the overflow pipes (6) and steam offtake pipes (5) before entering the stream drum.
- Corner tube cage: The corner tube cage is a monocoque body make up of a stable, rectangular arranged framework of downcomers (2, 8), unheated return pipes (7) and headers (3). The headers and distributors are welded to flue gas-tight tube walls, creating a closed body of tubes making the boiler self-supporting. Furthermore, the boiler framework can be identified through 8 components as seen in the drawing above.

- Steam Drum: ERK Corner Tube Boilers have only one drum, the steam drum. The steam drum is located outside the corner tube cage and is isolated from the heat generated in the combustion chamber. The mixture pipes (4) connected to steam drum delivers a mixture of steam / water. The annular steam drum (provided at the upper portion of boiler) is constructed from high quality boiler steel plates suitably stiffened with stay bars. The steam drum is furnished with necessary drum internals and various nozzles for mounting of required valves and instruments.
- Membrane Walls: The membrane walls are made of riser tubes welded to form a skin-tight casing, which absorbs the radiant heat from the combustion chamber.
- All boiler parts/segments will be drainable.
- The boiler internal surfaces will be chemical cleaned (flushed) prior to first introduction of treated boiler feedwater.
- Start-up from cold to operating drum pressure will be maximum 12 hours.
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6.2. Superheaters

The superheaters shall be of the vertical convection type and consist of hanging U bent tube elements forming multi passages and two headers per superheater. Each element tube will be rolled and welded into the headers.

The superheater tubes will be 57 mm diameter with cross pitch 150 mm, to reduce the risk of slagging/blockage from ash.

The first rows of superheater tubes will be fitted with “half-moon” 3 mm thick NI-Cr steel cover plates in order to reduce tube corrosion/erosion and hence increase tube life. Fin al design by ERK to determine number of rows to which cover plates will be applied.
A two-stage external control attemperator will be installed between the first and second superheater and will consist of spray type desuperheaters.

6.3. Economisers

The boiler will be equipped with multiple economizer tube banks made of closely spaced continuous loop elements, which shall be welded at both ends to the terminal headers. Each element shall be of straight steel tubes and be connected by U-bends forming an integral loop. Economizer design and sizing has been done to ensure the exhaust gas exit exceeds the dew point of the flue gas, taking into account the FW temperature of 145 °C .
An automatically controlled water-side economiser bypass will be included to maintain a final exhaust gas temperature >150 °C, as required for the flue gas treatment system.
Shielding will be provided if required by detail design by ERK) on rows of economiser and evaporator tubes that are subject to impingement by steam soot blowers.

6.4. Condensate Pre-heater

The boiler will be equipped with a condensate pre-heater tube bank (after the economisers) made of closely spaced continuous loop elements, which shall be welded at both ends to the terminal headers. Each element shall be of straight steel tubes and be connected by U-bends forming an integral loop.

6.5. Refractory and Inconel Cladding

For the protection of the boiler water tube walls, the first vertical pass of the boiler will be refractory lined up to approximately 2/3rd of the height (radiation room 1 of the drawing below). The top of the first vertical pass and top 1/3rd of the second vertical pass (roof sections included) will have Inconel clad tubes, 2 mm thick (radiation room 2 and 3 of the drawing below).

7. Steam Turbine

7.1. Overview

Produced steam from the boiler will be led to the steam turbine to covert the energy in the steam to power by the generator.

The steam turbine generator will be sized to produce electricity at the steam parameters defined in the Specification. When running at the optimal Plant design point this will result in a maximum amount of electricity exported to the local grid. The Plant will be optimized for electricity production. The STG will be located in a separate building (turbine hall) with overhead gantry crane for major maintenance works.

The Steam turbine will be the condensing type with radial upwards or axial exhaust and with pressure casing and oil system to DIN 4312. Overspeed protection is included.

The turbine extractions, or bleeds, will be used to for the feed water heater and deaerator tank. The unit will be positioned directly on a separate foundation slab, designed to absorb the static and dynamic loads of the turbine generator set. The steam turbine will be of a proven design applied in several reference plants. The steam path will be tailor engineered for the parameters of the Plant. The steam turbine will have vibration monitoring.

The design exhaust pressure of the turbine will be around 0.10 bar(a) in conditions where the ambient air temperature is 15°C. The last blading of the turbine will be designed to be able to withstand the loads associated with a lower exhaust pressure than 0.10 bar(a). The turbine set will include a generator, gear box, glands, gland steam system, balance piston, oil system (lubrication, power and control) and protection and control.

7.2. Extraction provisions

The turbine will supply bleed steam for low pressure users including:

- Deaerator heating
- Feed Water Pre-Heater;
- Turbine LP sealing steam;

A gland steam condenser will be included in the scope of supply. The gland steam will not be vented into the atmosphere but condensed in a heat exchanger with the condensate discharged into the foul water drainage system. The exchanged heat can be recovered and used to preheat the condensate. The gland steam system supplier for turbine, including gland steam condenser, is Siemens.

7.3. Turbine Bypass System

If the turbine for some unusual operational reason cannot accept the produced steam a 100% MCR bypass valve with steam cooling water injection will be included and will operate to provide safe shut-down in case of such an emergency. Additionally, as a further safety backup measure pressure safety valve will be included as part of the boiler construction and this bypass system will be included in order to prevent the operation of these pressure safety valves, unless as a last resort if the bypass system also fails.

Furthermore, this bypass valve will be required for start-up purposes in the closed cycle, without the need to blow-off steam to the atmosphere. The bypass provision will be designed to allow long term continuous operation of the plant whilst not running the steam turbine.
Design capacity of the turbine bypass system to equal the boiler maximum continuous rate (105 t/h at 44 bara).

Pressure Reducing Station to comprise of a Pressure Reducing valve, and spray water de-superheating valve using feedwater from feedwater pumps.
At turbine start-up steam will be vented until it’s possible to seal the turbine and generate a vacuum. Air extraction ejectors are included to provide this.

The by-pass system will be insulated to ensure the noise level at 1 m and at 1,5 m elevation will be below 85 dB(A).

7.4. Turbine Auxiliary Systems

A lube oil supply unit will be incorporated into the baseframe of the STG comprising lube oil tank, main oil pump, motor driven auxiliary 100 % oil pump, DC motor driven emergency 30% oil pump, oil tank heater, oil coolers and oil filters.

Battery (UPS) for 30 minutes’ drive of the emergency DC motor driven oil pump is included.
Jacking oil systems for the turbine and generator are included
Turning gear for the turbine is included

7.5. Turbine Control System

The turbine control system will be supplied by the STG supplier, based on Siemens PLCs, thus ensuring seamless integration with the DCS.

7.6. Generator

The Steam turbine will be coupled to a 11 kV 50 Hz 24.9 MW 29.29 MVA 0.85pf generator to IEC standards, via a double helical parallel-shaft gear unit to AGMA 421.06.

The generator will be water-cooled and connected to a closed (dry) cooling system. The cooling system will also provide cooling for the oil system. The oil system will be provided with a duplex oil cooler to provide high reliability.

8. Steam, Feedwater and Water Treatment System

8.1. Condensate

After condensing, the condensate from the steam turbine will be collected in a condensate tank which also collects other smaller flow steam condensate returns. The condensate will then be pumped back to the deaerator via a condensate pre-heater using boiler exhaust gas. Condensate pumps will be 2 x 100 %, continuously rated duty/standby.

8.2. Deaerator & Feedwater Tank

The deaerator and feedwater tank will be heated by a bleed steam supply from the steam turbine, which is regulated to control the deaerator operating pressure (4 bara) and hence temperature to 145 °C.

As the deaerator will be operating above 100 °C, any air (and hence oxygen) is vented, thus providing oxygen free feedwater to the boiler and steam system thus minimising corrosion. The deaerator level will be controlled by the introduction of fresh make-up water to account for steam and condensate losses from blowdown, sootblowing, steam traps losses etc.

8.3. Feedwater

The feedwater from the deaerator tank will be fed by 2 x 100%, high pressure duty/standby continuously rated pumps to the boiler economiser. The high pressure feedwater is also used for boiler steam temperature control by two spray-water type attemperator valves.

8.4. Boiler Water Treatment

Boiler water treatment (and blowdown) will be provided in order to achieve the steam purity according to IEC TS 61370 2002-06.

Boiler water treatment chemicals (oxygen scavenger (Carbohydrazide) and alkalinity builder) will be injected into the boiler feedwater between the deaerator tank outlet and the feedwater pumps. Dosage rates will be controlled from outputs from the continuous online sampling and monitoring system to ensure the feedwater always meets the requirements of the boiler and steam turbine.

8.5. Make-up Water (Water Treatment Plant/WTP)

Make-up water for the boiler and steam system will be taken from the raw water storagebreak tank. It is treated by a water treatment plant comprising base-exchange softening, carbon filtration, reverse osmosis, electro-deionisation units and mixed bed polisher to provide high quality demineralised water to meet the requirements of the boiler and steam turbine.
The de-mineralised make-up water will be fed to the blowdown system where it is pre-heated by waste heat from the boiler blowdown before entering the deaerator.

8.6. Drains & Effluent Water Treatment

Various process and floor drains, water treatment plant drains, will be collected in a sedimentation basin, then will be pH neutralized and send to effluent treatment plant for further treatment and storage. Treated effluent will be reused as much as possible.

9. Flue Gas Treatment (FGT)

9.1. Introduction

The FGT system will comply with the following emission to air limits:

- Daily averages per Commission Implementing Decision (EU) 2019/2010 of 12 November 2019 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for waste incineration (upper limits), namely:

Dust	5 mg/Nm^3	At 11% O_2 dry
HCl	6 mg/Nm^3	At 11% O_2 dry
HF	1 mg/Nm^3	At 11% O_2 dry
SO_2	30 mg/Nm^3	At 11% O_2 dry
NO_x	120 mg/Nm^3	At 11% O_2 dry
NH_3	10 mg/Nm^3	At 11% O_2 dry
CO	50 mg/Nm^3	At 11% O_2 dry
TVOC	10 mg/Nm^3	At 11% O_2 dry
Hg	20 µg/Nm^3	At 11% O_2 dry

The emission limits will be achieved by a combination of combustion technology, dry-scrubbing, urea injection and filtration.

The FGT supplier (other than the SNCR system) is DP Cleantech (UK) who have a strong track record in waste-to-energy. The supplier proposal detail, technical data and scope of supply can be found in attachment 2.

The flue gas flow and emission data for the following 12 operating cases for each supplier is given in attachment 3, for the full extent of the Firing Diagram, encompassing:

- Design RDF fuel LCV.
- Min RDF fuel LCV.
- Max RDF fuel LCV.
- Boiler nominal output.
- Boiler maximum output.
- Boiler 50 % load.
- Average RDF fuel Cl and S contents.
- Maximum fuel Cl and S contents.

9.2. NOx

The NOx emission limit will be achieved by air flow control across the multiple combustion zones in the grate (thus reducing flame temperature and reducing atmospheric NOx) and **Selective Non-Catalytic Reduction** (SNCR) NOx removal by the diluted urea injection in the first pass of the boiler, above the grate.

Multiple nozzles across multiple rows of the boiler first pass will be installed to allow for system optimization during commissioning.

Urea solution will be stored in a tank to provide a minimum of 4 days' supply. The solution will be further diluted according to the vendor's recommendations, prior to injection into the boiler. Technical proposals for suppliers for the SNCR system are given in attachment 3.

9.3. HCL, SO2 and HF

The acid gases in the exhaust gas will be removed by a dry scrubber reactor tower after the boiler economiser with hydrated lime injection. The tower will be sized for approximately 4 seconds' reaction time.
Lime is stored in a silo. The silo will be located next to the scrubber with feed by two conveyors via metering systems to a blower, then onto the base of the scrubber tower.

For the extreme cases of maximum chlorine and sulphur in the RDF feedstock (cases 10, 11 and 12 in the FGT data in appendix 2), the HCl and SO2 emission limits required) are guaranteed with increased reagent consumptions as stated.

9.4. Hg, Cd, and Ti

The hazardous metal oxide gases in the exhaust gas will be removed within the same dry scrubber reactor tower as for the acid gases by powdered activated carbon (PAC) injection.
PAC will be stored in a silo. The silo is located next to the scrubber with feed by conveyor via a metering system to a blower, then onto the base of the scrubber tower

9.5. Particulates/Fly Ash and APCR

The particulates/fly ash and used reagents (APCR) will be removed by fabric filter elements. The captured product is recycled back to the reactor tower via a recirculation surge hopper and conveyors. An additional conveyor, rotary valve arrangements and pneumatic conveyor transports the APCR (fly ash and FGT residue) to a silo for final removal from site by suitable dry ash handling lorries.

The fabric filter system comprises compartments allowing one compartment to be isolated for maintenance purposes while the other five compartments remain online and meeting the Plant's regulated emission requirements.

Clean gas then exits the fabric filters and passes to the exhaust stack via the induced draft (ID) fan. The FGT fabric bags are automatically and sequentially cleaned on-line by compressed air injected into a row of filter bags, thus creating an over-pressure in the relevant bag which momentarily stops the filtration on that bag and abruptly inflates the filter bag, causing the dust cake to break away and fall into the lower hoppers. There is one hopper for each of the 6 compartments. Boiler fly-ash and APCR generation rate, based on average HCl and S content in the RDF feedstock, (including residue from FGT scrubber) is approx. 36 t/d, thus assuming 18ton loads, frequency is 2 per day, or higher after Sundays and Bank Holidays when collections may not take place. Such collection frequencies will increase with higher HCl and S content in the RDF feedstock, due to increased FGT residue generated.

10. Induced Draft Fan, Continuous Emission Monitoring (CEMS) and Exhaust Stack

10.1. Induced Draft Fan

An induced draft fan will be installed after the FGT system at the base of the exhaust stack outdoors. It will be sized for the full duty of the boiler and to maintain a negative pressure through the boiler system, thus ensuring no escape of exhaust or ash from the system.
It will be directly driven by a electric motor, pedestal mounted, via a coupling with flexible bellows on its inlet and outlet. The motor speed will be controlled by a variable speed drive from the motor control centre (MCC).
The fan will be mounted on anti-vibration mounts, to concrete foundations.
The fan will be fitted with temperature and vibration monitoring sensors.

10.2. CEMS

A dual redundant (2 x 100 %) continuous emission monitoring systems will be installed for the measurement and monitoring of CO, NO (NO_x), NH_3, SO_2, HCl, H_2O, TOC and O_2.

Please refer to separate description include in this application.

10.3. Exhaust Stack

The exhaust stack will be designed according to EN1993-3-2 and will be self-supporting and double walled. The overall height will be 50m (per Planning Permission) and have an outside diameter of 2.5 m. Design life shall be 25 years (50 years for structure) based on corrosion classification of chemical attack class “low” according to EN13084-1:2000. Structural design life shall be 50 years. The structural shell shall be made from EN 10025 S235JR G2/S275JR/S355J2G3 steel according to EN 10025-2 with plate thicknesses according to calculations.

The baseplate shall be circular with stiffeners for anchor bolts into the cast concrete foundation. The inner liner will be made from 3 mm 316Ti steel and insulated with 2 x 30 mm rockwool bats (100 kg/m^3) on steel wire with joints between layers staggered. Insulation is retained by means of wire nails welded to the liner.

The exhaust stack will include one inspection door (600 mm dia.), one drain (50 mm dia.) and emission sampling points as necessary.

Externally, there will be one ladder with back support from ground level to a measuring platform to provide access to the CEMS instrumentation for operational purposes, with sidesteps per each 6 m according to EN ISO standard 14122-4.

Above the measuring platform a safety ladder with safety harness and retaining carriage will continue to the chimney top. The measuring platform will include a certified lifting davit fitted with a capacity of 250kg.

External surface treatment will be blast cleaned to SA 2.5 followed by the application of 1 x 60 microns zinc rich epoxy primer, 2 x 100 microns high build epoxy paint, 1 x 60 microns polyurethane enamel to give a total dry film thickness of approximately 320 microns, according to DS / EN ISO 12944-5:2000 class C4.

The colour is RAL 7038.

11. Air Cooled Condenser (ACC)

11.1. Overview

The air-cooled condenser (ACC) will be of the A-frame type and comprise numerous finned parallel tubes.

The ACC shall be arranged to minimise the recirculation of air including a windboard fitted around the outside periphery of the condenser to minimise air recirculation. Physical wind barriers will be provided to protect ACC tube bundles from wind gusts that otherwise can upset equilibrium operating conditions.

The low-pressure steam from the axial turbine exhaust will flow towards the ACC through an exhaust duct, designed for low vacuum conditions. The low-pressure steam duct will include a hot well to prevent any condensate running back into the turbine. This condensate will be pumped to the condensate tank. The steam will be distributed to a steam distribution header on top of the ACC.

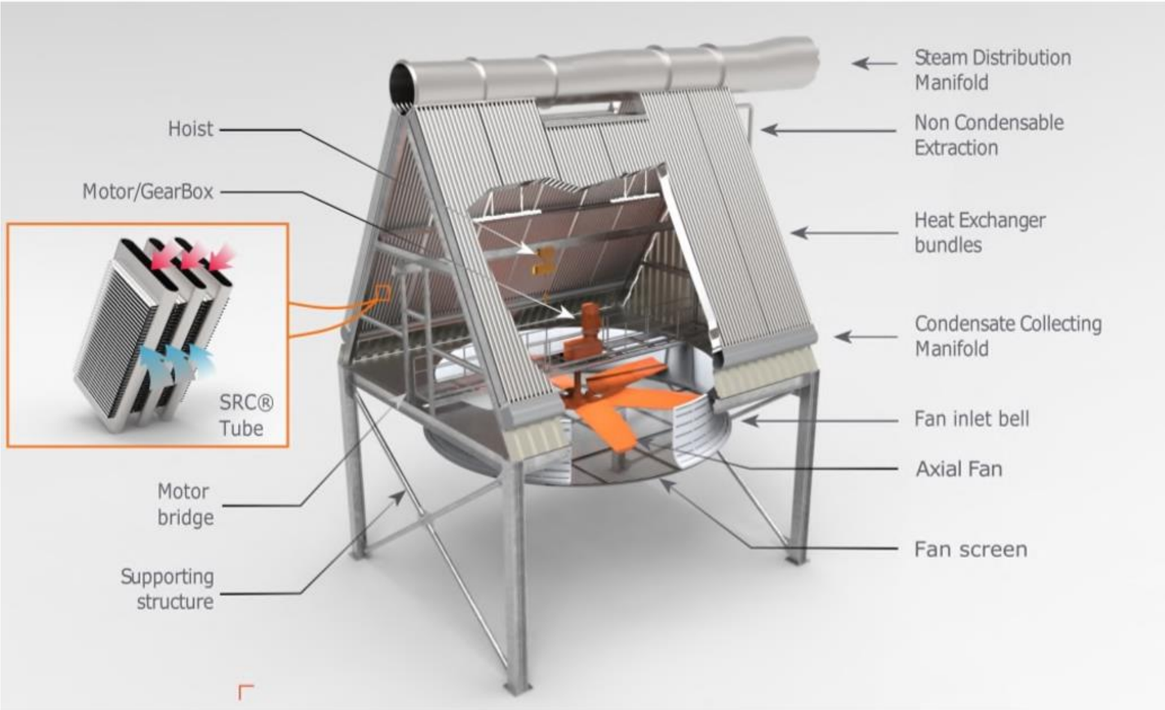
When operating in turbine bypass mode the bypass steam will be injected into the low-pressure steam duct through a dump tube inside the turbine hall. The ACC will be designed for operation below 3 bar (a). A rupture disc and safety relief valve will be installed to limit the maximum pressure inside the ACC.

11.2. Description of ACC

Exhaust steam from the STG will pass to an air-cooled condenser operating under vacuum to condense the steam to water using axial fans driven by electric motors via reducing gearboxes. Fan speeds will be variable according to demand by motor frequency inverters (variable speed drives).

Condensed water will be collected in bottom manifolds and drained by gravity or pumped to the condensate tank.

A sectional arrangement drawing (SPG) is shown below:

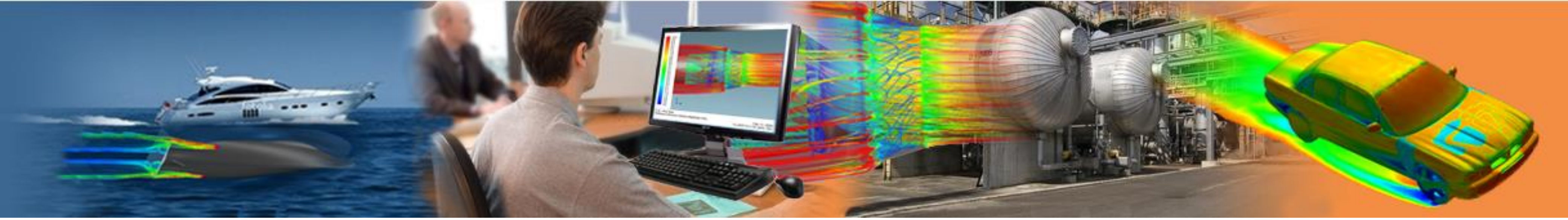


12. Emergency power supply

An emergency diesel generator (approx.800 kWe) shall be supplied to provide sufficient power to be able to shut down the plant in a controlled manner without damage to plant, in the event of total loss of normal supplies to the main HV switchboard. The Emergency Diesel Generator (EDG) will be able to synchronize to the grid through a separate low voltage circuit breaker located in the Main low voltage switchboard and be capable of back synchronization to allow a seamless reconnection to the grid on resumption of supply.
DC and UPS system.

A duplicate 110 V DC battery/charger systems and a 230 V UPS System will be supplied to provide power to the control and safety systems for the duration of one (1) hour after public grid failure. It will also remain operating the fire and smoke detection systems and CCTV etc. within the buildings.
UPS.

Floor standing UPS / battery panel sized to support a 15 kVa Load @ 400 Vac for 1 hour
Floor standing UPS / battery panel sized to support a 2.0 kVa Load @ 230 Vac for 1 hour



EUROCFD
INDUSTRIAL SIMULATIONS

leroux & lotz groupe altawest

Contacts : Mazen AL HADDAD
Stéphane GUIHARD

Aerothermal Analysis of the Newport Boiler

Progress Note 01

Janvier 2023

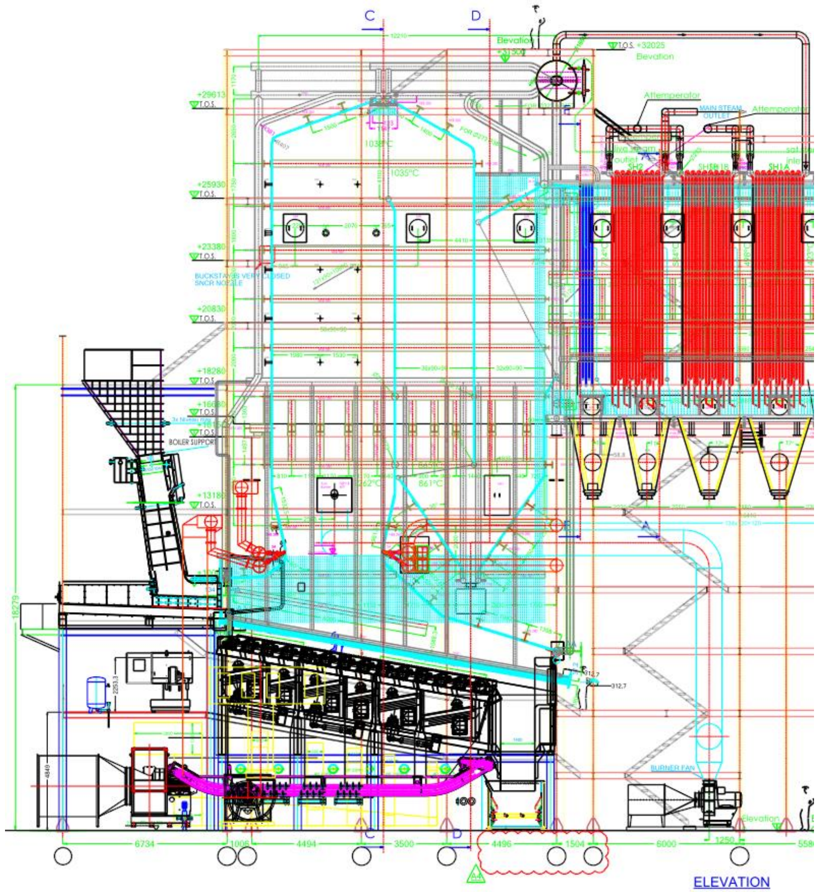
Julien LAMOUROUX

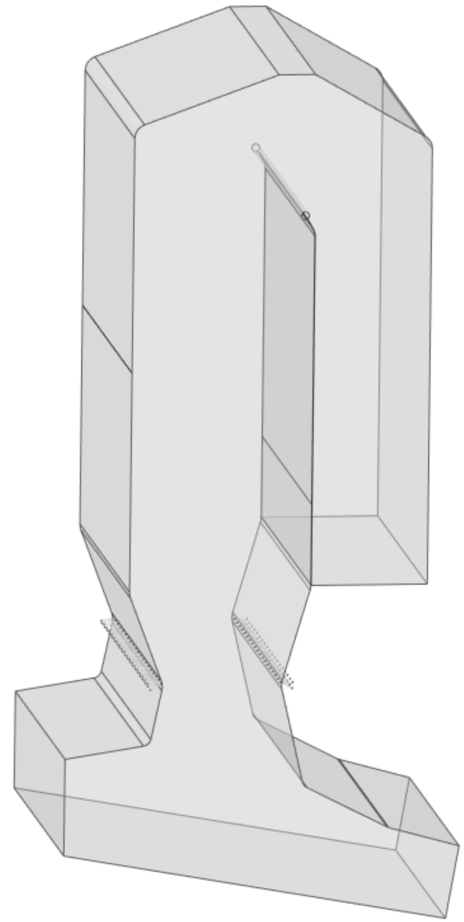
Techn'Hom 1 – 27, rue Becquerel – 90 000 Belfort – France
Tél : +33 (0)3 39 03 42 42

www.eurocfd.com

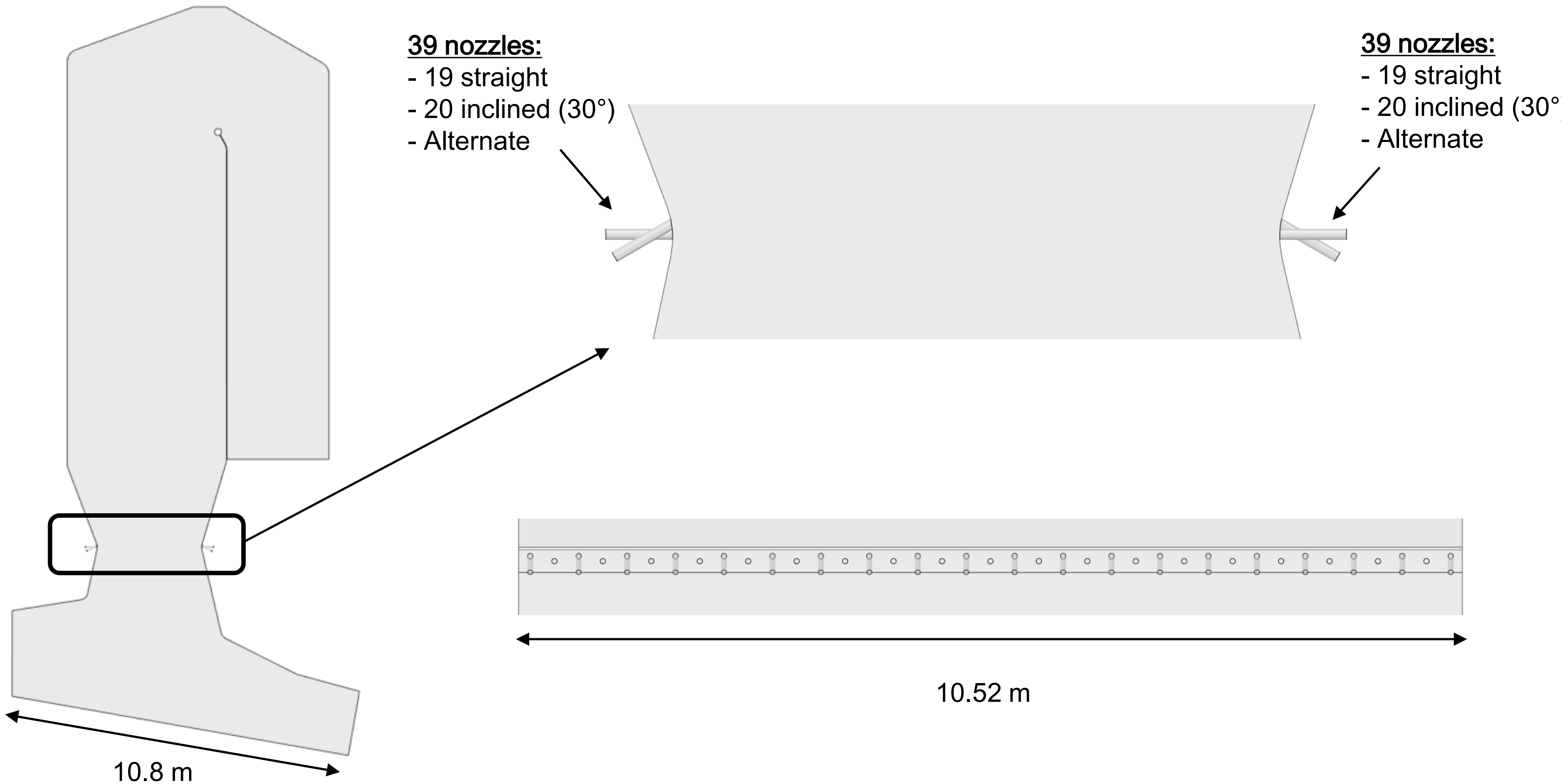
Geometry

❖ The CFD model was built by EUROCFD from the 2D plans provided by LLT





Geometry


39 nozzles:
- 19 straight
- 20 inclined (30°)
- Alternate
39 nozzles:
- 19 straight
- 20 inclined (30°)
- Alternate
10.52 m
10.8 m

Hypothesis and Numerical Model

Hypothesis

- 3D
- Steady
- Turbulent
- with Heat Transfer
- Radiative
- Monophasic & mono-species
- No reaction

Numerical Model

- RANS Model : k-ω SST
- Radiation Model: DO
- Discretization: Second Order
- CFD Code: Star-CCM+ 17.04

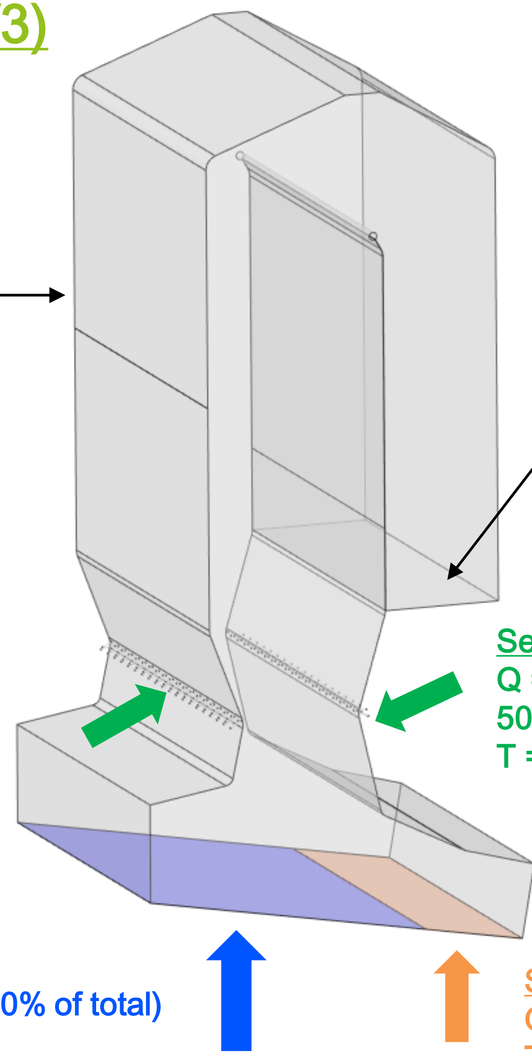
Gas Properties

- Density: Ideal Gas
- Viscosity: mixing law (function of temperature)
- Specific Heat: mixing law (function of temperature)

EUROCFD

Boundary Conditions (1/3)

Walls:
Smooth
No slip condition



Outlet:
Pressure = 101 325 Pa

	Smoke Composition (%mass)
O_2	2.065
H_2O	13.266
CO	0
CO_2	20.402
N_2	64.267

SO_2, NO_2, NH_3, HCl and Ar were neglected and added to N_2 mass fraction

Secondary Air Inlet:
Q = 55 379 kg/h (total)
50% on each side
T = 40°C

	Air Composition (%mass)
O_2	22.732
H_2O	1.77
CO	0
CO_2	0.05
N_2	75.448

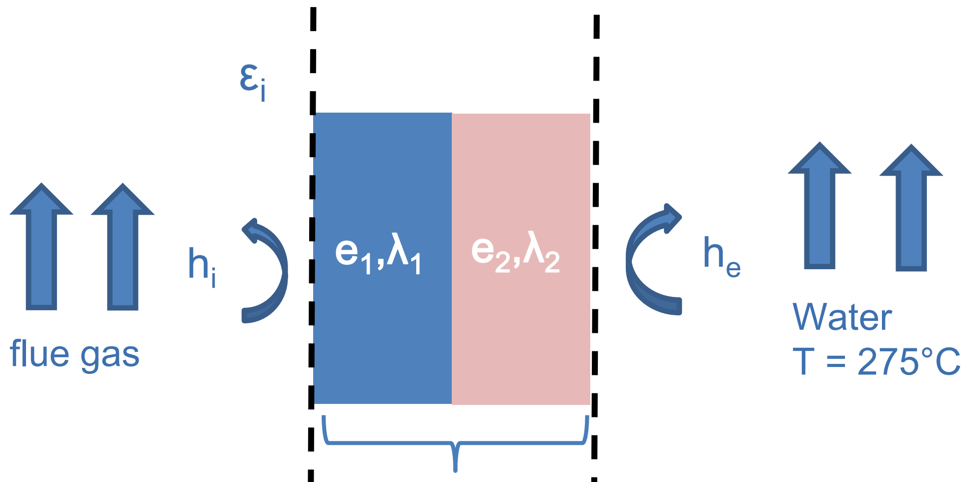
Smoke Inlet:
Q = 138 741 kg/h (90% of total)
T = 1 538°C

Smoke Inlet:
Q = 15 416 kg/h (10% of total)
T = 1 538°C

Point N: Clean Boiler

Boundary Condition (2/3)

- The heat transfer on the boiler walls is computed from the internal emissivity ε_i, the thermal resistance of the wall R_{th}, the external heat transfer coefficient h_e, and the temperature of the water (275°C)
- The thermal resistance is computed from the thickness e_i and thermal conductivity λ_i of each material layer
- The internal heat transfer coefficient h_i is not needed as an input since it is computed by the software

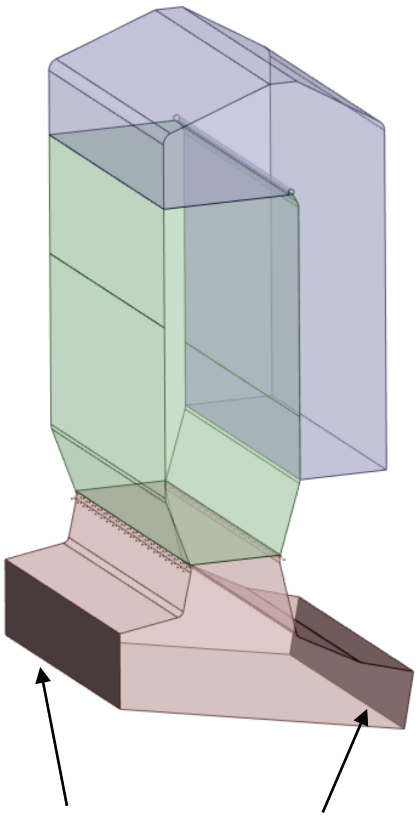


$$R_{th} = \sum_i \frac{e_i}{\lambda_i}$$

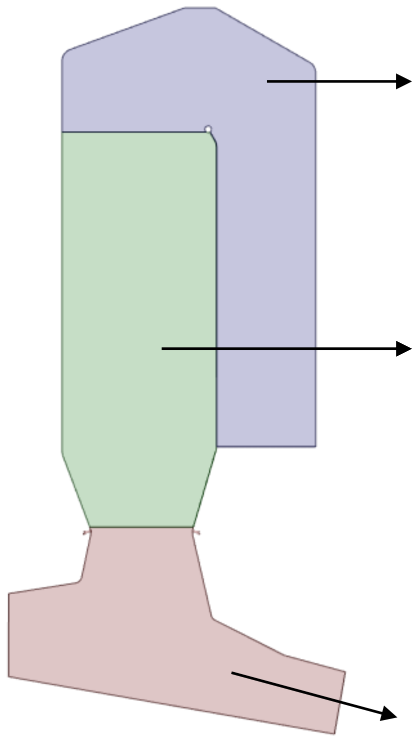
EUROCFD

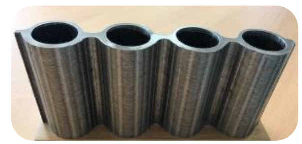
Boundary Conditions (3/3)

	λ (W/m.K)
Steel	46
Refractory	15



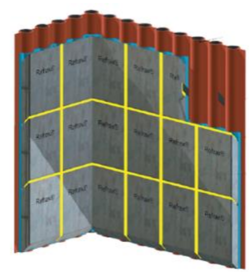
Virtual walls → adiabatic





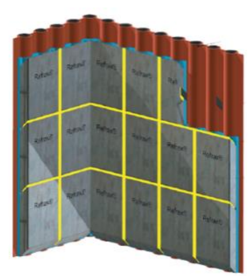
Emissivity = 0.65

	e (mm)
Steel	5.6
Refractory	-
R_{th} (m².K/m)	1.22e-4



Emissivity = 0.9

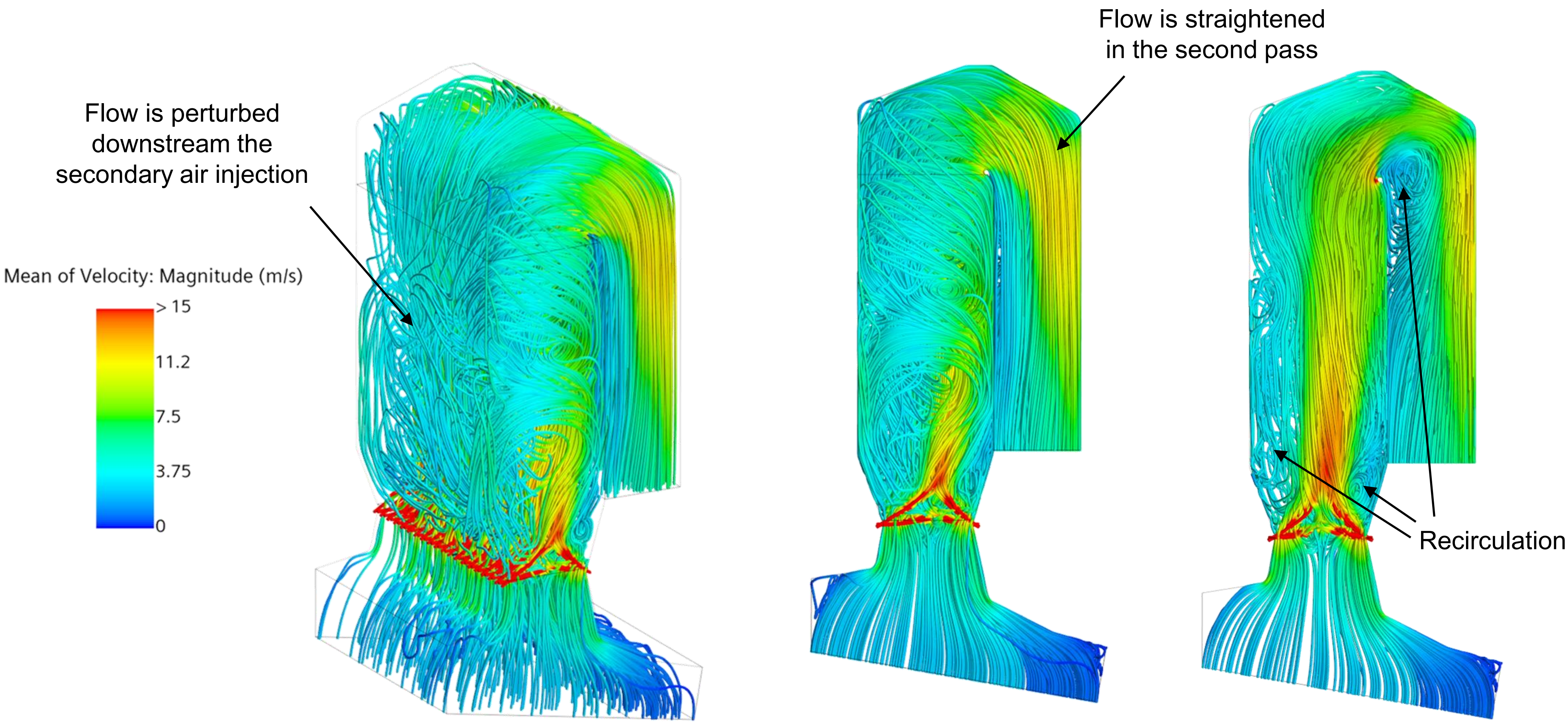
	e (mm)
Steel	5.6
Refractory	77
R_{th} (m².K/m)	5.26e-3



	e (mm)
Steel	5.6
Refractory	62
R_{th} (m².K/m)	4.26e-3

Results

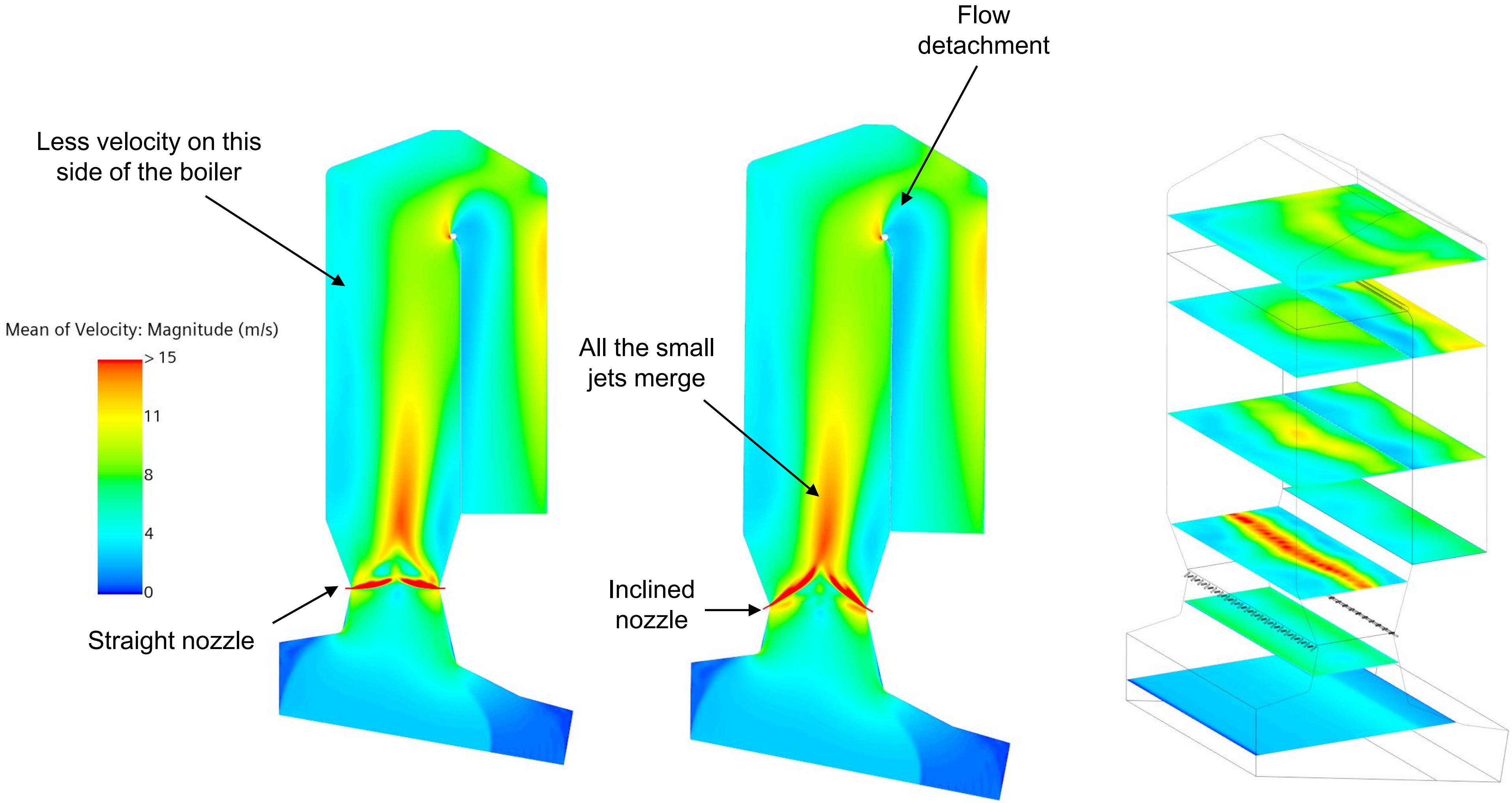
Streamlines colored by Mean Velocity Magnitude



Side view

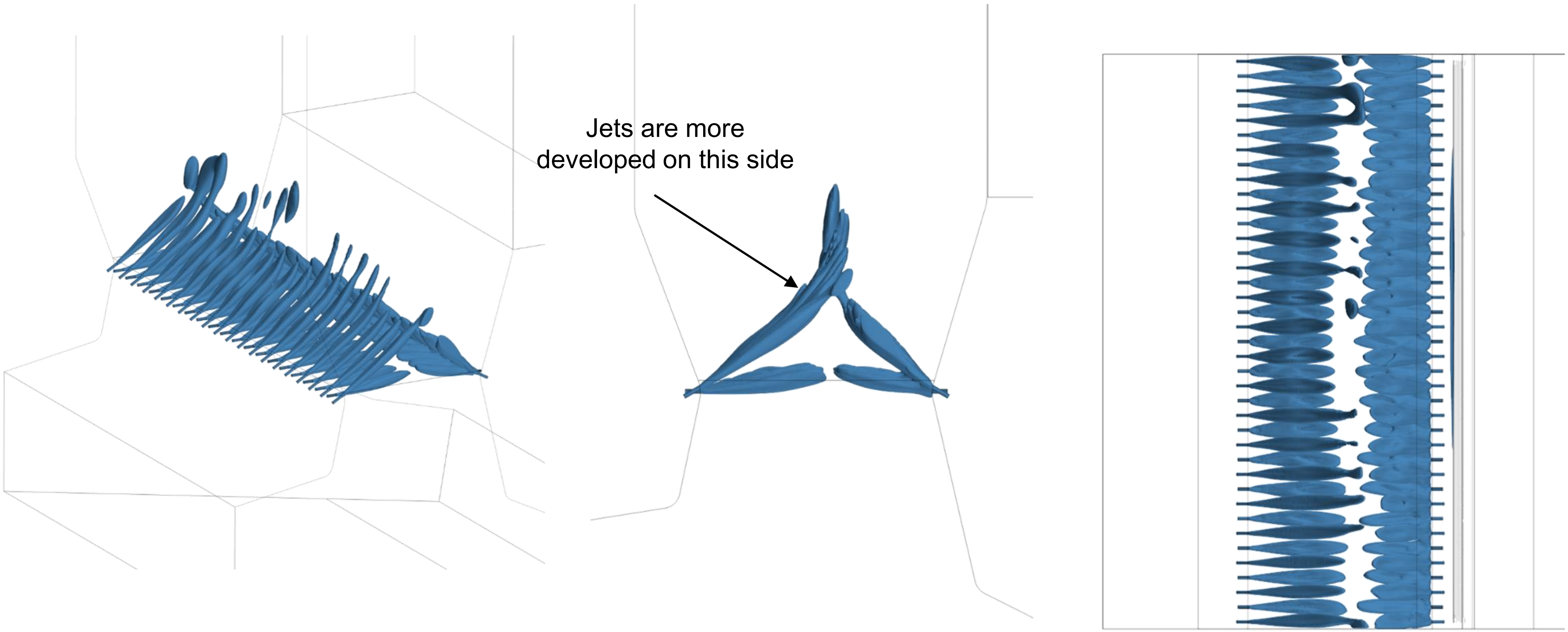
Side view with cut plane in the middle

Mean Velocity Field



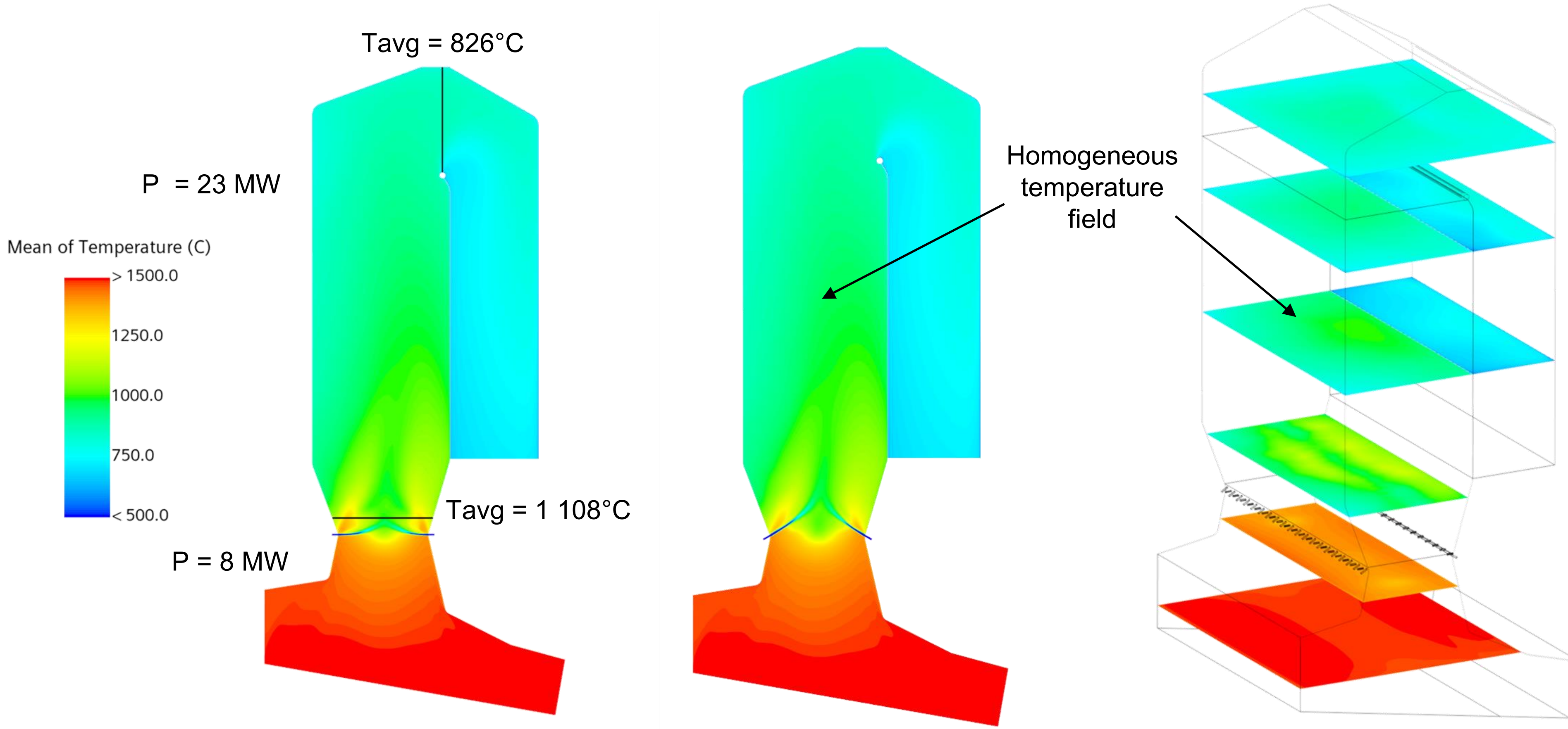
Velocity Iso-Surface

- The iso-surface of 15 m/s are displayed below



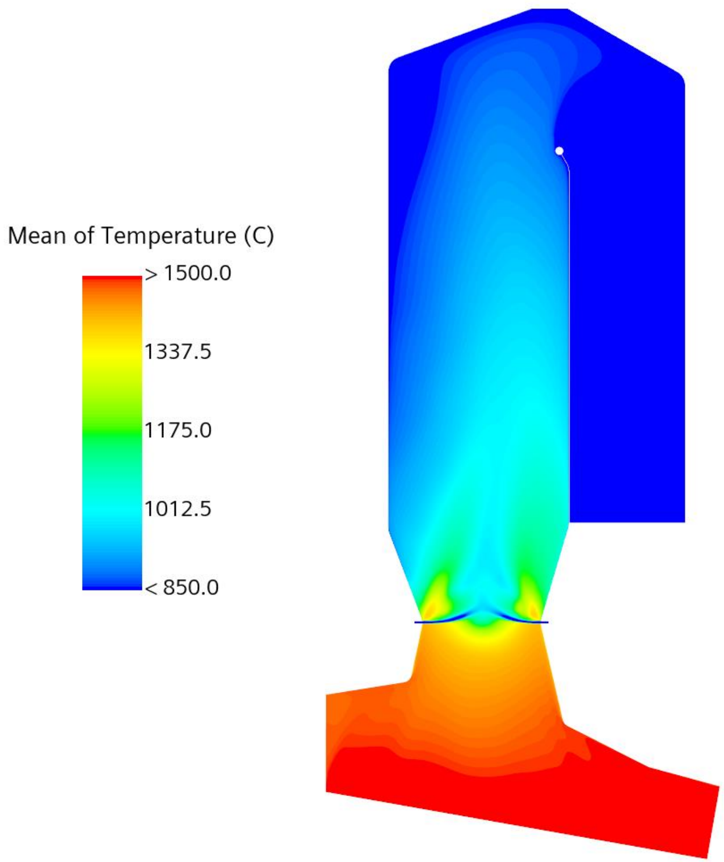
Mean Temperature Field

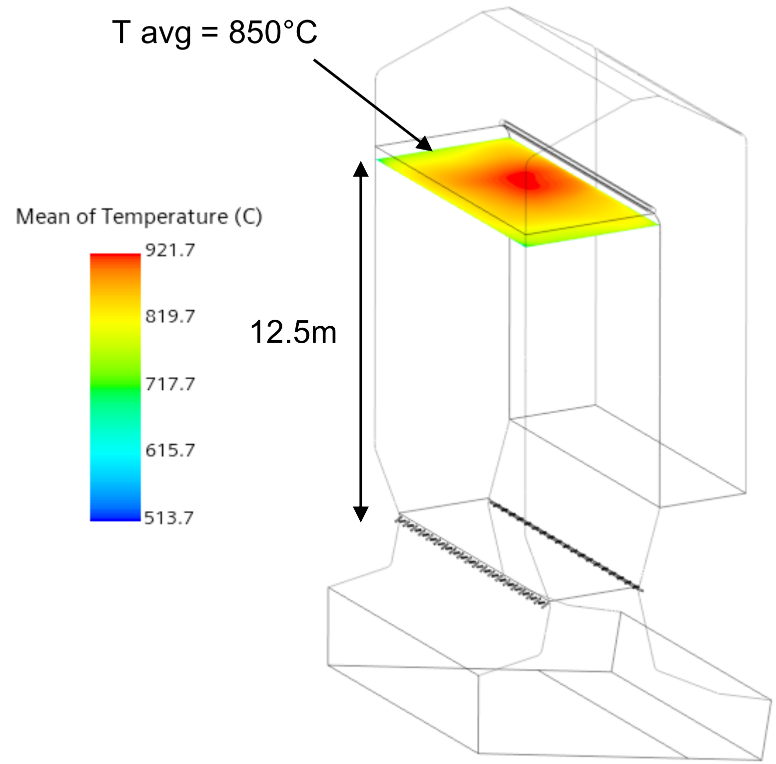
- The obtained average temperatures after the secondary air injection, and at the outlet of the chamber are represented here below
- Same for the dissipated heat on the bottom and top parts



Mean Temperature Field

- An average temperature of 850°C is reached 12.5m downstream the secondary air injection





Flue gas Height 2s After Air Injection – Method 1

❖ Assuming a perfectly homogenous and vertical flow, the height traveled by the flue gas during 2s downstream the secondary air injection can be estimated as follow:

1) Time to travel through the divergent:

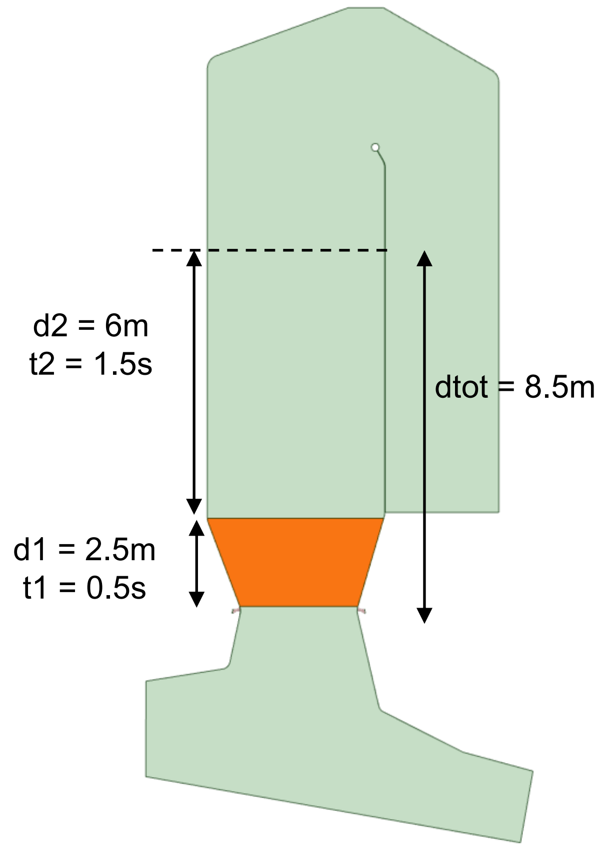
- Mass Flow Rate = 58.2 kg/s
- Average Density (from CFD) = 0.26 kg/m^3

→ Volume Flow Rate = 224 m^3/s

- Average Section = 44.3 m²

→ Average Velocity = 5 m/s

→ t1 = V/d1 = 5/2.5 = 0.5s



2) Distance traveled 1.5s after the divergent

- Mass Flow Rate = 58.2 kg/s
- Average Density at divergent outlet (from CFD) = 0.27 kg/m^3

→ Volume Flow Rate = 215 m^3/s

- Section = 53 m²

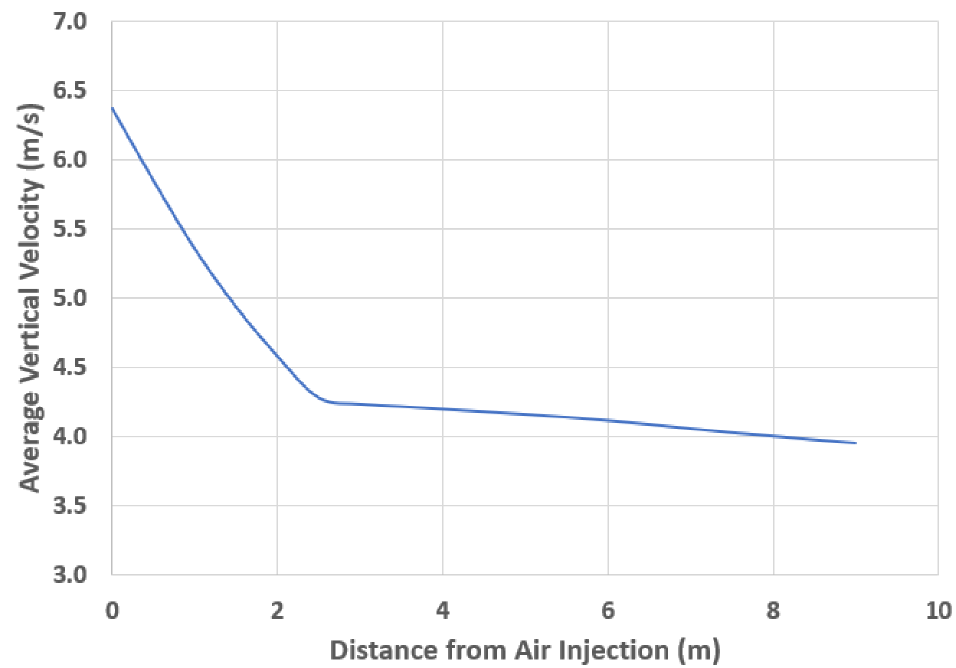
→ Average Velocity = 4 m/s

→ d2 = V*t2 = 4*1.5 = 6m

Flue gas Height 2s After Air Injection – Method 2

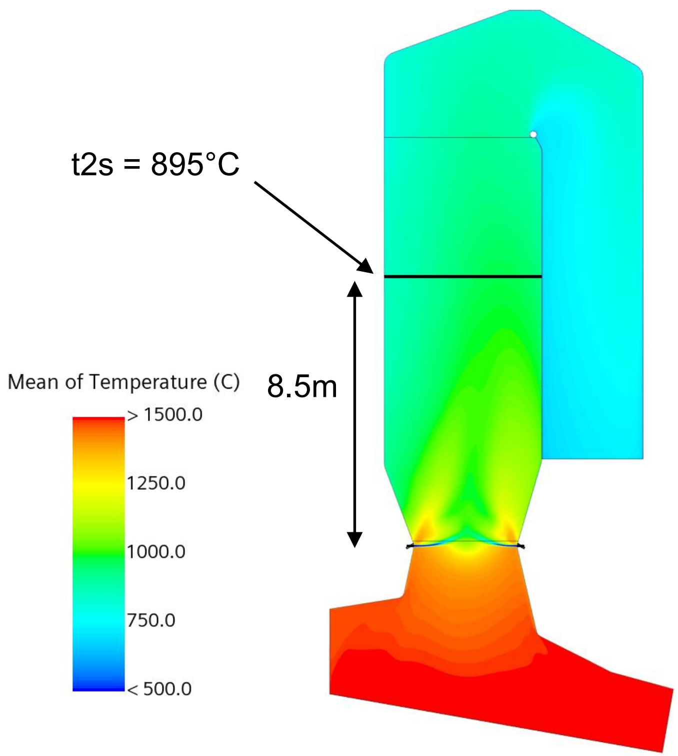
- Another method is to plot the average vertical velocity on several planes along the boiler
- The time to travel between two planes can than be estimated
- According to the table below, after 2s, the flue gas is between 8.5 and 9m downstream the air injection, which is similar to the results found with the previous method

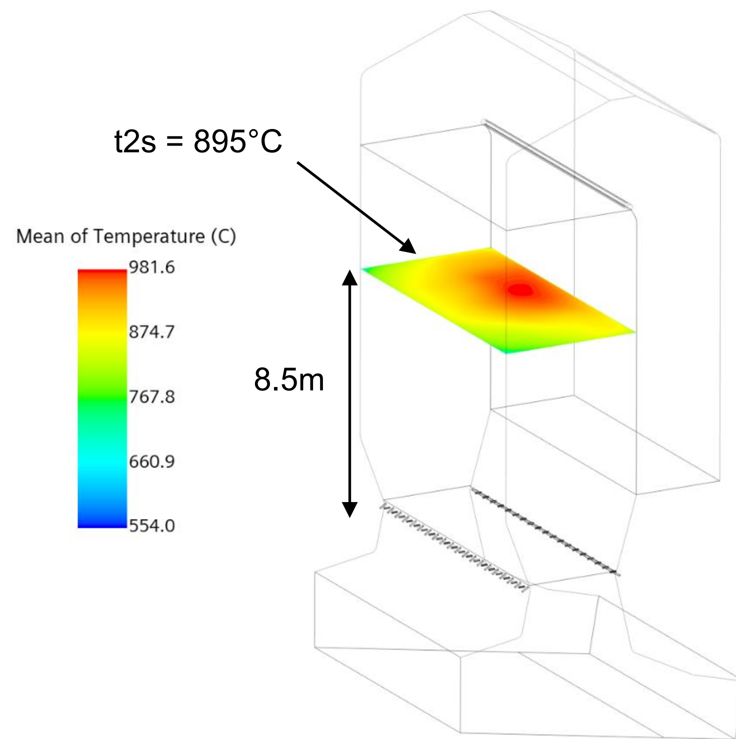
Distance from Air Injection (m)	Average Vertical Velocity (m/s)	Travel time (s)
0	6.37	0
0.5	5.85	0.08
1	5.35	0.17
1.5	4.93	0.27
2	4.58	0.37
2.5	4.28	0.49
3	4.23	0.60
3.5	4.21	0.72
4	4.19	0.84
4.5	4.18	0.96
5	4.16	1.08
5.5	4.14	1.20
6	4.11	1.32
6.5	4.08	1.44
7	4.05	1.57
7.5	4.02	1.69
8	4.00	1.82
8.5	3.97	1.94
9	3.95	2.07



Flue gas t2s

- 895 °C is the mean temperature of the flue gas 2s after secondary air injection. This temperature is higher than 850°C.
- **Thus t2s conditions for Maximum Continue Rating with Clean boiler are fulfilled.**





Grate Combustion System

(Extract from Mitsubishi Power Europe gmbh offer, date 19-02 2020)

1. Introduction

1.1 Basis of Design

Based on the waste fuel specification the offered incinerator is of a stoker grate type. The combustion grate is constructed as a water-cooled moving grate in the first and second section and as an air-cooled moving grate in the last section. In total the grate is constructed as a three track grate in the width.

The combustion grate is designed and fabricated in accordance with DIN EN 12952-16, DIN EN 13480 and Directive 2006/42/EC.

All parts according to EN standards.

1.2 Process Description Combustion / Grate

The principal task of the grate is to ensure transportation, uniform distribution of the fuel by mixing and agitation of the waste bed and uniform distribution of the primary air. The waste shall be turned frequently during the combustion process to obtain complete combustion. The furnace above the grate comprises the combustion chamber and encloses the flames.

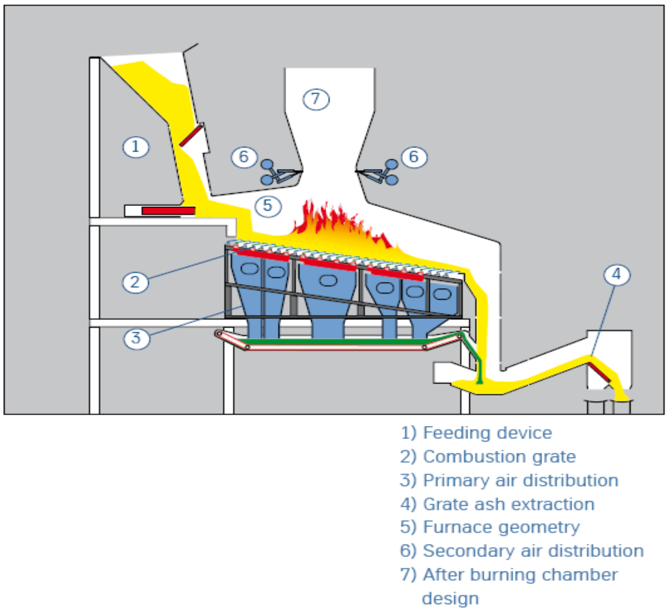


Figure Grate Firing System (schematic)

Grate Combustion System

(Extract from Mitsubishi Power Europe gmbh offer, date 19-02 2020)

Solid waste fuel is pushed onto the grate by the dosing ram feeder system. The waste is stoked and transported on the grate system with help of hydraulic driving grate modules until it is completely burned-out.

Primary air is fed through the ash hoppers underneath the grate surface and is distributed evenly across the grate surface. This is achieved with sufficient pressure drop across the grate bars. For the air distribution there is a distribution channel below the grate foreseen, with air control valves and air flow measurements.

Even during load change resulting in a change of waste quantity, the incineration process must stay smooth, and the burn-out quality should be as good as possible.

A slightly negative pressure is required inside the combustion chamber. This pressure will be controlled with the help of the induced draught fan of the flue gas cleaning plant

Secondary air is injected in the transition area between combustion chamber and the first boiler pass. The added oxygen helps to complete the burn-out of the flue gas entering the first pass.

The amount of fly ash entering the first boiler pass shall be as low as possible. The burned-out bottom ash and the grate riddling's are discharged via the plate belt de-slagger.

1. Technical Description

2.1 Grate Firing

The stoker firing mainly comprises the following elements and sub-systems:

• a feeding device consisting of: hydraulically actuated shut-off damper, water-cooled feed chute with level monitor, feeder table with hydraulic ram feeders,

• a combustion grate consisting of ash collecting and primary air distributing hoppers, individually controlled combustion zones, grate drives,

• a combustion chamber individually and optimally shaped in regard to the individual fuel specifications (capacity, calorific value, both material and chemical composition, ash and water contents, etc.).

• secondary air injection manifolds, fan and ducts

• ash extractor, with discharge chutes

- Primary air fan and ducts
- Primary air control valves and air flow measurements

- a hydraulic system unit

- automatic combustion control (ACC) for the combustion grate system programmed and implemented in the overall DCS system

The grate surface cast iron elements are manufactured to a high degree of precision to maintain a constantly high air pressure for even air distribution during continuous operation within the service interval.

The air speed between the grate elements and other grate components is substantially uniform. It is designed to minimize the passage of riddling through the grate whilst providing sufficient space for the passage of primary air. The design of the elements ensures free gaps between the elements. The material and design ensures resistance against corrosion at high temperatures as well as effective cooling of the elements.

The individual grate elements are replaceable without dismantling the grate as a whole.

Similar parts are interchangeable.

Sufficient access to the grate surface from above and below enables safe and effective maintenance and inspection.

The grate support construction is robust to withstand the forces from the drives, even if the grate elements become blocked.

All equipment will be designed according to the maximum possible pressure of the hydraulic system. Heavy duty hydraulic cylinders are provided for all drives. The design includes means to avoid the same oil being trapped in the cylinder or piping for long periods of operation in order to prevent cylinders from excessive wear. Easy access for maintenance is provided. All hydraulic cylinders of the grate system are of the same type.

2.2 Feeding Device

Underneath the fuel distribution feeding system (waste fuel hopper) a damper is incorporated
in the fuel chute which is driven by the central hydraulic. This damper must be closed during start-up and cool-down procedure of the plant.

The feeding chute continues underneath the damper. The chute expands downwards in order to prevent blockages.

The lower part of the feeding chute is designed with water cooling in order to protect the wall material in case of thermal exposure, for example, in case of backfire during start-up and shut-down of the plant.

Level indicators are installed for checking and signaling the fuel height in the shaft consisting of 5 Micro Wave Level sensors (fuel)
1x min min, 1x max, 3x min to control the feeding crane.

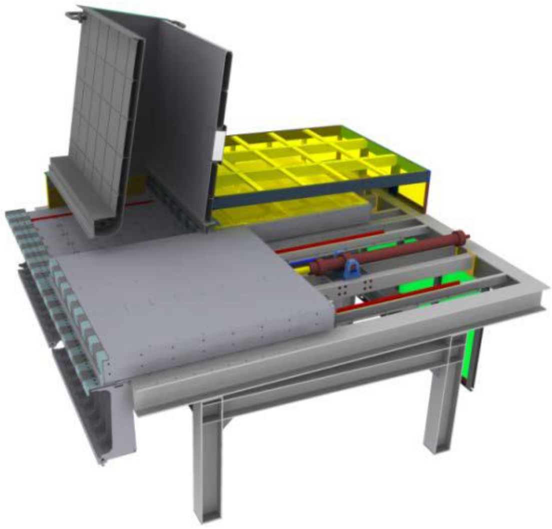


Figure feeding system

The charging of the combustion grate takes place via hydraulic driven ram feeders. The RDF is pushed out of the shaft along the feeder table and the feed drop onto the combustion grate.

The feed speed of the ram feeders is variably controlled via the automated combustion control system (ACC) implemented in the overall DCS system. An even charging of the combustion grate along the grate width is ensured by means of the design of the transition piece between feeder table and the combustion chamber.

2.3 Combustion Grate

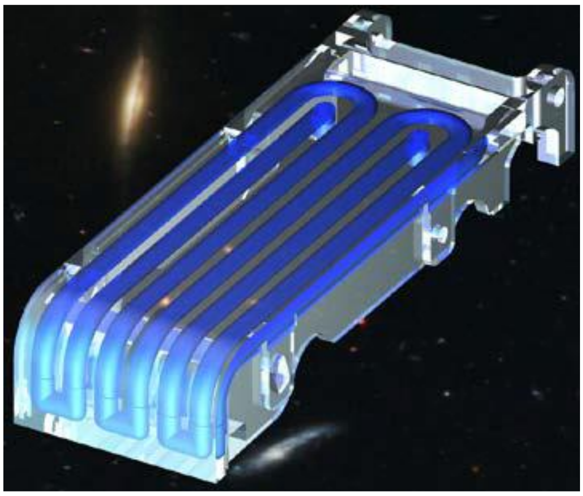
Annex 08 Grate Combustion System

(Extract from Mitsubishi Power Europe gmbh offer, date 19-02 2020)

The grate consists of three separate grate sections in longitudinal direction. The grate is constructed as a water-cooled moving grate in the first and second section and as an air cooled moving grate in the last section.

Figure Typical Water-cooled Grate

The individual cast iron grate bars are held together with two screws. They form the grate bar rows.



Annex 08 Grate Combustion System

(Extract from Mitsubishi Power Europe gmbh offer, date 19-02 2020)

Figure Grate Bar (typical water-cooled design)

The grate bars in the first and second section are water-cooled by an inside coil, which is flown through by the cooling medium. The moving grate-bar-rows are connected to the cooling system with flexible hoses.

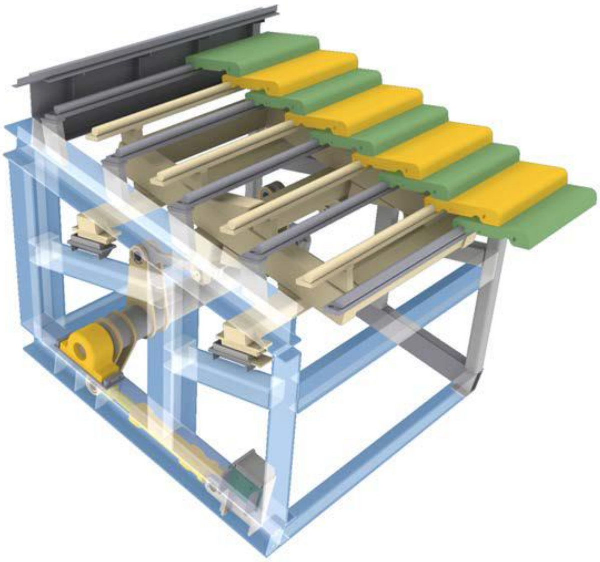


Figure Grate Firing System

Each grate module is equipped with a hydraulic drive (cylinder). By this the respective grate speed can individually be adapted to the fuel structure. The stroke length of the moved grate bar rows is operated between 10 mm to 390 mm (400 mm is mechanical maximum). The drive transmission from the cylinder to the grate carriage takes place via a combined rocker shaft / push rod structure. Each grate area is equipped with its own hydraulic drive so that the grate speed can be individually adapted to the respective fuel structure.

Figure Typical MHPS Hydraulics Grate Drive Arrangement

The bearings of the grate carriage are designed as a special ball-on-prism structure

Data:

Grate Area	m^2	12,6
Grate with	m	10,43
Grate lenght	m	10,8
Mechanical load	Kg/(m^2xh)	331
Thermal load	736 kW/m^2	736
Grate zone 1+2 /16 rows		Water cooled
Grate zone 3/11 rows		Air cooled

2.4 Cooling Water System for the Grate

The water cooling circuit will be designed as a closed circuit. It will be provided as a complete system with redundant water pumps, required piping and valves. Heat captured by the water cooling system will be used mainly to preheat the condensate through a heat exchanger.

MHPS will install an additional air/water-cooler. It is part of the closed water-cooling circuit and is used to dissipate the heat released during peak load operation or during start-up and shut-down. The housing for the cooler is equipped with blinds and a small electrical heater to protect the system against freezing during shut-downs in winter time.

2.5 Ash and Slag Extraction

MHPS will supply a complete system to extract the ashes underneath the grate as well as the slag coming from the combustion grate.
The ash hoppers will be connected to a wet ash conveyor per track. This conveyer will be filled with water to cool down the hot slag material and to provide a water-seal to prevent flue gas escaping.
The ash and slag coming out of the wet ash conveyor will be dropped on a crosswise slag conveyer. This transport the slag to a belt conveyer (not in our scope) towards a concrete bulk storage.

2.6 Combustion Air Supply

The combustion air system consists of the primary and secondary air system
Provision of the complete air zone ducts below the grate system with air quantity measurement and control flaps. Delivery limit of the air flow measurement is outlet pressure measurement which is installed immediately at the measurement and at the entrance flange of air zone duct.

2.7 Primary air

The primary air flow is drawn in from the warehouse (max. length 50m, not in scope of supply) by means of a fan (basic eng. in scope of supply) before entering the combustion chamber through corresponding ducts into the hoppers underneath the grate.
The ducts to the air zones are equipped with motor-driven dampers and flow meters. They are controlled via the automatic combustion controller.

2.8 Secondary air

The secondary air system starts with the intake duct opening underneath the boiler house roof and ends at the secondary air injection nozzles (nozzles and ducts not in our scope, fan basic eng. included). The secondary air flow serves to fully oxidize the un-burnt gases generated through the low-oxygen combustion on the grate.

Behind the secondary air injection the completely burn-out flue-gases should form a homogeneous flue gas field
cross-section.

2.7 Combustion Chamber Rear Wall

The combustion chamber rear wall is made in rigid stiffened double steel plate construction. The outside steel plates of the rear wall are equipped with air-openings to ensure a cool surface by means of natural ventilation.

Large access doors in rectangular section allow for accessing the grate surface in case of maintenance works.

Furthermore, peepholes and holes for the combustion camera systems are installed. Movable bridges close the gap between the combustion chamber rear wall access door and the grate surface.

Figure Typical View on Combustion chamber Rear Wall

2.8 Hydraulic Station

There is one central hydraulic station provided for the incineration plant. It operates the drives for the grate modules, the shut-off damper in the feed chute and the ram feeder.

Figure Typical Hydraulic Drive Unit

The hydraulic station is equipped with 2 (two) pumps and is manufactured as workshop assembled package unit.

2.9 Automatic Combustion Control (ACC)

During normal operation the entire combustion process inclusive of waste feed will be controlled by the automatic combustion control system (ACC) implemented in the overall DCS system. Operators will be able to set speeds, pressures, frequencies of any drive equipped with frequency converter etc. manually from the central control room and to actuate grate drives locally.

The combustion control system achieves a minimum of fluctuation in the entire combustion process and thus ensures continuous maximum plant performance.

Fluctuations of the waste composition and its heating value within the agreed admissible limits of the firing load diagram will not lead to unstable operating conditions.

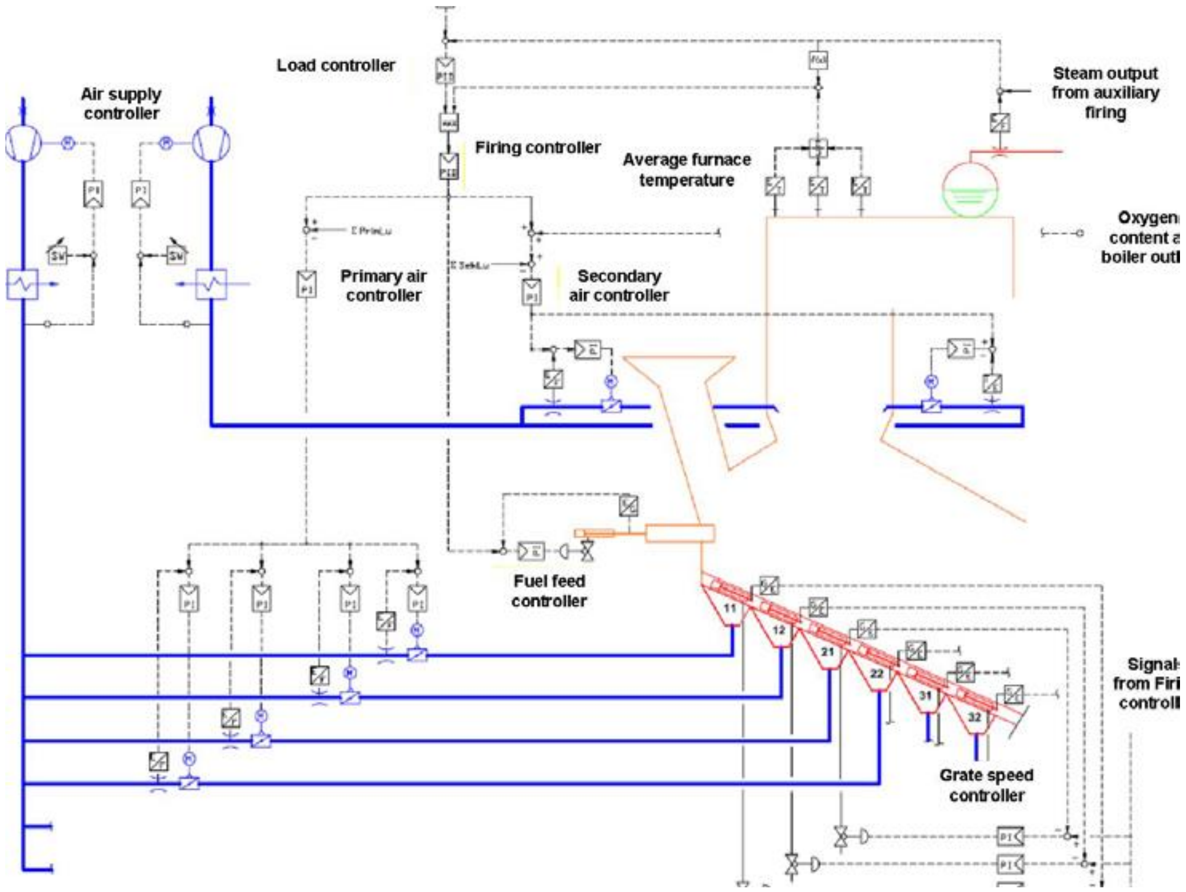


Figure MHPS Firing Load Control (general concept)

The controlled variables includes: the feed rate, grate drive speed, primary air flow, and primary air distribution per zone.

2. Scope of Supply and Service

Below summarize of the stoker-grate firing system main components.

3.1 Fuel Hopper and Waste Feed Duct

- Waste feed fuel hopper
- Waste Feed Duct as steel construction, double-walled and water cooled.
- Waste Feed Duct Damper with hydraulic drive (fuel isolating flap, hydraulic driven).
- 5 Micro Wave Level sensors (fuel) 1x min min, 1x max, 3x min to control feeding crane.

3.2 Fuel Dosing Ram Feeder

- Four rams with a hydraulic drive each, horizontal feed table.
- Enclosure of the fuel dosing ram feeder.

3.3 MHPS Moving Grate (water & air-cooled)

- Feed Drop as membrane wall construction (supply by Harris Pye). The feed drop is protected with a water-wall-panel connected to the boiler system and is covered with refractory.
- 3-Track Moving Grate with water & air-cooled grate bars sloped in longitudinal direction with hydraulic grate carrier drive.
- Cooling Water System with:
- Pumps, pressure-retaining system, hoses, lines, heat exchanger to be installed into a protection housing equipped with blinds and electrical heater

3.4 Primary Air System

- Ducts, flaps, measurements, fan

3.5 Secondary Air System

- Ducts, flaps, measurements, Fan

3.6 Ash/ Slag Extraction System

- Slag chute with wear protection

- Ash hopper, one for each grate air zone
- De slagger for each track
- crosswise slag conveyer

3.7 Hydraulic Station

- Piping and electrical wired as package unit consisting of:
- Main hydraulic system cubicle with 2 hydraulic pumps
- Regulation of the hydraulic cylinders for ram feeder and grate drive via proportional valves
- Hydraulic tank, oil collecting tray with leakage sensor
- Oil cooler
- Pipes, valves inside of the package unit Filter in the return flow with protection against stopping up and/or bypass
- Regulating switch and monitoring devices, i.e. all measuring and controlling field
- instruments inside hydraulic system cubicle.
- 1 hydraulic system cubicle enclosure with door, sound insulation and view port 1

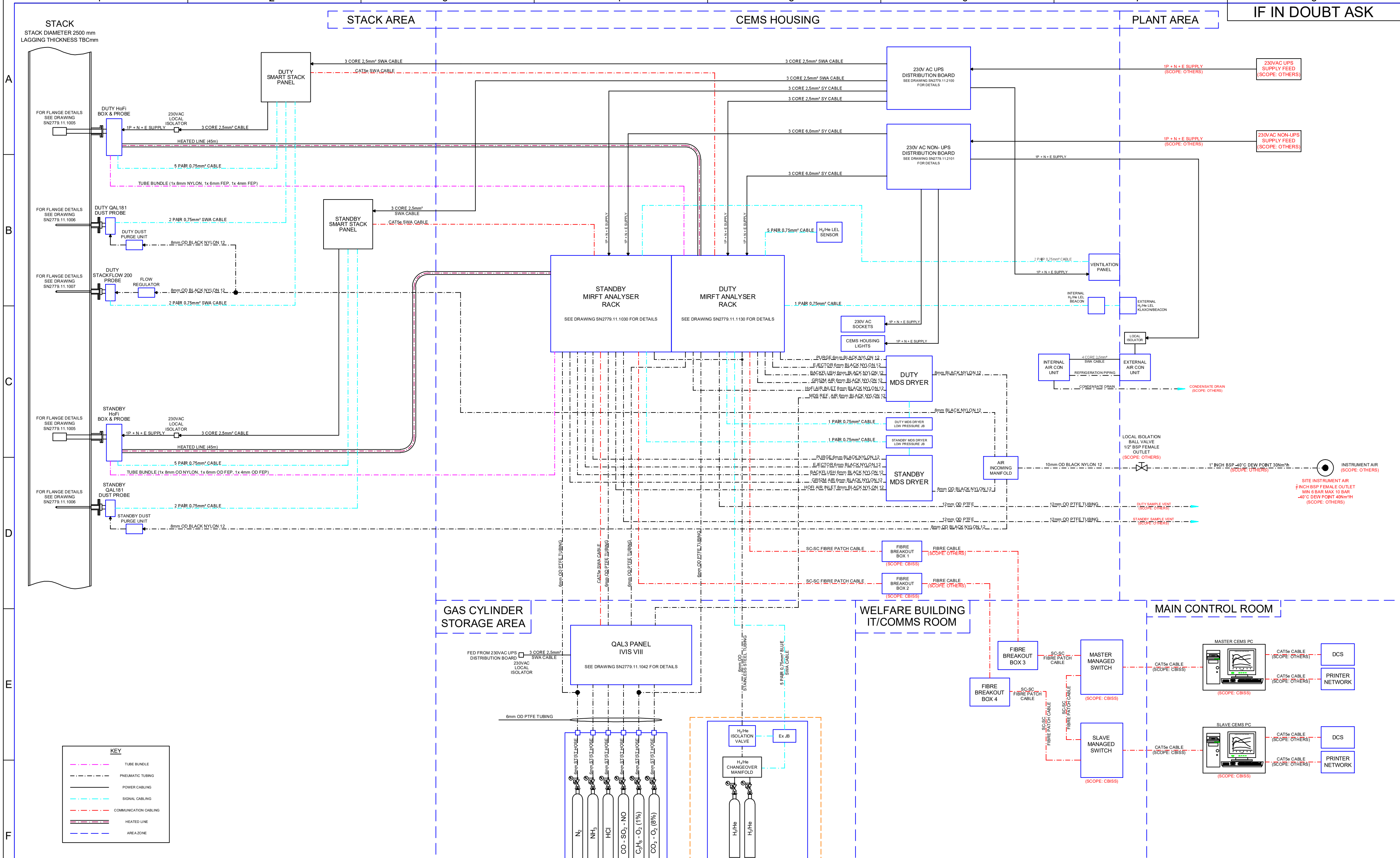
- Hydraulic system functions checked at workshop with protocol
- Hydraulic cylinders for shut-off damper waste feed duct 4 Hydraulic cylinder for dosing ram feeder
- 9 Hydraulic cylinders for grate drive
- Hydraulic piping between station and pistons (only delivery, erection by Harris Pye)

3.8 Electrical and instrumentation part

- Necessary the field instrumentation, actuators and electrical consumers such as motors, motorized actuators as required for a safe and optimal operation of the grate combustion system.

3.9 ACC System

- The ACC is implemented in the overall DCS system.



NOTES:
- ALL CABLING TO BE LSZH.
- ALL CABLING TO HAVE BLACK OUTER SHEATH UNLESS OTHERWISE SPECIFIED.
- HARRIS PYE TO CONFIRM PC's CONFIGURATION.

5 Valiant Way
Lairdside Technology Park
Tranmere, Wirral
CH41 9HS
Tel: +44 (0)151 666 8300
Fax: +44 (0)151 666 8329
Email: cdoc@a1-cbiss.com
www.a1-cbiss.com

SCALE	PROJECTION
NTS	

Security Class:- A1-CBISS Ltd

REV No	DESCRIPTION	DATE	DWN	CHK'D
A	1st Issue (For Approval)	26/10/20	CB	
B	Fibre Breakout Boxes Added	12/11/20	CB	

HARRIS PYE
CONTINUOUS EMISSION MONITORING
OVERVIEW DIAGRAM

CBISS DRG No SN2779.11.0000 Rev B

Newport EfW Project

Flue Gas Treatment System

Commercial and Technical Offer for Project Completion

Customer: Scandinavian Energy Contractor A/S

Prepared by: DP CleanTech UK Ltd.

Project code: 7140038

DP CleanTech

Clean energy, natural solutions

Newport EfW Project

List of Contents

Project Code: 7140038

Chapter 1

Time Schedule

Flue Gas Treatment Plant

Client:	**Scandinavian Energy Contractor A/S**
Project Name:	Newport EfW Project
DPCT Project Code:	7140038
DPCT Document Ref.:	7140038-TS-OFR-2000-001-00
Pages:	3

Version	Date	Description	Author	Approved
00	2022-08-17	First Issue – Re-start Price	CBR	MC

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The time schedule described in this section is taken from the original contract tender from August 2020, for reference only. At this time the new project schedule is not known, once the project schedule is published an updated time schedule will be produced for the FGT plant.

1. Time Schedule

DP CleanTech (DPCT) anticipate carrying out the design, manufacturing, supervision of mechanical installation and commissioning of the FGT system according to the time schedule shown below.

A detailed time schedule for design, production and purchase will be made after contract.
A preliminary programme has been submitted on 19th August 2020 (iur ref 2640032-PM-PRG-2000-001-02).

DP will be able to meet the following milestones:

No	Approx. Week	
1	0	Contract signing (28/08/2020)
2	4	Submission of civil loads (4 weeks) as “not to exceed” values
3	22	Order placed for FGT silos.
4	22	Order placed for filter fabrication, reactor fabrication.
5	22	Order placed for structural steelwork
6	22 to 44	Order placed for equipment balance
7	27 to 49	Manufacturing, supply of FGT equipment
8	Week 40 40 43 44 44 46 to 52 48 to 55	FGT equipment start delivery to site: Structural steelwork, Reactor tower Recirculation equipment Filter unit Silos Balance of FGT plant
9	40	Start mechanical installation (supervision by DPCT)
10	40 to 60 (12/09/2021)	Finish mechanical installation
11	52 to 60	Thermal insulation, cladding, trace heating
12	48	Start electrical installation (by others)
13	59 to 72	Commissioning of FGT plant
14	73 onwards	After trial run and performance test – max. 3 month after commissioning completion or maximum 12 months after delivery whichever comes first.

The overall time schedule for this project is estimated to be 19 months from contract start date until the end of the trial run and performance test period.

We will be able to commence delivery to site in 9 months.

Mechanical completion will be complete by 2nd week in September, 2021.

Chapter 2

Performance Data

Flue Gas Treatment Plant

Client: **Scandinavian Energy Contractor A/S**
Project Name: Newport EfW Project

DPCT Project Code: 7140038
DPCT Document Ref.: 7140038-TS-OFR-2000-001-00
Pages: 8

Version	Date	Description	Author	Approved
00	2022-08-17	First Issue – Re-start Price	CBR	MC

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APPENDIX 1

- Table of all operating cases

The performance data in this section has not been updated from the original contract tender from August 2020. It is assumed that there is no change to the plant process parameters at this time. There is a possibility of there being a change in fuel on the project, if this happens the performance data will need to be re-evaluated to determine if the plant guarantees are still valid.

2.0 Performance Data

2.1 FGT Data

We have based our design for the FGT system based on the following data.
The 3 cases below are considered as the design gas flows and their respective inlet pollutants.
Additional cases are provided in Appendix 1.

Flue Gas Inlet		CASE 2b 11MJ / 23MWe duty	CASE 2 11MJ / ERK MCR	CASE 3b 9.5MJ / 23MWe duty
Flow of gas at FGT inlet (wet)	Nm³/hr (wet)	160088	172138	168339
Gas temperature at FGT inlet	°C	151	153.9	154
Main components in % v/v (wet)	CO_2	10.76	10.76	10.8
	H_2O	12.8	12.8	14.31
	O_2	6.76	6.76	6.76
	N_2	69.68	69.68	68.13

Inlet pollutants are as follows based on the above:

		CASE 2b 11MJ / 23MWe duty		CASE 2 11MJ ERK MCR		CASE 3b 9.5MJ / 23MWe duty	
		Design	Expected	Design	Expected	Design	Expected
Particulate in mg/Nm³		2500	2500	2500	2500	2500	2500
HCL in mg/Nm³		1383	702	1383	702	1482	728
HF in mg/Nm³		16	16	16	16	14	14
SO_2 in mg/Nm³		1651	841	1651	841	1756	864
NOx in mg/Nm³		150	150	150	150	150	150
Heavy Metals in mg/Nm³		50	50	50	50	50	50
Hg in mg/Nm³		0.3	0.3	0.3	0.3	0.3	0.3
Cd + Tl in mg/Nm³		1	1	1	1	1	1
Dioxins and furans in ng/Nm³		1 to 5	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5
Upstream equipment pressure drop	mbar	-11.3 (-115 mmWG)	-11.3	-11.3	-11.3	-11.3	-11.3

All concentrations are expressed at reference conditions 273 K (0°C), 1.013 bar(a) and 11% oxygen dry gas.

2.1.1 Testing and Standards

Certain guarantees given are based on flue gas inlet conditions as defined in FLD condition in section 2.1 above. The flue gas is dependent on fuel composition. Correction curves will be issued during the project execution and approved by the Client prior to any testing taking place. Consumption guarantees will be calculated using the flue gas data from the CEM's monitoring equipment and the correction curves provided.

2.1.2 Noise Emissions

Plant Performance Test	Performance Guarantee	Remark
Noise	Less than or equal to Lp (A) 85 at 1m distance, free field conditions	Performance Test

When noise emissions from the plant are measured, it is presumed that noise emissions from other sources than those emitted from the Supplier's scope of supply are eliminated from the measurements.

The noise level is defined as the measured noise according to ISO 3746 "Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane" taken directly from the source.

Noise emissions from discontinuous sources such as filter cleaning as well as noise emissions from equipment outside the scope of supply are excluded from the guarantees for noise emissions.

2.1.3 Tolerances on Guaranteed Values

The tolerances or permitted variations during normal and steady operation are determined by use of the Correction Curves that will be issued upon project commencement.

2.1.4 Other Pre-conditions

- Minimum continuous load ....≥ 60 %
- Elevation above sea level ....≤ 100 m
- Ambient design pressure...910 mbar
- Ambient design temperature ....15 °C
- Ambient temperature range ....-20 to +30 °C
- Relative humidity at ambient design temperature ....70 %
- Relative humidity range ....58 – 92 %

If these ambient conditions are not satisfied at the actual Performance Test, adjustments to the Guaranteed Performance shall be made using correction curves.

2.2 Mechanical Warranty

The DPCT FGT plant as defined in this Document shall have a Defects Liability Period of 24 months commencing from the date of the first hot gas passing through or 3 months after completion of installation, whichever is the sooner.

If any defect appears in any part of the works within the above period, the same shall be made good by DPCT by repair or replacement.

This guarantee is made on the basis that the plant has been operated in accordance with DPCT's instructions, specified design parameters have not been exceeded and documentation is available to prove that this is the case.

We would also wish to incorporate the above guarantee into the agreed Conditions of Contract.

Wear parts are not covered by the warranty.

2.2.1 Filter Bag Warranty

The following table shows the Expected failure rate for the lifetime of the filter bags. This table coincides with the warranty offered by the Filter Bag suppliers.

Filter Bag Lifetime :	
Expected replacement after first year or 8,000 operation hours:	2%
Expected replacement after first two years or 16,000 operation hours:	4%
Expected replacement after first three years or 24,000 operation hours:	6%

The filter bags should not require replacement for a period of 36 months or 24,000 operating hours (whichever occurs first), from date of **First Introduction of Hot Gas** to the bags, subject to suitable backstop.

This guarantee is made on the basis that the equipment has been operated in accordance with DPCT instructions, specified design parameters have not been exceeded and documentation is available to prove that this is the case.

The percentages given are the quantities we would expect to fail through normal wear and tear.
These bags are a consumable and we would expect them to be replaced as part of the spares holding for the project. Quantities in excess of these percentages will be replaced under warranty.

2.3 Guaranteed Performance Figures

Based on the pre-conditions in section 2.2, we give the following technical performance figures for the FGT System within the scope of supply.

2.3.1 Performance Figures

Ba Based on **CASE 1** 'Design' gas data and 'Design' inlet pollutants specified in section 2.1, the guarantees are:

Parameter		Guarantee	Expected
Hydrated lime [$CaOH_2$] * **at 'case 2' design inlet pollutants**	kg/h	1735	1731
Hydrated lime [$CaOH_2$] * **at 'case 2b' expected inlet pollutants**	kg/h	788	785
Powder Activated Carbon (PAC) **at 'case 2' design inlet pollutants**	kg/h	12.5	12.5
Powder Activated Carbon (PAC) **at 'case 2b' expected inlet pollutants**		11.5	11.5
Residue product **at 'case 2' design inlet pollutants**	kg/h	2610	2610
Residue product **at 'case 2b' expected inlet pollutants**	kg/h	1440	1440
Residue product **at 'case 4' maximum residue generation**	kg/h	3005	3005
Power consumption, total absorbed	kW	153	-
Total installed power	kW	205	-
Compressed air consumption (average over 1 hour)	Nm3/h**	390 (TBC)	-

Additional cases are detailed in Appendix 1.

Based on past performance with similar plants, the expected consumption figures are realistic targets that we would expect our FGT plant to achieve (based on 'Design' inlet pollutants).

* Lime consumption calculated with a purity of 95%.

** Air consumptions expressed as Nm^3 Free Air Condition (FAC), i.e., at atmospheric pressure, inlet to compressor. To sustain operation during short term peaks, an air receiver should be provided capable of sustaining a flow of up to (1630) m^3/h FAD.

2.3.2 Emissions

DP will guarantee that the emissions to air will not exceed the following when the equipment operates within the parameters stated within Section 2.2.
The BREF emission limits will be met for all operating conditions listed in section 2.1 above.

IED Emission Level Values

Parameter		IED Daily Average	IED Extractive Sampling
HCl	mg/Nm³	10	
SO_2	mg/Nm³	50	
HF	mg/Nm³	1	
Dioxins / Furans	ng/Nm³		0.1
Hg	mg/Nm³		0.05
Cd + Tl	mg/Nm³		0.05
Particulates	mg/Nm³	10	
Heavy metals	mg/Nm³		0.5

Half Hourly average emission values according to EU Directive 2010/75/EU			
		(100%) A	(95%) B
Particulates	mg/Nm³	30	10
HCl	mg/Nm³	60	10
SO_2	mg/Nm³	200	50
HF	mg/Nm³	4	2

BREF emission limits – Commission Implementing Decision (EU) 2019/2020 of 12 November 2019
Upper limits to be applied.

Parameter		Daily Average	Periodic Sampling
Particulates	mg/Nm³	5	
HCl	mg/Nm³	6	
SO_2	mg/Nm³	30	
HF	mg/Nm³	<1	
Dioxins / Furans	ng/Nm³		0.06
Hg	µg/Nm³	20	
Cd + Tl	mg/Nm³		0.02
Heavy metals	mg/Nm³		0.3

Start-up, shutdown and low load periods (<60% load) are excluded from the above guarantees.

2.3.3 Availability

The planned yearly overhaul of the plant is assumed to be 15 days. The plant is designed to be available for a minimum of 8000 hours.

The remaining period to be used for planned/unplanned maintenance.

The plant shall be considered in operation:
1. If fuel is being combusted by the thermal process plant and providing that the environmental requirements are met.
2. If the plant could have combusted fuel (complying with the environmental requirements) but is actually not in operation due to reasons not attributable to the Supplier (as listed below):

- No/not enough fuel
- Residue storage capacity exhausted
- No outside electricity to start the plant
- No personnel available (illness, operator not available).
- Governmental decision or declaration not to operate or start the plant
- Damages due to operator's fault.
- No/not enough consumable material available
- Plant outage caused by failure of parts not in Supplier's scope

2.3.4 Noise

The sound pressure level from the DP equipment shall not exceed a maximum of 85 dB(A) provided the preconditions are complied with:

- The noise level is defined as *specific noise pressure level* i.e. excluding background noise as defined in the standard.
- Materials and design of the building environment do not increase sound pressure levels.
- The noise level is defined as the measured noise according to the regulations in the UK taken directly from the source.
- Noise emissions from discontinuous sources such as start-up valve, safety valves, soot blowers, among others, are excluded from the Guaranteed Performance for noise emissions.

APPENDIX A Rev 10 - SUMMARY of GAS CONDITIONS at inlet to FGT plant "Design Composition"

Description	Unit	CASE 1	1a IF ECO1	1b 23MWe	CASE 2	2a IF ECO1	2b 23MWe	CASE 3	3a IF ECO1	3b 23MWe	CASE 4	4a IF ECO1	3b 23MWe
	Boiler case	16 MJ	OFFLINE	DUTY	11 MJ	OFFLINE	DUTY	9.5 MJ	OFFLINE	DUTY	8 MJ	OFFLINE	DUTY
		ERK MCR		93%	**ERK MCR**		93%	**INT. MCR**		93%	**ERK MCR**		93%
		OPERATION CASE	OPERATION CASE	OPERATION CASE	**DESIGN CASE**	OPERATION CASE	**DESIGN CASE**	OPERATION CASE	OPERATION CASE	**DESIGN CASE**	OPERATION CASE	OPERATION CASE	OPERATION CASE
					FOR BAG AND REACTOR		FOR ASH, LIME & PAC			FOR BAG AND REACTOR			
Fuel composition:					*SIZING*		*STORAGE*			*SIZING*			
- RDF sulphur	%mass		0.48			0.42			0.39			0.36	
- RDF chlorine	%mass		0.79			0.69			0.65			0.60	
Gas flow	Nm³/h	150695		140146.35	172138		160088.34	181009.5		168338.835	189883		176591.19
Gas flow	Am³/h	233826	244866	217150	269178	285257	248635	285173	302346	263299	301378	319671	278147
Gas temperature	°C	150.6	170.6	150	153.9	179.4	151	157.1	183	154	160.3	186.6	157
Gas pressure at boiler/econo outlet	Pa	-1150	-950	-1150	-1150	-950	-1150	-1150	-950	-1150	-1150	-950	-1150
Gas pressure at inlet (FGT vendor to confirm	Pa						≈ -2500						
Gas constituent:													
- H2O	% v/v		12.79			13.34			14.88			16.41	
- CO2	% v/v		9.51			10.76			10.8			10.83	
- O2	% v/v		6.75			6.76			6.76			6.75	
- N2	% v/v		70.9			69.09			67.07			65.04	
- SO2	% v/v		0.04			0.05			0.05			0.05	
Gas pollutant:													
- Dust	mg/Nm³		2500			2500			2500			2500	
- HCl	mg/Nm³		1210			1383			1482			1582	
- SO2	mg/Nm³		1442			1651			1756			1862	
- HF	mg/Nm³		21			16			14			12	
	kg/hr		376.7			430.3			452.5			474.7	
Filter: total filtration area (7.0m long bags)	m²	4433	4433	4433	4433	4433	4433	4433	4433	4433	4433	4433	4433
Filter: filtration velocity (6 compartments)	m/min	0.903	0.943	0.84	1.038	1.098	0.96	1.1	1.163	1.017 (?)	1.161	1.23	1.073
Filter: filtration velocity (5 compartments)	m/min	1.083	1.133	1.007	1.247	1.318	1.152	1.32	1.397	1.22	1.395	1.475	1.288
Highlighted RED = NOT SUITABLE													
Filter: total filtration area (7.2m long bags)	m²	4560	4560	4560	4560	4560	4560	4560	4560	4560	4560	4560	4560
Filter: filtration velocity (6 compartments)	m/min	0.878	0.92	0.817	1.01 (OK)	1.07	0.933	1.07	1.133	0.988	1.13	1.197	1.043
Filter: filtration velocity (5 compartments)	m/min	1.053	1.103	0.978	1.212	1.285	1.12	1.283	1.36	1.185	1.355	1.438	1.252
"Design" reactor tower suitable?	Y / N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lime consumption (expected)	kg/h	1345	1345	1251	1731	1731	1610	1885	1885	1753	2040	2040	1897
Lime consumption **(guaranteed)**	kg/h	**1350**	**1350**	**1253**	**1735**	**1735**	**1615**	**1890**	**1890**	**1755**	**2045**	**2045**	**1900**
PAC consumption	kg/h	11	11	10	12.5	12.5	11.5	13.5	13.5	12.5	13.5	13.5	13
Residue generated	kg/h	2080	2080	1935	2610	2610	2430	2805	2805	2610	3005	3005	2795
Outlet emission:													
- Dust	mg/Nm³	5	5	5	5	5	5	5	5	5	5	5	5
- HCl	mg/Nm³	6	6	6	6	6	6	6	6	6	6	6	6
- SO2	mg/Nm³	30	30	30	30	30	30	30	30	30	30	30	30
SILO CAPACITIES													
Lime silo, 90Te (net)	no of days	2.75	2.75	3	2	2	2.25	2	2	2	1.75	1.75	2
Residue silo, 125Te / 250m³ (net)	no of days	2.5	2.5	2.5	2	2	2	1.75	1.75	2	1.75	1.75	1.75

SILO CAPACITIES	Days cap	Capacity (net)
Lime silo	4	90 Te
PAC silo	99	25 Te
Residue silo	4	250m3 / 125 Te

APPENDIX A Rev 10 - SUMMARY of GAS CONDITIONS at inlet to FGT plant "Expected Composition"

Description	Unit	CASE 1	1a IF ECO1	1b 23MWe	CASE 2	2a IF ECO1	2b 23MWe	CASE 3	3a IF ECO1	3b 23MWe	CASE 4	4a IF ECO1	3b 23MWe
	Boiler case	16 MJ	OFFLINE	DUTY	11 MJ	OFFLINE	DUTY	9.5 MJ	OFFLINE	DUTY	8 MJ	OFFLINE	DUTY
		ERK MCR		93%	**ERK MCR**		93%	**INT. MCR**		93%	**ERK MCR**		93%
		OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE	OPERATION CASE
							FOR LIME & PAC						
Fuel composition:							*CONSUMPTION*						
- RDF sulphur	%mass	0.24			0.22			0.20			0.18		
- RDF chlorine	%mass	0.41			0.36			0.33			0.30		
Gas flow	Nm³/h	150695		140146.35	172138		160088.34	181009.5		168338.835	189883		176591.19
Gas flow	Am³/h	233826	244866	217150	269178	285257	248635	285173	302346	263299	301378	319671	278147
Gas temperature	°C	150.6	170.6	150	153.9	179.4	151	157.1	183	154	160.3	186.6	157
Gas pressure at inlet (FGT vendor to confirm	Pa	≈ -2500											
Gas constituent:													
- H2O	% v/v	12.36			12.8			14.31			15.81		
- CO2	% v/v	9.51			10.76			10.8			10.83		
- O2	% v/v	6.75			6.76			6.76			6.75		
- N2	% v/v	70.9			69.09			67.07			65.04		
- SO2	% v/v	0.02			0.03			0.03			0.03		
Gas pollutant:													
- Dust	mg/Nm³	2500			2500			2500			2500		
- HCl	mg/Nm³	618			702			728			754		
- SO2	mg/Nm³	709			841			864			887		
- HF	mg/Nm³	21			16			14			12		
	kg/hr	376.7			430.3			452.5			474.7		
Filter: total filtration area (6.5m long bags)	m²	4433	4433	4433	4433	4433	4433	4433	4433	4433	4433	4433	4433
Filter: filtration velocity (6 compartments)	m/min	0.903	0.943	0.84	1.038	1.098	0.96	1.1	1.163	1.017 (?)	1.161	1.23	1.073
Filter: filtration velocity (5 compartments)	m/min	1.083	1.133	1.007	1.247	1.318	1.152	1.32	1.397	1.22	1.395	1.475	1.288
Highlighted RED = NOT SUITABLE													
Filter: total filtration area (7m long bags)	m²	4560	4560	4560	4560	4560	4560	4560	4560	4560	4560	4560	4560
Filter: filtration velocity (6 compartments)	m/min	0.878	0.92	0.817	1.01 (OK)	1.07	0.933	1.07	1.133	0.988	1.13	1.197	1.043
Filter: filtration velocity (5 compartments)	m/min	1.053	1.103	0.978	1.212	1.285	1.12	1.283	1.36	1.185	1.355	1.438	1.252
"Design" reactor tower suitable?	Y / N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lime consumption (expected)	kg/h	646	646	600	843	843	785	887	887	825	930	930	865
Lime consumption **(guaranteed)**	kg/h	**650**	**650**	**605**	**845**	**845**	**788**	**890**	**890**	**830**	**935**	**935**	**870**
PAC consumption	kg/h	11	11	11	12.5	12.5	11.5	13	13	12	13.5	13.5	13
Residue generated	kg/h	1245	1245	1160	1545	1545	1440	1610	1610	1500	1680	1680	1560
Outlet emission:													
- Dust	mg/Nm³	5	5	5	5	5	5	5	5	5	5	5	5
- HCl	mg/Nm³	6	6	6	6	6	6	6	6	6	6	6	6
- SO2	mg/Nm³	30	30	30	30	30	30	30	30	30	30	30	30
SILO CAPACITIES													
Lime silo, 90Te (net)	no of days	5.75	5.75	6	4.25	4.25	4.75	4.25	4.25	4.5	4	4	4.25
Residue silo, 125Te / 250m³ (net)	no of days	4	4	4.5	3.25	3.25	3.5	3.25	3.25	3.5	3	3	3.25

SILO CAPACITIES	Days cap	Capacity (net)					
Lime silo	4	90 Te					
PAC silo	99	25 Te					
Residue silo (500kg/m³ density)	4	250m3 / 125 Te					280m2 / 140Te
							or use 560kg/m³ density

Chapter 3

Scope of Supply

Flue Gas Treatment Plant

Client: **Scandinavian Energy Contractor A/S**
Project Name: Newport EfW Project

DPCT Project Code: 7140038
DPCT Document Ref.: 7140038-TS-OFR-2000-001-00
Pages: 28

Version	Date	Description	Author	Approved
00	2022-08-17	First Issue – Re-start Price	CBR	MC

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The scope of supply described in this section has not been changed from the original contract tender from August 2020. It is assumed that when the project re-starts, DP will continue to supply the same scope.

3 General Scope of Supply – FGT Plant

The Flue Gas Treatment (FGT) plant is designed to process flue gases from the Client's thermal treatment system plant. Using a dry scrubbing system, the DPCT process will reduce the level of pollutants to meet the requirements detailed in Chapter 2 of this offer using hydrated lime and activated carbon.

The inlet gas temperature to the FGT plant is between 150°C and 157°C under normal operation. If the economiser fails the temperature could reach 186°C for a short period

3.1 DP Clean Tech FGT Plant Benefits

Our proposed flue gas treatment plant provides a proven and effective method of meeting the required emission limits, and gives the following benefits:

- The FGT equipment proposed will consistently achieve the mandatory emission requirement.
- New BREF emission limits will also be met.
- The equipment will be designed and built to the latest and up-to-date engineering practices and rules.
- Equipment will be designed for reliability. Material selection and standby equipment, where possible, provide a long-term reliable plant.
- The FGT plant will be designed to provide easy access for inspection and maintenance.
- The plant is designed for outdoor location.
- Maximum contact time will exist between the reagent and flue gas in the reactor tower section, (approximately 4.0 seconds), ensuring effective mixing before entering the fabric filter section.
- Filtration velocity is designed to enable dust entering the filter to be captured by the bags.
- Filter bag selection will ensure successful dust collection, including finer dust particles, and offers a high temperature stability and 3-year bag guarantee.
- The type of equipment proposed has been installed on other sites and operates successfully and consistently achieves the mandatory emission standards.

3.2 Future Plant Sustainability

We have designed the FGT plant for the current emission standards (IED and BREF) but also considered how the plant can meet future, more stringent, emissions:

- The reactor tower will be designed to receive higher levels of recirculation product. A residence time of approximately 4 seconds will be capable of effective mixing of any higher recirculation levels and higher levels of fresh lime dosing.
- The recirculation equipment will be designed for an increased level of recirculation product; approximately 110% of the current design.
- The lime metering equipment will use two separate dosing systems and these have a built-in over capacity which will allow more lime to be injected without the need for modification.
  The current lime injection requirement at 'design' is 1755kg/h and the two systems will be used to achieve this. Under the worst case scenario the required injection rate is 2045kg/h.
  The system design for the lime metering systems is approximately 2500kg/h.
- The PAC metering will also be similarly designed for built-in over capacity.

- The residue conveyors will be designed to remove product should an emergency condition occur, for example if the ID fan fails the residue collected on the bags will immediately fall into the filter hoppers and we would need to remove this in around one hour.
- Additionally, we may be able to add an injection of sodium bicarbonate into the ducting before our FGT; if future limits go even lower, a small amount of bicarb could be injected to help get the inlet pollutants to a more manageable level before we add lime into the reactor tower.
  With a small quantity of bicarb, and the small residence time it requires, the reaction should take place before our reactor.

  We would need to do some research to see if there are any potential problems mixing lime and bicarb residues.

3.3 DP Clean Tech Team

The DP CleanTech UK Ltd team of engineers have many years of experience working together and have supplied many flue gas cleaning systems around the world.

The process we have put forward for this project has been proven.

This specialist team also benefits from the collective experience and in-house knowledge of the DP engineers at the Group's Design Centre of Excellence in Copenhagen, Denmark and Katowice, Poland.

A majority of the plant equipment will be manufactured in the UK and this will allow the UK engineering team to regularly check the progress and quality of the work and also ensure that the planned delivery schedule will be met.

The same team will also be able to attend progress meetings in person and should we be required to act quickly we can be either on site or at your UK office within 4 hours if necessary.

For post-completion operation and warranty support, we will provide contact points from our UK office to respond to operational queries and issues.

3.4 FGT Plant Design and General Description

Our scope of supply starts at the inlet flange of the DPCT reactor tower and ends at the outlet flange of the filter unit. Residue product will be collected into a single residue storage silo.

Our process is based on an "All-Dry" process using hydrated lime and activated carbon to reduce the level of pollutants present in the gas stream to meet the requirements of the Industrial Emissions Directive (2010/75/EU) and new EU BREF limits. Details of these are contained in Chapter 2, Section 2.3.2 of this Tender.

The flue gas firstly enters our Reactor Tower where acid neutralisation takes place by injecting a mixture of fresh hydrated lime and powdered activated carbon (PAC) into the base of the tower.

Fresh lime will be stored in a single silo complete with two conveying and metering systems. Lime is conveyed from the lime storage silo by two transfer conveyors (or similar device) to each of the two metering systems, each comprising a surge hopper, blowing seal and isolation valves. Lime will be pneumatically conveyed by a positive displacement blower to the reactor tower.

PAC will be stored in a single silo with one conveying and metering system. PAC is conveyed from the PAC storage silo via a rotary valve to the metering system which comprises a surge hopper, metering feeder and eductor. PAC will then be pneumatically conveyed by a side channel blower to the reactor tower.

The next process stage is a fabric filter to remove particulate and used reagent. The captured product is recycled back to the reactor tower via a recirculation surge hopper and a series of conveyors. An additional two conveyors and a single rotary valve arrangement allows the product to be periodically directed from the surge hopper to a dense phase conveying system, whereupon the residue is conveyed to a single residue storage silo.

Clean gas exits the fabric filter and passes via a duct into the Client's ID Fan. The gases are then exhausted to atmosphere through the Client's single flue exhaust stack.

The proposed flue gas cleaning plant provides a proven and effective method of meeting the requirements of gas emissions detailed in Chapter 2 of our Tender.

3.4.1 Layout – FGT Plant

The main FGT plant will be designed for outdoor use.

3.4.2 Support Structure, Platforms, Stairs and Ladders

Platforms, stairs and galleries for the safe operation and maintenance of the FGT equipment will be designed according to the applicable UK standards.
The steel structures shall be supported at ground level on concrete foundations supplied by others.

Our supply includes the steel structures to support the filter, reactor, recirculation equipment, lime silo, PAC silo and residue storage silo. Exact details are given in section 3.15.

3.4.3 DPCT Scope of Supply

DP's scope of supply and services for the FGT plant is listed in this section. Section 3.23 lists the main exclusions from the FGT supply.

Ref No.	Description	DPCT	Harris Pye	Notes
3.5	Reactor Tower	X		
3.6	Fabric Filter	X		
3.7	Interconnecting Ductwork		X	The flanged inlet to the reactor and from the filter unit outlet are in HP scope. Within the battery limits, equipment is flanged and jointed directly so no ductwork is expected, only utility piping and this shall be in DPCT scope.
3.8	Hydrated lime Storage and Metering System	X		1 silo with 2 metering systems. Includes structure & intermediate platform. Access from filter stairtower.
3.9	Activated Carbon Storage and Metering System	X		1 silo with 1 metering system. Includes structure. Access from filter stairtower.
3.10	Recirculation conveying Equipment	X		
3.11	Residue conveying	X		Screw and chain conveyors. Dense phase residue conveying.
3.12	Residue storage	X		Single storage silo, including structure, access ladders and platforms. No separate stairtower is included.
3.13	ID Fan, Motor, Silencer, VSD		X	
3.14	Thermal Insulation, cladding and Trace Heating	X		Design, supply and labour for site installation. Excludes scaffolding and MEWP's
3.15	Support Structure and Access facilities, filter stairtower, ladders	X		
3.16	Exhaust stack		X	
3.17	Electrical and Control, Electrical installation		X	
3.18	Compressed Air supply system		X	
3.18.1	Compressed air pipework	X		Includes pipework, fittings, valves. Termination as at a single point on the FGT plant.
3.19	Civil Works		X	
3.20	Wear and spare parts for 2 years			Spare parts will form part of a separate O&M and lifecycle cost. See Chapter 5 for details.

Ref No.	Description	DPCT	Harris Pye	Notes
3.21	Mechanical installation, cranage and scaffolding		X	No site labour is included. DPCT provides site supervision during mechanical installation only. See section 3.22.
3.22	Commissioning and training	X		Based on durations stated in section 3.22.
3.23	Engineering and documentation	X		Refer to section 3.23 for DPCT supply.

In the following sub-sections, the main component of the packages supplied by DPCT are described. The scope of supply includes design, engineering, manufacturing, quality assurance and documentation of the following scope.

3.5 Reactor Tower

3.5.1 Design Data

1 off reactor tower

Inlet gas flow (design CASE 2)	172138 Nm^3/h
Added pneumatic conveying air from lime & PAC injection	1200 Nm^3/h
Operating temperature – at reactor inlet	153.9° C

3.5.2 Description

The first stage of the Flue Gas Cleaning process is acid neutralisation utilising the All Dry Scrubbing process. This process begins with the pneumatic injection of the reagents into the venturi section of the Reactor Tower. The reactor tower consists of three (3) sections, the venturi section, the up-flow section and the down-flow section.

Hydrated lime and activated carbon are pneumatically conveyed from the metering system to the venturi where they are blown into the gas stream. The venturi section is designed to give maximum turbulence of the flue gases so that good mixing of the reagents and the flue gases takes place to give effective removal of the acidic pollutants.

The reagents are injected at the narrowest section (venturi) where the gas velocity is at its highest, as the gas travels up the reactor the chemical reactions will begin to take place.

As the gas flows change direction at the top of the reactor turbulence is created once more which will mix the reagent more effectively in the gas stream increasing the removal efficiency.

The gas is slowed down as it travels down the reactor and enters the filter, the residence time within the reactor tower between the flue gases and the reagents will be calculated at approximately 4.0 seconds. The residence time is the length of time that the reagent spends in contact with the flue gases. The more time the reagent spends in the gas stream the more the pollutants will react to form neutral salts and be removed by the filter.

The reactor tower will be fabricated from carbon steel and will be externally fully insulated and clad. This ensures minimal heat loss and more importantly, that cold ambient air does not contact the walls. This may lead to localised chilling of the casing and condensation of the flue gas, resulting in local acid formation and subsequent corrosion of the equipment.

3.5.3 Support Structure & Access Platforms

The reactor will be supported by an integrated structure for the reactor and filter unit. For maintenance and inspection purposes a platform at the reagent injection level is necessary.
The supply and fabrication of this structure is included within our supply.

3.5.4 Surface Finish

External surfaces, which are to be thermally insulated, will be painted with 1 coat of primer. Any surfaces which are visible (such as the injection nozzles) will be painted one coat primer, one intermediate coat and one top coat.
Support structure, access platforms, ladders and handrails will be shotblasted and galvanised.

3.6 Bag Filter

3.6.1 Design Data

1 off filter unit

Unit Designation	7.0/14D/48R2/6C/150
Type of cleaning system	On-line
Inlet gas flow (design, 'Case 2b)	160088 Nm³/h (plus 1200 Nm³/h from reagent injection)
Added filter cleaning air	210 Nm³/h
Operating temperature – at filter inlet	151° C
Type of filter media	100% P84 bags on a PTFE scrim with a PTFE surface or bath finish.
Number of filter elements	1344
Diameter of filter elements	150 mm
Length of filter elements	7015 mm
Filter total surface area	4430 m²
Number of compartments	6
Number of filter bags per compartment	224
Filtration velocity – Design	0.96 metre/min
Filtration velocity with 1 compartment off line	1.152 metre/min
Maximum temperature continuous rating for fabric	240° C
Peak temperature rating for fabric (restrictions apply)	260° C
Maximum withstand pressure of filter casing	-750 mm WG (7.35 kPa)
Design case pressure drop within the filter unit	180 mm WG
Filter body material	BS EN 10025 S275 or equivalent

The filter proposed is a DP Cleantech Reverse Jet compartmentalised filter with facilities to enable one compartment to be isolated for emergency maintenance purposes whilst maintaining adequate particulate removal efficiency.

The Filter is fully automatic equipped with a reverse jet compressed air cleaning system.

Dust laden gas enters the bag filter via a central inlet plenum that will distribute the flue gases evenly into each of the filter compartments. There are six (6) compartments, each containing a set of filter bags and the compressed air cleaning system. A series of inlet isolation valves admit the flue gases into the lower half of the filter. The flue gases are deflected by a series of guides and a baffle plate, to pass through the filter bags and into the clean gas section. Poppet valves are used on the clean gas section to give a gas tight seal when a compartment needs to be isolated.

Distribution baffles inside the filter ensure that the heaviest particles are disentrained directly into the hoppers, while most of the gas is distributed evenly onto the filter bags. As the gas passes through the filter bags, the particulates build up on the surface of the filter media, which improves the filtration efficiency, while allowing a further reduction of the acid gas with unspent reagent in the dust cake.

During the on-line cleaning cycle, compressed air is injected into one row of filter bags through the high efficiency venturi incorporated in the filter bag support cage, thus creating an over-pressure inside the bags which:

- Momentarily stops the filtration on those bags.
- Abruptly inflates the filter bag causing the dust cake to break away and fall into the hoppers.

The cleaning cycle of the individual rows of bags is governed by an electronic controller configured to clean each row of bags. It is preferable to actuate the cleaning cycle by the increase in the pressure drop across the filter media, which has the advantage of reducing the compressed air consumption and increasing contact between the reagent and gas, thus increasing acid neutralisation.

The cleaning sequence is programmed to stop once the differential pressure returns to normal. When the pre-set level is exceeded once more, the next row in the cleaning sequence is cleaned first.

Displaced particulate falls into the bottom of the chamber, which is in the form of a pyramidal hopper. There is one such hopper for each compartment.

The resultant particulate will be conveyed from the hoppers to the residue handling system specified in section 3.10 of this Specification.

The DP Clean Tech Reverse Jet Filter comprises principally of: -

Six (6) fully welded hoppers fabricated from carbon steel plate, suitably braced and stiffened. Each hopper is externally painted with a suitable primer and fitted with one access door, one (1) rodding port, a pneumatic hammer, one (1) strike plate and one level probe.

One fully welded carbon steel body suitably braced, stiffened and incorporating the inlet plenum. The casing will be divided into six (6) individual gas-tight compartments. The casing will be externally painted with a suitable primer.

One fully welded clean gas section fabricated from carbon steel plate, suitably braced and stiffened, and incorporating the filter bag support plate, pulse jet cleaning blast tubes, externally mounted diaphragm valves and compressed air manifolds. The top face of the casing will comprise insulated access doors providing maintenance access. The access doors will be painted with a non-slip paint finish.

The filter bags will be approximately 150 mm diameter and 7.0m long.

We have selected 100% P84 bags on a PTFE scrim with a PTFE surface finish. This bag will be provided with a 3-year bag life warranty from first introduction of hot gases.

Filter bag support cages are fabricated from multi-strand mild steel with a Cataphoresis (electromechanical coating process) surface treatment, incorporating in the top plate a venturi section.

To enable the top access doors to be lifted safely we include a manual lifting trolley, which traverses the length of the filter on a lifting beam arrangement (lifting beam is part of the filter penthouse structure).

3.6.2 Trace Heating and thermal insulation

We have included the design, supply of trace heating equipment and local control panel(s) within our scope. The trace heating cables will be site installed and each circuit will be wired to a junction box. Positioning of the local control panels and subsequent wiring from each junction box to the respective control panel is excluded from our scope.

The filter hoppers must be trace heated to prevent moisture forming on the internal surfaces during operation. These circuits will operate continually to prevent corrosion and aid product discharge into the residue transport system. A control panel to control the heating circuits will also be required.

External thermal insulation and cladding is required to protect the mild steel casing and to prevent its temperature from approaching the acid dewpoint of the flue gas.
The supply and installation of this work is also included within our scope.

3.6.3 Support Structure & Access Platforms

The filter will be supported by an integrated structure for the reactor and filter unit. The structure will provide the necessary support for the reactor tower and filter unit, with access provided to all major points of regular maintenance.
The supply and fabrication of this structure is included within our supply.

3.6.4 Filter Penthouse

A filter penthouse structure will be required for weather protection to the top of the filter.

We include the design and supply of a structural frame located at the filter top and this will incorporate 2 runway beams for filter door removal.

DPCT will also provide a suitable manual trolley and hoist for this purpose.

The penthouse will also require cladding support rails to walls and roof and then covered by single skin 0.7mm thick profiled plastisol cladding. All flashings, closures and a door will be required together with ventilation louvers, rainwater guttering, downpipes and light fixtures.

The supply and fabrication of this penthouse structure and the cladding and associated items is included within our supply.
We have not included for insulation of the penthouse.

3.6.5 Surface Finish

External surfaces, which are to be thermally insulated, will be painted with 1 coat of primer. Any surfaces which are visible (such as the filter top access doors) will be painted one coat primer, one intermediate coat and one top coat.
Top access doors will include an anti-slip finish.
Support structure, access platforms, ladders and handrails will be shotblasted and galvanised.

3.7 Interconnecting Ducting

We exclude all ducting and connections between the inlet of the DPCT reactor tower and the inlet flange of the Client's ID fan.
A duct from the economiser to the inlet flange of our reactor inlet box is excluded.
A duct from the outlet of our filter unit to the ID fan is excluded. All other ducts after the ID fan are also excluded.
Equipment items within the FGT package are flange bolted directly with no interconnecting gas flow ductwork.
Interconnecting pipework within the FGT package is included, see section 3.18 for further details.

3.8 Lime Silo and Metering Feeders

3.8.1 Design Data

1 silo complete with two sets of metering and pneumatic conveying systems:

Recommended Lime specification	Singleton Birch Ultralime
Lime silo capacity	188m³ (90 tonne) net capacity
Bulk density of lime	480 kg/m³
Lime consumption (Design 'Case 2' guaranteed)	1735 kg/h
Lime consumption (Design 'Case 2', expected)	1731 kg/h
No of days storage capacity (Design 'Case 2b)	~2 days
Lime consumption (Design 'Case 2b' guaranteed)	788 kg/h
Lime consumption (Design 'Case 2b', expected)	785 kg/h
No of days storage capacity (Design 'Case 2b)	~5 days

<u>NOTE:</u> The silo capacity may increase depending upon Harris Pye final design criteria (ie. number of days capacity) and if certain cases outlined in Chapter 2, Appendix 1 form part of the design requirement.

3.8.2 Description

Fresh lime is stored in a storage silo with 90 tonne (188m^3) net capacity which will provide approximately 5 days storage based on lime consumption at Design operation with 'expected' composition fuel. The silo is also capable of allowing deliveries from a full road tanker (capacity 28 tonnes) to reduce delivery costs. The silo is constructed in mild steel, suitably braced and strengthened, with two outlets at the bottom of the silo. The silo cone will terminate in flanged outlets to suit the discharge equipment.
We may elect to use an alternative silo discharge device which will fulfil our process requirements.

The storage silo incorporates a level probe located in the silo cone, aeration devices with a steel ring main and plastic piping to the devices, to prevent arching, rat holing and flooding. In addition, a series of load cells will be fitted to give an accurate assessment of the levels within the silo.

The roof of the silo features a manhole cover, an under/over pressure vent, level probe, pressure transmitter and a spare port. A dust extraction filter with an electronic controller and weatherproof cover is also situated on top of the silo.
An inlet connection pipe for road tanker filling is also included, terminating approximately 1.0m above ground level. This pipe includes a Unicone coupling to allow the tanker hose to connect and a pneumatically operated shut-off valve.
A fill control local panel featuring pushbuttons for 'start filling' and 'stop filling', lamps for 'filling request' and 'filling complete', an alarm cancel/reset button and an isolator switch is included to control the silo filling operation. The silo weight will also be displayed on the front of the panel. The panel allows certain signals to interface with the plant PLC.

The discharge equipment of the fresh lime system comprises three manual isolation valves and two transfer screw feeders at the outlet of each conical hopper of the silo, which conveys the reagent to two sets of metering equipment.

Each of the two sets of metering equipment comprises a pneumatically operated isolation valve (at the outlet of the screw feeder), a flexible connection, surge hopper, complete with level probe, load cells, air venting filter and aeration (or vibrators) and an inverter controlled metering screw conveyor (inverter by others).
Both sets of metering systems will operate simultaneously; if 1 set should fail the remaining one can be increased in throughput to enable lime metering into the FGT reactor to continue and emissions to be met.

Conveying pipe will be manufactured from a clear, durable and flexible pipe that will be supported on cable tray and fixed using cable ties. There will be duty and standby pipes supplied to the injection point. The pipes are connected at each end by super clamps.

Each metering system surge hopper is mounted on load cells, which gives a continuous indication of the hopper contents and is also used to calculate the reagent flow on a loss-in-weight basis. When the surge hopper requires re-filling the silo transfer screw conveyor operates to provide a batch of material for the surge hopper. The surge hopper is fitted with a metering screw conveyor, which runs continuously to dose the correct amount of reagent, via a blowing seal and pneumatic conveying line.
The blower then conveys the reagent to the reactor tower inlet nozzle.
We have excluded a spare blower.

3.8.3 Support Structure & Access Platforms

A silo support structure is required together with a platform to gain access to the silo cone and metering equipment. A single access ladder from floor level to this platform is also required.
Access to the silo roof will be from the filter stairtower, based on the silo being located close to the filter and filter stairtower. We have not included a separate stairtower for the lime silo.
The silo roof includes kicking flats and double handrailing around its perimeter.
The supply and fabrication of the structure, platform and ladder is included within our supply.

We have also allowed for weatherproofing for the metering equipment located underneath the silo.
No weatherproofing for the top of the silo has been included.

3.8.4 Surface Finish

External surfaces of the silo, surge hoppers and screw conveyors will be painted one coat primer, one intermediate coat and one top coat. The roof will be finished with a non-slip coating.
Handrails will be shotblasted and galvanised.
The control panel will be painted.
Motors, valves will be the manufacturers standard paint finish.

3.9 PAC Silo and Metering Feeder

3.9.1 Design Data

1 silo complete with one metering and pneumatic conveying system:

Recommended PAC specification	Cabot Norit GL 50
PAC Silo capacity	52m³ net (25 tonne) capacity
Bulk density of PAC	490 kg/m³
PAC consumption (Guaranteed, design ‘Case 2’)	12.5 kg/h
PAC consumption (Guaranteed, design ‘Case 2b’)	11.5 kg/h
No of days storage capacity (‘Case 2’ Design)	~88 days
No of days storage capacity (‘Case 2b’ Design)	~90 days

Important Note:
Activated Carbon is classed as **“Potentially Explosive”** and requires a risk assessment to determine the appropriate classification.

A DSEAR Risk Assessment and Area Classification will need to be carried out if these products are adopted. We have included for ATEX rated equipment and suitably zoned equipment will be provided upon completion of the Risk Assessment.

Powdered Activated carbon (PAC) is stored in a silo with a 25 Tonne (52m³) net capacity which provides approximately 88 days of storage, based on PAC consumption at ‘Design’ operation and will also allow a full tank delivery from a road tanker.
The silo will be constructed in mild steel suitably braced and strengthened, with a single outlet at the bottom of the silo. The silo cone will terminate in a flanged outlet to suit the discharge equipment.

The storage silo incorporates a level probe located in the silo cone, aeration devices with a steel ring main and plastic piping to the devices, to prevent arching, rat holing and flooding. In addition, a series of load cells will be fitted to give an accurate assessment of the levels within the silo.

The roof of the silo features a manhole cover, an under/over pressure vent, pressure switch, level probe and a spare port. A dust extraction filter with an electronic controller and weatherproof cover is also situated on top of the silo.
Suitable explosion relief device(s) will also be fitted to the silo roof, type will be determined by the risk assessment and silo location.

An inlet connection pipe for road tanker filling is also included, terminating approximately 1.0m above ground level. This pipe includes a Unicone coupling to allow the tanker hose to connect and a pneumatically operated shut-off valve.

A fill control local panel featuring pushbuttons for 'start filling' and 'stop filling', lamps for 'filling request' and 'filling complete', an alarm cancel/reset button and an isolator switch is included to control the silo filling operation. The silo weight will also be displayed on the front of the panel. The panel allows certain signals to interface with the plant PLC. Load cell barriers will also be included within the panel.
A road tanker static grounding (earthing) system will also be supplied for protecting personnel and equipment from static hazards during road tanker filling.

The silo discharge equipment for the activated carbon comprises a rotary valve and pneumatically operated valve. The rotary valve will operate to discharge a quantity of PAC into the metering equipment. The valves will operate in sequence to provide a positive isolation between the silo and the metering equipment.

The metering equipment comprises a flexible connection, surge hopper, complete with load cells, vent sock and agitator, an inverter-controlled metering screw conveyor (inverter by others), conveying eductor, rubber abrasion resistant pneumatic conveying pipe and a conveying blower. The blower will be positioned outside the ATEX zone.

The surge hopper is mounted on load cells, which give a continuous indication of the hopper contents and is also used to calculate the reagent flow on a loss-in-weight basis. When the surge hopper requires re-filling, the silo discharge rotary valve operates to provide a batch of material for the surge hopper. The surge hopper is fitted with a metering screw conveyor, which runs continuously to dose the correct amount of PAC, via a conveying eductor injection system into the pneumatic conveying line. The blower then conveys the PAC to the reactor tower injection point.
We have excluded a spare blower.

3.9.2 Support Structure

A silo support structure is included.
Access to the silo roof will be from the filter stairtower, based on the silo being located close to the filter and filter stairtower. We have not included a separate stairtower for the PAC silo.

The silo roof includes kicking flats and double handrailing around its perimeter.
The supply and fabrication of the silo structure and ladder is included within our supply.

We have also allowed for weatherproofing for the metering equipment located underneath the silo. No weatherproofing for the top of the silo has been included.

3.9.3 Surface Finish

External surfaces of the silo and screw conveyors will be painted one coat primer, one intermediate coat and one top coat. The roof will be finished with a non-slip coating.
Stainless steel items (surge hopper) will be acid cleaned and washed.
Handrails will be shotblasted and galvanised.
The control panel will be painted.
Motors, valves will be the manufacturers standard paint finish.

3.10 Recirculation Conveying System

Particulate and used reagent are recovered in the fabric filter hoppers and transferred via three screw conveyors – each serving 2 filter hoppers – to a single chain conveyor which in turn transfers residue to a recirculation system located at one end of the filter.
Each filter hopper outlet will be fitted with a manual isolation valve.

To gain the maximum utilisation of the unreacted lime within the residue, the particulate and unused reagent that is collected by the filter is recirculated back to the reactor tower. To ensure a constant recirculation flow, a recirculation surge hopper is used.

Recirculation
The recirculation product typically contains Calcium Chloride ($CaCl_2$), Calcium Fluoride (CaF_2), Calcium Sulphite/Sulphate ($CaSO_3$/SO_4), Carbon Ash and unused Hydrated Lime ($Ca(OH)_2$). By re-injecting this residue, it ensures that all of the lime reacts with pollutants making the FGT plant more cost effective because less fresh lime is required.

By using a recirculation system any short-term spikes in emissions can be removed without having to adjust the lime feed rate; which can take time to show results.

Particulate and used reagent are recovered in the fabric filter hoppers and transferred via a mechanical conveying system described above to the recirculation surge hopper mounted at low level. The hopper has two outlets; one for the recycled product to be transferred back to the reactor tower, the other for residue (waste) product. Both outlets are incorporated into the hopper, each outlet having a screw conveyor fitted. The recirculation conveyor transports the product directly into the venturi section of the reactor tower whilst the residue conveyor periodically transfers material to a single residue storage silo using a dense phase conveying system.

The surge hopper will be designed so that when a 'shut down' occurs, the entire contents of the recirculation hopper can be removed to the bulk bag filling line.

A load cell based weighing system for the surge hopper will instigate the discharge of product to maintain the surge hopper weight between limits.

All the above items will be trace heated and thermally insulated and clad, all of which is included within our scope, specifically as described in section 3.6.3 above.

3.10.1 Support Structure & Access Platforms

The recirculation hopper will be supported from the integrated reactor and filter structure.
The hopper will require a local weatherproof cover located above the hopper, incorporated as part of the support structure.
The supply and fabrication of this structure and the weatherproofing items is included within our supply.

3.10.2 Surface Finish

External surfaces, which are to be thermally insulated, will be painted with 1 coat of primer.

3.11 Residue Conveying System

1 set of dense phase conveying equipment.

Residue product flow (Design, 'Case 2')	2610 kg/h
Residue product flow (Design, 'Case 2b')	1440 kg/h
Residue product flow (Maximum, 'Case 4')	3005 kg/h
Bulk density of residue product	500 to 600 kg/m^3 approximately.

The residue product will be transferred from the recirculation equipment firstly to a small reception hopper, fitted with aeration devices, which provides a head of material. Material will pass through a rotary blowing seal into a conveying line where a blower conveys the product to the residue silo.
We have excluded a spare blower but included the conveying pipework, bends, gaskets, fixings and associated pipe supports.

All the above items will require trace heating and thermal insulation and cladding to prevent corrosion due to cold spots forming moisture on the surface of the equipment. We have included the design, supply and installation of this equipment, specifically as detailed in section 3.6.3 above.

3.12 Residue Storage

1 silo including residue discharge equipment.

Residue Silo capacity	250m^3 net (~125 tonne) capacity
Residue product flow (Design, 'CASE 2b')	1440 kg/h (at 500 kg/m^3 density)
No of days storage capacity (Design, 'CASE 2b')	~4 days
Bulk density of residue product	500 to 1100 kg/m^3 approximately.

Residue product will be mechanically conveyed from the filter to the recirculation equipment with a portion being discharged to a dense phase conveying system.
A single 250m³ (approx. 125 Tonne) net capacity residue silo is included and is designed to accept residue product from the FGT pneumatic conveying system.

The silo will be constructed in mild steel suitably externally braced and strengthened with a single conical hopper manufactured in the same manner.

The silo incorporates a roof mounted filter unit, a manhole cover, under/over pressure vent, a level switch that gives a 'high-high' level alarm and a lifting davit. Also incorporated in the roof is the knock-out box/residue inlet flange for the pneumatically conveyed residue product.
A temperature probe will be fitted to the silo cone to indicate the residue temperature and ensure it is safe to unload the silo into the road tanker; an ash temperature of 60°C is the maximum temperature that can be discharged into a road tanker.

A bin activator will also be fitted to the silo hopper to promote efficient outflow of material. An air hammer may also be fitted to the silo hopper.
In addition, a series of load cells will be fitted to give an accurate assessment of the levels within the silo.

Residue discharge from the silo is via a rotary valve with a manual isolation valve and a pneumatic isolation valve above and a telescopic loading chute featuring a fan assisted integral filter, slack wire and closed position switches, and a rotating level switch. This enables the contents of the silo to be discharged to a standard UK road tanker. A local pendant type controller with a control box will be used to raise and lower the discharge chute.

The road tanker will position itself underneath the silo structure and the discharge equipment will convey residue to the tanker.

A discharge control local panel featuring pushbuttons for 'start filling' and 'stop filling', lamps for 'filling request' and 'filling complete', an alarm cancel/reset button and an isolator switch is included to control the road tanker filling. The silo weight will also be displayed on the front of the panel. The panel allows certain signals to interface with the plant PLC.

The silo hopper will require trace heating with the whole silo requiring to be insulated and clad, all of which is included within our scope, specifically as detailed in section 3.6.3 above.
The silo roof will be supplied as a double skin with insulation in between.

Support Structure & Access Platforms

We have included the supply of the silo support structure and an intermediate platform, required to gain access to the silo hopper and discharge valves. Also included is a ladder from floor to the intermediate platform.
We have included a ladder from the floor to the intermediate platform and ladders plus rest platforms from the intermediate platform to the top of the silo.
NOTE: We have not included a dedicated stairtower for the residue silo; ladders will be used for access to all areas of the silo.

The silo roof will include kicking flats and, as the silo is over 15 metres in height, triple handrailing around its perimeter with the full height fitted with in-filled mesh panels. This provides additional security for personnel and prevents loose debris, e.g. tools and dropped items, from falling to the ground level.

We have not allowed for weatherproofing for the silo roof.

Surface Finish

External surfaces, which are to be thermally insulated, will be painted with 1 coat of primer. Any surfaces which are visible will be painted one coat primer, one intermediate coat and one top coat.
The silo roof will be finished with a non-slip coating.

Handrails will be shotblasted and galvanised.

3.13 Induced Draught (ID) Fan

The ID fan is excluded from DPCT's scope of supply.

3.14 Thermal Insulation and Trace Heating

We have included the design, supply of trace heating equipment and local control panel(s) within our scope. The trace heating cables will be site installed and each circuit will be wired to a junction box. Positioning of the local control panels and subsequent wiring from each junction box to the respective control panel is excluded from our scope.

Also included is the supply and labour for site installation of all necessary insulating and cladding materials for the flue gas cleaning plant.

Trace heating is to be applied to some external surfaces of the flue gas treatment plant to maintain a surface temperature of approximately 125° C for the filter hoppers and to the complete recirculation and residue conveying equipment and for the residue silo.

The following areas will require trace heating to protect the waste product from condensation during plant operation and during shutdown:

- Whole section of the filter hoppers.
- Residue conveyors and rotary valves.
- Recirculation hopper and screw conveyors.
- Residue conveyors.
- Dense phase conveying vessel.
- Residue storage silo hopper section and first metre of the barrel section.

Local control panels should be included to provide control of the heating circuits. See section 3.17.3 for the anticipated number of panels required (subject to final design).

Each trace heating circuit will be fitted with a local surface RTD (PT-100) sensor which will be used to provide the plant PLC temperature signals which in turn gives a signal to local trace heating control panels. A 4-20mA transmitter for each RTD will be included in the trace heating control panels. Each individual circuit is to be enabled and disabled from the plant DCS.
The local panels should be designed to provide local indication of each circuit, shown on the front of the panel as 'running' or 'error' lamps. Exact method and requirements are to be discussed and agreed with Harris Pye.

The following areas will require thermal insulation using 100 mm thick mineral wool, clad with 0.7 mm thick colour coat steel sheet (unless stated otherwise).
Insulation to be a minimum 100 kg/m3 density for flat sections and 90 kg/m3 density for circular/curved areas.

- Inlet duct to reactor tower.
- Complete reactor tower.
- Filter unit casing and hoppers.
- All items for the residue conveying system (from filter hoppers to recirculation hopper).
- All items for the recirculation system.
- All items for the residue conveying equipment.
- Complete residue storage silo.

3.15 Support Structure and Access Facilities

We include the structural design, supply and fabrication of an integrated support structure and system of access ways, filter stairtower and ladders for the flue gas cleaning plant.

The structural design of the above will be signed by a qualified structural engineer.

The plant access facilities will be designed to integrate with the support structure where appropriate, and open mesh flooring will be provided to all access platforms. Access is required to all major points of regular maintenance as follows:

- Filter hopper conveyors, manual isolation valves and hopper access doors.
- Filter inlet isolation valves, located near the top of the filter hoppers
- Filter top access doors and filter compartment isolation valves (roof mounted). A perimeter platform at the top of the filter is required for access to the cleaning manifolds.
- Lime surge hopper and associated equipment (part of the lime silo structure).
- Residue discharge equipment.
- Recirculation surge hopper.
- Structure and access for the residue storage silo hopper and discharge valves (part of residue silo structure).
- Top of the lime, PAC silos.
- Top of the residue silo.

The lime and PAC silos support structures, platforms, access ladders with rest platforms as appropriate are included within our supply.
We also include the residue silo support structure, intermediate platform, all ladders and appropriate rest platforms.
A stair tower will be included for the filter unit to allow access to all areas of regular maintenance on the filter unit, with a possibility of access to the lime silo roof and PAC silo roof should the FGT layout permit.

A series of ladders will be required for the residue storage silo, from ground to the intermediate platform and then up to the top of the silo. We have not included a separate stairtower for this silo.

As detailed in section 3.6.5 a filter penthouse is also required together with cladding and associated items.

Weatherproofing for the lime and PAC metering equipment and for the recirculation equipment is also included.
No weatherproofing for the tops of the silos are included.

3.16 Exhaust Stack

We have excluded this from DPCT's scope of supply.

Emission monitoring equipment is also excluded.

3.17 Electrical and Control – FGT Plant

Voltage: 24 V – DC

We include all instruments for the FGT plant and anticipate that the following instruments will be required:

- Temperature transmitters - PT100 with 4-20mA transmitter including thermowell.
- Pressure indicators at inlet of the FGT system.
- Pressure transmitters – Piezo resistive type with 4-20mA transmitter.
- Differential pressure and pressure gauges for filter cleaning.
- Level probes - Capacitance and paddle type.
- Filter cleaning controller.
- Load cell weighing systems.

All instruments will be suitable for outdoor use.

3.17.1 Motors

Voltage: 400 V AC 3-phase
Frequency: 50 Hz ± 1%

All motors for the flue gas treatment system will conform to UK standards.

Some motors require variable speed drives which are excluded from our offer.

We have excluded all local motor isolation panels.

3.17.2 Process Control System

We have excluded the complete control system for the flue gas treatment plant however we do include the following control information to allow others to design and supply this part of the plant::

- Written FGT plant control philosophy.
- Process Flow Diagram.
- P&ID's
- Motor and heater list.
- Pneumatic consumer list.
- Instrument list.
- Valve list.
- I/O list.
- Field instrument connection diagrams.
- Alarm list and process set points.
- Termination schedule
- Electrical equipment location drawings.
- Layouts of local control panels (see section 3.17.3 for list of anticipated panels).

The distributed control system (DCS) is excluded from DPCT's supply.

3.17.3 Local Control Stations

A number of plant items will be supplied by DPCT with their own dedicated control panels, which allow an operator to control this equipment locally. The following plant items will have their own control panel:

- Filter cleaning controller.
- Fill control panel for the lime silo.
- Fill control panel for the PAC silo, including an Earthrite panel.
- Discharge control panel for the residue silo.
- Local panel for the residue silo discharge chute.
- Local emergency stop panel for the lime delivery motors.
- PAC load cell barrier panel (required for ATEX regulations)
- PAC explosion relief barrier panel (required for ATEX regulations)
- Trace heating control panels; either 2 or 3 separate panels.

3.17.4 Electrical Installation

We exclude the electrical installation of the FGT plant and site supervision during this period.
We have not included for wiring any equipment to local junction boxes as we expect that this will be carried out by the main electrical contractor.
The supply of junction boxes is also excluded from our supply, with the exception of the trace heating system, which will be supplied. Each trace heating circuit will be wired to a junction box by ourselves however wiring from these junction boxes to their respective local control panel is excluded.

3.18 Compressed Air System

The compressed air system is excluded from DPCT's scope of supply.

Air Quality:
Compressed air will be required at the following minimum quality rating:

Dry, clean and filtered to ISO8573.1 Quality Class 2:2:1 where:

- Dirt : Class 2: <1µm
- Water : Class 2: -40° C pressure dewpoint at 7 bar(g)
- Oil : Class 1: <0.01 mg/m^3 (including vapour)

Compressed air should be available to the FGT equipment 7 bar(g) to allow for transmission losses.

The compressed air supply should have sufficient capacity within the system to allow the FGT plant to be safely shut down in the event of power loss.

We have based our offer on the supply of all valves, air sets for each of our compressed air consumers. These are local to the equipment or will be supplied loose, to be incorporated into the pipework runs.

We have included all compressed air pipework, bends, tees, reducers and valves from a single take-over point within 1 metre of our plant to our compressed air local terminations. Installation of this pipework will be part of the mechanical installation (by others).
We would like to discuss the possibility of having a second termination point close to the residue silo as this item is detached from the rest of our plant.

No dedicated air receivers have been included.

3.19 Civil Works

This package is outside DPCT's scope of supply.

3.20 Wear and Spare Parts

We have included a provision for FGT commissioning spare parts but have excluded wear and strategic spares for the FGT plant within the main FGT scope.

Chapter 6 lists separately a proposal for Long Term Service Agreements and Lifecycle costs and this includes provision for spare parts.
This Chapter was sent previously and there may be minor variations when the scope of supply is finalised.

3.21 Mechanical and Electrical Installation and Supervision – FGT Plant

Our offer excludes all labour for the mechanical installation of the FGT plant but includes the site installation of trace heating, insulation and cladding work.

Regarding the on-site phase of the flue gas cleaning plant, we include for the following main elements:

- Site supervision during the FGT mechanical installation period. Our engineers will attend regular site progress meetings with Harris Pye and the end user, provide progress reports and participate in on site safety related matters.
- Site supervision during trace heating, thermal insulation and cladding of the FGT equipment.

In addition to the above, our offer is based on the following site services:

- Office facility for our own use will be provided by others.
- A mobile internet facility will be provided by others.
- Site facilities will be provided by others.

Our tender for the mechanical installation and site supervision of the flue gas cleaning plant is based on:

i) A normal working week, Monday to Friday between 07:00 and 18:00 hours.
Saturday between 07:00 and 16:00 hours.

ii) DP CleanTech Supervisors to be on site for a total of 25 weeks during the mechanical installation of the FGT plant. In this we anticipate mechanical installation to be 20 weeks. Trace heating and insulation work would be started during mechanical installation and will overlap with the mechanical installation by 5 weeks.

The total DPCT supervision period we have allowed for the above is therefore 25 weeks or 270 man days (1 man for 25 weeks during whole installation period, 1 man for 20 weeks during mechanical installation).

Note: We have based our offer on uninterrupted working. Any additional time over and above our stated 25 week total period for reasons outside the control of DPCT will be charged extra at the daily rates applicable at the time.

3.22 Commissioning – FGT Plant

Commissioning scope for the FGT plant is based on setting to work the DP CleanTech equipment and training of the Employers' operating personnel.

Our tender for commissioning of the flue gas cleaning plant is based on:

i) A normal working week, Monday to Friday between 08:00 and 18:00 hours.

ii) DP Clean Tech Commissioning Engineers to be on site for 8 weeks to carry out Cold Commissioning and sequence checks.

iii) DP Clean Tech UK Ltd Commissioning Engineers to be on site for 8 weeks to carry out Hot Commissioning.

iv) DP Clean Tech UK Ltd Commissioning Engineers to be on site for 3 weeks during performance testing.

The total DPCT commissioning period for the above is 19 weeks or 213 man days.

Note: Commissioning Engineers will not start work until the DPCT Site Supervisor is satisfied with all aspects of the FGT installation work and a mechanical & electrical completion certificate has been issued by Harris Pye and the end user.
Commissioning Engineers will remain on site until the plant is operational. We include a total of 8 weeks for Cold Commissioning and sequence checks and 8 weeks for Hot Commissioning, all based on uninterrupted working with all upstream equipment being operational and available during this period. However, our experience with other plants shows that this sequence can take longer and is dependent on other equipment being available. Therefore, any additional time over and above our stated 19 week total period for reasons outside the control of DPCT will be charged extra at the daily rates applicable at the time.

3.22.1 Sequence for Commissioning and Testing

We have based our offer on the following FGT commissioning sequence:

- At the end of FGT mechanical installation and electrical installation, the plant will be 'cold commissioned' to ensure the safe and correct operation of all motors, drives and instruments. We anticipate this to be complete in 5 weeks.
- Once cold commissioning is complete, there will be a period of 3 weeks for sequence checks to be conducted.
- We then expect that the plant will be hot commissioned, initially using burners only (refractory dry out). Filter bags will be installed (by others) after refractory dry-out.
- Following the installation of the filter bags, the FGT plant will now be 'hot gas' commissioned. We anticipate this to be complete in 8 weeks.
- A 3 week period for performance testing has been allowed.

3.23 Engineering and Documentation – FGT Plant

The services for the documentation of the FGT delivery packages are the following (but not limited to):

General documents:
- Document schedule listing all documents sent to Harris Pye.
- List of documents to be sent by date time (number of weeks from contract signing). This may be incorporated into the Document schedule or be a separate document.
- Design Plan, listing all relevant BS/EN/ISO standards and Harris Pye schedules.
- Project programme (in Microsoft Project).
- Technical Risk Assessment.
- Designer Risk Assessment.
- PAC DSEAR risk assessment.
- Internal HAZOP study for the FGT plant.
- RAMS for trace heating.
- RAMS for insulation and cladding.
- RAMS for commissioning.
- Progress reports.
- Construction procedure.
- Calculations, where necessary.

Basic design documents:

- Civil loading layout.
- Process Flow Diagram.
- Process and instrumentation diagrams (P&ID's).
- Layout, elevation and arrangement drawing of FGT plant.
- 3D plant layout.
- Structural design of the filter and reactor support structure, platforms and filter stairtower.
- Structural design of the lime and PAC silo support structures.
- Structural design of the residue storage silo support structure and intermediate platform.

Detailed engineering of:

- Reactor tower.
- Fabric filter; overall arrangement; compartment assembly; centre plenum arrangement.
- Steel structure, platforms, ladders and stairs, including weatherproofing. This will be in AutoCAD Inventor 2020, not a recognised Structural 3D package.
- Lime and PAC storage, metering and conveying equipment, including structure and weatherproofing.
- Recirculation and residue conveying equipment.
- Residue storage silo and discharge equipment.
- Dense phase conveying.
- Datasheets of supplied mechanical and electrical equipment.

Controls documentation:
Refer to section 3.17.2

QA documents:

- Quality Plan
- Test & Inspection schedules: overall for FGT plant; installation; commissioning.
- Test & Inspection schedules for specific plant items (filter, reactor, silos, residue conveying, trace heating, insulation).
- Supplier workshop inspection reports.
- Site inspection reports.
- Non-Conformance Reports.

Commissioning documents:

- Commissioning procedure.
- Commissioning fingerprint sheets.
- Performance testing.

The final documentation related to the delivery of DPCT's supply generally consists of:

- Operation and maintenance documentation.
- Training document.
- As-built documentation.
- Inspection, testing and Client approval.

3.24 Battery Limits – FGT Plant

Definition of the limits of DPCT's scope of supply:

Description	Beginning with	Ending with
Reactor tower	Complete unit, including inlet duct, terminating at an inlet flange.	Connects to the filter unit
Filter unit	Complete unit	Outlet flange of filter.
Lime storage silo	Fill pipe inlet	Silo baseplates (connecting to structure). Electrical terminations on local filling panel, load cell local display units.
PAC storage silo	Fill pipe inlet	Silo baseplates (connecting to structure). Electrical terminations on local filling panel, load cell barrier panel, load cell display unit, barrier panel for explosion relief panel.
Dense phase residue conveying and residue silo		Baseplate of silo support pads. Outlet of telescopic loading chute.
Compressed air supply	Client's single main compressed air termination(s) local to the FGT plant.	Pipework from Harris Pye's single take over point to each compressed air consumer.
Steel structure support for the FGT	Complete structure, access requirements	Ending at baseplates of all structures
Instrumentation	Cabling and cable routing from instruments	Ending at the instrument terminals. NOTE: we have not included for wiring from any electrical terminal to junction boxes. Supply of junction boxes is also excluded (but see trace heating for exception).
Trace heating	Heating cables for each circuit. Local control panels.	Trace heating cable junction boxes. Control panel terminals. NOTE: we have included for wiring from each circuit to a junction box. Supply of junction boxes is included. Excluded wiring from junction boxes to a local control panel.

3.25 Exclusions – FGT Plant

All packages highlighted as 'Client' in section 3.4.3 above, including the following components and services are excluded from DPCT's scope of supply, unless otherwise agreed:

Civil work

- All civil work, foundations, buildings, trenches, building services.
- Cast in foundation bolts, for others to cast into the foundation.
- Grouting of foundations.
- Site cleaning.
- Plant lighting.
- Ventilation.
- Permits and licenses including fees.
- General marking of plant outside scope supply limits.

FGT Mechanical plant

- Duct from Client's boiler/economiser to our reactor tower inlet duct section.
- Duct from filter outlet to ID fan inlet.
- ID fan, motor and acoustic enclosure.
- Duct from ID fan to exhaust stack.
- Exhaust stack.
- Emission monitoring equipment.
- Compressor package.
- Dedicated air receiver for the filter cleaning.
- Dedicated air receiver for the dense phase conveying (if required).
- Compressed air pipework, from compressors to a single termination point local to the FGT plant. Possibly a second termination point for the residue silo.
- Stair for the residue silo, we have included access ladders only.
- Separate stairs for the lime silo and for the PAC silo. We intend utilising the filter stairtower to access both silos, subject to plant layout.
- Weatherproofing for the tops of the silos.
- Spare blower for the lime conveying.
- Spare blower for the PAC conveying.
- Insulation for the filter penthouse.
- Filter and reactor pre-heat system.
- Wear and strategic spares (part of Chapter 6).

FGT Electrical and instrumentation

- DCS.
- Transformers, switchgear, distribution panels.
- Emergency generator and UPS.
- Motors and instruments outside DPCT's limits of supply.
- Plant lighting.
- Junction boxes (except for trace heating circuits).
- Local isolation boxes for all motors.

FGT Installation and commissioning

- All labour for the mechanical installation of the FGT plant.
- Scaffolding and all lifting equipment (MEWP's) for the mechanical installation of the FGT plant.
- Scaffolding and all lifting equipment (MEWP's) for the trace heating, thermal insulation and cladding work on site.
- Electrical installation of the FGT plant. Wiring from each motor or instrument or light fitting to junction boxes for any of our electrical equipment is excluded, with the exception of trace heating (see section 3.14 for details).
- Special measuring equipment for use at the guarantee test.
- Consumables during installation and commissioning, e.g. lime and PAC.
- Collection and disposal of FGT waste residue.
- Removal of scrap and general waste from site.
- Additional time over and above the timescales detailed in sections 3.19 (for supervision) and 3.20 (for commissioning) for reasons outside the control of DPCT.
- Additional time over and above the 3 week timescale for performance testing.
- Site services.

Health and Safety and Security on site

- CDM Principle Contractor role.
- CDM Principle Designer role.
- Responsibility for overall Health & Safety on site (we will be responsible for our own Health & Safety on site).
- Guarding entrance and site perimeter.
- Site fire-fighting services.
- Notices and signs on site.

Chapter 5

Responsibility Matrix

Flue Gas Treatment Plant

Client:	**Scandinavian Energy Contractor A/S**
Project Name:	Newport EfW Project
DPCT Project Code:	7140038
DPCT Document Ref.:	7140038-TS-OFR-2000-001-00
Pages:	8

Version	Date	Description	Author	Approved
00	2022-08-17	First Issue – Re-start Price	CBR	MC

RESPONSIBILITY MATRIX

General Responsibilities

Specific Responsibilities

The responsibility matrix in this section has not been updated from the original contract tender from August 2020. It is assumed that when the project re-starts, DP will continue to supply the same scope.

5 Responsibility Matrix

General Responsibilities

DP = DP CLEAN TECH UK C = Harris Pye

Item No	Item	Arranged by		Paid for by		Notes
		DP	C	DP	C	
1	**Authorisation**					
1.1	Planning permission and information to obtain.		X		X	
1.2	Environmental permit		X		X	
2	**Inspection and Testing during Manufacture.**					
2.1	Inspection/testing by DPCT	X		X		
2.2	Inspection/testing by Customer.		X		X	
3	**Transport and Delivery**					
3.1	Packing for transportation	X		X		
3.2	Transport of goods to site	X		X		
3.2	Insurance during transport	X		X		
3.4	Unloading at site.		X		X	
3.5	Reception of goods at site.		X		X	
3.6	Storage at site.		X		X	
3.7	Lay-down area		X		X	
3.8	Transport of goods within site.		X		X	
3.9	Access to site for plant and equipment.		X		X	
4	**Site Personnel and Establishment**					
4.1	Travel between accommodation and site.	X		X		Supervisors & commissioning
4.2	Hotel accommodation for site personnel.	X		X		Supervisors & commissioning
4.3	Parking area on site.		X		X	
4.4	Catering for site personnel.	X		X		Supervisors & commissioning
4.5	Mess facilities.		X		X	
4.6	Toilet and washing facilities.		X		X	
4.7	Office accommodation.		X		X	
4.8	Internet facilities.		X		X	
4.9	Connection points for 4.8.		X		X	
4.10	First Aid facilities.	X	X	X	X	
5	**The Works**					
5.1	Foundations and civil works.		X		X	
5.2	Dimension and level check 5.1.		X		X	
5.3	Cast in foundation bolts.		X		X	Anchor bars and pockets in concrete
5.4	Other foundation bolts.	X		X		Anchor bolts (loose)
5.5	Setting out DPCT equipment to reference dimensions.		X		X	
5.6	Primer painting.	X		X		
5.7	Finish painting.	X		X		
5.8	Touch-up painting.	X		X		
5.9	Grouting of foundations.		X		X	
5.10	Alterations to existing plant services (e.g., air, water, sewer)		X		X	
5.11	Protection of floor slab during construction and commissioning.		X		X	
5.12	'As-built' drawings.	X		X		
5.13	Demolition of existing plant.		X		X	
5.14	Modifications to existing buildings.		X		X	
5.15	Opening and closing of building for erection purposes.		X		X	

General Responsibilities (Continued)

DP = DP CLEAN TECH UK C = Harris Pye

Item No	Item	Arranged by		Paid for by		Notes
		DP	C	DP	C	
6	**Erection of DPCT Equipment**					
6.1	Cranage for off-loading.		X		X	
6.2	Cranage for erection.		X		X	
6.3	Ancillary lifting equipment.		X		X	
6.4	Electrical supply for small tools and lighting		X		X	
6.5	Welding equipment.		X		X	
6.6	Tools for erection.		X		X	
6.7	Supply, installation and demolition of scaffolding.		X		X	
6.8	Stores for tools and small items.		X		X	
6.9	Labour for mechanical erection.		X		X	
6.9 a	- trace heating; labour for mechanical installation	X		X		Excluding MEWPS and scaffolding
6.9 b	- positioning of trace heating local panels		X		X	
6.9 c	- insulation & cladding: labour for installation	X		X		Excluding MEWPS and scaffolding
6.10	Labour for electrical installation.		X		X	
6.11	Supervision of erection activities.	X		X		As defined in Tender (25 weeks)
6.12	Commissioning of FGT.	X		X		As defined in Tender (213 man days)
6.13	General plant lighting.		X		X	
6.13a	Plant lighting for filter penthouse (supply only)	X		X		
6.14	Point of use lighting.		X		X	
6.15	Crane studies and method statements		X		X	
6.16	Method statements for scaffolding and access equipment (including lifting strategy).		X		X	
6.17	Method statements and risk assessments for mechanical installation: - Filter - Reactor tower - Lime silo and metering, structure & access - PAC silo and metering, structure and access - Residue silo and discharge, structure & access. - Recirculation equipment - Residue conveying equipment - Compressed air pipework		X		X	
6.17 a	RAMS for trace heating installation	X		X		
6.17 b	RAMS for insulation and cladding installation	X		X		
7	**Consumables During Erection**					
7.1	Internet usage		X		X	
7.2	Ventilation.		X		X	
7.3	Welding consumables.		X		X	
7.4	Electrical supply.		X		X	
7.5	Oil and lubricants.		X		X	
7.6	Compressed Air.		X		X	

General Responsibilities (Continued)

DP = DP CLEAN TECH UK C = Harris Pye

Item No	Item	Arranged by		Paid for by		Notes
		DP	C	DP	C	
8	**Consumables During Plant Commissioning, Testing and Operation.**					
8.1	Reagent and adsorbent (lime & PAC).		X		X	
8.2	Electrical supply.		X		X	
8.3	Compressed air (dry, filtered and oil free).		X		X	
8.4	Steam	-	-	-	-	Not required
8.5	Process water.	-	-	-	-	Not required
8.6	Lubricants.		X		X	First fill by DPCT
8	**Consumables During Plant Commissioning, Testing and Operation.**					
8.1	Reagent and adsorbent (lime & PAC).		X		X	
8.2	Electrical supply.		X		X	
8.3	Compressed air (dry, filtered and oil free).		X		X	
8.4	Steam	-	-	-	-	Not required
8.5	Process water	-	-	-	-	Not required
8.6	Lubricants		X		X	First fill by DPCT
8.7	Disposal of all FGT residues.		X		X	
9	**Commissioning and Testing of Plant**					
9.1	Commissioning procedure for the FGT plant	X		X		As defined in Tender
9.2	Mechanical commissioning of FGT plant	X		X		As defined in Tender
9.3	Electrical commissioning of FGT plant		X		X	
9.4	Performance testing of FGT plant	X	X	X	X	As defined in Tender
9.5	RAMS for commissioning	X		X		
10	**Emission Testing**					
10.1	Third party emission tests.		X		X	
11	**Cleaning**					
11.1	DPCT site offices.		X		X	
11.2	Mess rooms.		X		X	
11.3	Toilets and wash rooms.		X		X	
11.4	Clearing and cleaning site of our materials before 'Take-over'.		X		X	
11.5	Removal of scrap and waste from site.		X		X	
11.6	Reagent, adsorbent and residue spillage.		X		X	
12	**Health and Safety and Security on Site.**					
12.1	Guarding entrance and site perimeter.		X		X	
12.2	Site fire-fighting facilities.		X		X	
12.3	Notices and signs on site.		X		X	
12.4	Responsibility for Health and Safety on the site.		X		X	
12.5	CDM Co-Ordinator		X		X	
12.6	CDM Principle Contractor.		X		X	
12.7	CDM Designer role.	X		X		
12.8	CDM Sub-contractor role.	X		X		
13	**Training of Customer's Personnel.**					
13.1	On-site during commissioning.	X		X		As specified in our Tender.
13.2	Formal classroom training for operators and supervisors.	X		X		As specified in our Tender.
13.3	Operating and Maintenance Manuals.	X		X		1 hard copy, 1 electronic
14	**Duties and Taxes**					
14.1	Import and other duties.		X		X	Where applicable
14.2	Local taxes.		X		X	Where applicable

Specific Responsibilities and Scope of Supply

DP = DP CLEAN TECH UK C = Harris Pye

Item No	Item	Basic Design	Detail Design	Supply	Install	Comm	Notes
1	**Mechanical Process Plant Equipment**						
1.1	Gas cooling equipment	C	C	C	C	C	Economiser
1.2	Gas scrubbing equipment	DP	DP	DP	DP	DP	
1.3	Fabric filter	DP	DP	DP	DP	DP	
1.4	Reactor tower	DP	DP	DP	DP	DP	
1.5	Reagent storage and handling (lime)	DP	DP	DP	DP	DP	Storage silo
1.6	Reagent recirculation equipment	DP	DP	DP	DP	DP	
1.7	Adsorbent storage and handling (activated carbon)	DP	DP	DP	DP	DP	Storage silo
1.8	FGT residue handling	DP	DP	DP	DP	DP	
1.9	FGT residue storage	DP	DP	DP	DP	DP	Storage silo
1.10	Humidification system	-	-	-	-	-	Not applicable
1.11	Ducting from economiser outlet to reactor tower inlet, including expansion compensator and supports.	C	C	C	C	C	
1.12	Duct from filter outlet to ID fan inlet including expansion compensator and supports.	C	C	C	C	C	
1.13	ID Fan and motor	C	C	C	C	C	
1.14	Noise attenuation equipment	C	C	C	C	C	For ID Fan
1.15	Exhaust stack	C	C	C	C	C	
1.16	Sampling platform for 1.15	C	C	C	C	C	
1.17	Continuous emission monitoring equipment (plant outlet)	C	C	C	C	C	
1.18	Continuous emission monitoring equipment (FGT plant inlet)	C	C	C	C	C	If required
1.19	Supporting structures for the FGT plant	DP	DP	DP	DP	DP	Where required
1.20	Access platforms for the FGT plant	DP	DP	DP	DP	DP	Where required
1.21	Access stairway for the FGT plant	DP	DP	DP	DP	DP	Stair tower for filter
1.21 a	Access stair for the residue silo	-	-	-	-	-	Ladders only for access
1.22	Access ladders for the FGT plant	DP	DP	DP	DP	DP	
1.23	Weatherproof enclosure for fabric filter	DP	DP	DP	DP	DP	Penthouse
1.24	Weatherproofing for the lime & PAC metering equipment	DP	DP	DP	DP	DP	
1.25	Weatherproofing tops of all silos	-	-	-	-	-	Excluded
1.26	Weatherproofing recirc equipment	DP	DP	DP	DP	DP	
1.27	Fabric filter top access door lifting equipment	DP	DP	DP	DP	DP	
1.28	FGT pre-heat equipment using ducts, external heater and fan	-	-	-	-	-	Not applicable
1.29	FGT filter pre-heat using trace heating cables (alternative to 1.25)	-	-	-	-	-	Not applicable
1.30	FGT gas by-pass system with isolation valves (external system)	-	-	-	-	-	Not applicable
1.31	Filter internal by-pass system	-	-	-	-	-	Not applicable
1.32	Thermal insulation of the FGT plant	DP	DP	DP	DP	DP	
1.32 a	Thermal insulation for penthouse	-	-	-	-	-	Not necessary
1.33	Cladding of the FGT plant	DP	DP	DP	DP	DP	
1.34	Trace heating of FGT plant items	DP	DP	DP	DP	DP	
1.35	Air compressor equipment	C	C	C	C	C	
1.36	Local air receivers (filter cleaning manifolds are supplied by DPCT)	C	C	C	C	C	If required (for dense phase system or for filter cleaning)
1.37	Fixings, gaskets, seals for the FGT plant	DP	DP	DP	DP	DP	
1.38	Labels and safety signs for the FGT plant	DP	DP	DP	DP	DP	
1.39	Foundation bolts for the FGT plant	DP	DP	DP	DP	DP	Anchor bolts (loose)
1.40	Instruments for the FGT plant	DP	DP	DP	DP	DP	
1.41	Central vacuum system for the FGT plant	-	-	-	-	-	Not applicable

Specific Responsibilities and Scope of Supply (Continued)

DP = DP CLEAN TECH UK C = Harris Pye

Item No	Item	Basic Design	Detail Design	Supply	Install	Comm	Notes
2	**Pipework**						
2.1	Valves and instrumentation	DP	DP	DP	DP	DP	Supply only
2.2	Pipework straights, flexible pipes, bends, tees, reducers, unions, connectors and supports.	DP	DP	DP	DP	DP	Supply only. Suitable for a single point takeover within 1 metre of the FGT plant. Possibly a 2nd termination close to the residue silo.
3	**Electrical Plant Equipment**						
3.1	Motor Control Centre (MCC)	C	C	C	C	C	
3.2	FGT control panel	C	C	C	C	C	
3.3	FGT PLC	C	C	C	C	C	
3.4	FGT Man Machine Interface (MMI)	C	C	C	C	C	
3.5	Field mounted instrumentation for FGT plant	DP	DP	DP	DP	DP	
3.6	Site wiring materials	C	C	C	C	C	
3.7	Junction boxes	C	C	C	C	C	
3.7a	Junction boxes for trace heating circuits	DP	DP	DP	DP	DP	
3.8	Wiring instruments, motors and other electrical equipment to junction boxes	C	C	C	C	C	
3.8 a	Wiring from each trace heating circuit to a junction box	DP	DP	DP	DP	DP	
3.8 b	Wiring from each trace heating junction box to a local control panel	C	C	C	C	C	
3.9	Earth bonding	C	C	C	C	C	
3.10	Mains incomer to the MCC and/or control panel	C	C	C	C	C	
3.11	Inverter drive for ID fan	C	C	C	C	C	
3.12	Inverter drives (other than ID fans)	C	C	C	C	C	
3.13	Thyristors for plant heaters	C	C	C	C	C	
3.14	Plant lighting	C	C	C	C	C	
3.14 a	Light fittings in filter penthouse	DP	DP	DP	DP	DP	Supply only
3.15	Lightning protection	C	C	C	C	C	
3.16	Local Control Panels for:-						
3.16.1	Fabric filter cleaning controller	DP	DP	DP	DP	DP	
3.16.2	Reagent storage silo (road tanker filling)	DP	DP	DP	DP	DP	
3.16.3	Reagent storage silo (load cell display panel)	DP	DP	DP	DP	DP	
3.16.4	Reagent storage (load cell display panel for buffer hoppers)	DP	DP	DP	DP	DP	
3.16.5	Adsorbent storage (PAC silo)	DP	DP	DP	DP	DP	
3.16.6	Adsorbent storage silo (load cell display panel)	DP	DP	DP	DP	DP	
3.16.7	Barrier panel for PAC silo load cells	DP	DP	DP	DP	DP	
3.16.8	Barrier panel for PAC silo rupture device(s)	DP	DP	DP	DP	DP	
3.16.9	Residue conveying (dense phase)	-	-	-	-	-	Not required
3.16.10	Residue silo (road tanker discharge)	DP	DP	DP	DP	DP	
3.16.11	Residue silo discharge chute panel	DP	DP	DP	DP	DP	If required
3.16.12	Trace heating local panels (number to be determined)	DP	DP	DP	DP	DP	
3.16.13	Local emergency stop for lime delivery	DP	DP	DP	DP	DP	
3.16.14	Local isolator panels for motors	C	C	C	C	C	
3.17	Positioning and securing of all above local panels	C	C	C	C	C	

Specific Responsibilities and Scope of Supply (Continued)

DP = DP CLEAN TECH UK C = Harris Pye

Item No	Item	Basic Design	Detail Design	Supply	Install	Comm	Notes
4	**Spare Parts**						
4.1	Spare parts during DP UK commissioning	DP	DP	DP	-	-	
4.2	Operational spares for the FGT plant	DP	DP	DP	-	-	2 years operation. Defined as items necessary for day to day maintenance of the FGT plant. Separate price to be given.
4.3	Wear spares for the FGT plant	DP	DP	DP	-	-	2 years wear spares. Separate price to be given.
4.4	Strategic spares for the FGT plant	DP	DP	DP	-	-	Defined as items essential to minimise plant outages due to breakdown. Separate price to be given
4.5	Spare blower for lime conveying	-	-	-	-	-	Excluded
4.6	Spare blower for PAC conveying	-	-	-	-	-	Excluded

Technical Specification

M&S UMWELTTECHNIK

Project: Newport, GB

Project. No.: 20052RF

Customer: Joulon

SNCR Plant with urea solution as reagent incl. storage area for a Waste-to-Energy Plant

Rev. 03

03	18.02.21	DvdH		DvdH	Guarantees & Consumptions
02	03.02.21	DvdH			Miscellaneous
01	22.01.21	DvdH	PL	DvdH	Adjusted guarantees and consumptions
00	26.08.20	KE	DvdH	DvdH	
Rev.	Revison Date	Created by	Checked by	Approved by	Description
Revision History					

Table of Contents

1 General System Overview

The SNCR technology relies on the reductive properties of ammonia-based chemicals like urea and ammonia water. The SNCR process of M&S removes nitrogen oxides (NO_X) by injecting an aqueous solution of urea with special additives (NOxAMID) or ammonia water into the flue gas stream of a combustor. In both cases molecular nitrogen and water vapour are formed according to the overall post-combustion reaction.

All the reaction products are natural components of the atmosphere. The temperatures where significant NO_X-reductions are obtained, range from approx. 870 – 1050° C. This temperature window depends on the flue gas composition and whether urea or ammonia is used as reagent. Especially CO and O_2 (who shift the temperature window to the left side) and SO_2 (who shift the temperature window to the right side) have a major impact on the necessary temperature window.

This document the main design data and technical details of our commercial offer for above mentioned project.

Main Components	Details
Storage Area	40 m³ GRP tank, double-walled 2 submersible circulation pumps
Mixing and Metering Module	24 (3x8) lances
Temperature Measurement (Option)	1 acoustic temperature measurement system (agam), one level with 8 transceiver units OR 1 optical temperature measurement system with 8 pyrometers
Process Control System	PLC-system Siemens S7
Interconnecting Piping	By client
Cabling	By client
Erection	By client

2 Design Data

The offered scope of supply and services is based on the below mentioned design data.

2.1 Flue Gas Data

All values relate to STP (0°C, 1013 mbar)

Description	Unit	Normal Load 16 MJ/kg fuel case	Maximum Continuous Rate (MCR) 11 MJ/kg fuel case	Normal Load 8 MJ/kg fuel case	Overload (110%) 16 MJ/kg fuel case	Overload (110%) 11 MJ/kg fuel case	Overload (110%) 8 MJ/kg fuel case
Boiler load	%	100	100	100	110	110	110
Flue gas, wet	Nm³/h	141.899	158.894	172.189	156.088	174.784	189.406
Flue gas, dry	Nm³/h	124.133	138.079	144.208	136.546	151.887	158.628
O_2, wet	%	6,8	6,8	6,8	6,8	6,8	6,8
O_2, dry	%	7,7	7,8	8,1	7,7	7,8	8,1
H_2O	%	12,5	13,1	16,3	12,5	13,1	16,3
CO_2, dry	%	10,91	12,42	12,94	10,91	12,42	12,94
SO_2, dry	%	0,05	0,06	0,06	0,05	0,06	0,06
NOx – daily average (dry, @ 11 Vol.-% O_2)	mg/Nm³	460	460	460	460	460	460
~~**NOx – half hour average** (dry, @ 11 Vol.-% O_2)~~	~~mg/Nm³~~	~~450~~	~~450~~	~~450~~	~~450~~	~~450~~	~~450~~
Flues gas temperature at injection point	°C	950 – 1050 °C					

Notice:
A NOx peak of 500 mg/Nm³ is possible as long as the daily average does not exceed 400 mg/Nm³

2.2 Specification Operating Supplies

2.2.1 Reagent – Urea Solution

The reagent is used to dissolve the nitrogen oxide concentration in the flue gases by a chemical reaction to N_2 and H_2O.

Specification:

Product name:	NOxAMID 45®
Chemical name:	Urea solution, approx. 45 wt.-%
Density:	1.116 kg/m³
pH-Value:	~ 9
Boiling temperature:	106 – 110 °C
Crystallisation point:	+11 °C
Flash point:	N/A
Ignition temperature:	N/A
Explosion limit:	N/A
Colour:	colourless
Odour:	faint NH_3 odour
Shape:	liquid
Water hazard according to WHG*:	WGK 1
Temperature:	approx. 10 – 30 °C

**WHG: Wasserhaushaltsgesetz: German water resources law*

2.2.2 Demin water (Deionat)

The reagent is diluted with demin water (deionat, full desalted water, distilled water, pure water) to insure an effective droplet distribution over the injecting cross section at any NO_X baseline value. The transfer point is at the Mixing and Metering Module.

Quality according to VGB - R 450 L respectively DIN EN 12952-12 salt free feed water with a conductivity < 0,2 µS/cm and SiO2 < 0,02 mg/l.

Pressure:	6,0 bar at the Mixing and Metering Module
Temperature:	approx. 10 – 30 °C

2.2.3 Compressed air

The compressed air (6 bar g) is used for atomizing the diluted reagent and for the control of various components inside the SNCR system. For the control air to the fittings, compressed dried air (instrument air) without oil is necessary. The transfer point is at the Mixing and Metering Module.

Instrument air	
(ISO 8573-1:2001 Class 3)	
Pressure:	6,0 bar at the Mixing and Metering Module
Temperature:	approx. 10 – 40 °C
Pressure related dew point:	- 20°C

Compressed air	
Pressure:	6,0 bar at the Mixing and Metering Module
Temperature:	approx. 10 – 40 °C

2.2.4 Electrical energy

AC Voltage:	400 V, 50 Hz, 3 Ph

2.3 Guarantees and Consumptions – daily average

Description	Unit	Normal Load 16 MJ/kg fuel case	Maximum Continuous Rate (MCR) 11 MJ/kg fuel case	Normal Load 8 MJ/kg fuel case	Overload (110%) 16 MJ/kg fuel case	Overload (110%) 11 MJ/kg fuel case	Overload (110%) 8 MJ/kg fuel case
Boiler load	%	100	100	100	110	110	110
NOx Clean (dry, @ 11 Vol.-% O_2)	mg/Nm³	120					
NH_3 slip at stack outlet (dry, @ 11 Vol.-% O_2)	mg/Nm³	10					

Consumables							
Urea solution (45%), approx.	kg/h	285	315	320	312	345	353
Demin water (6 bar), approx.*	kg/h	740	710	705	715	680	675
Compressed air (6 bar), approx.	kg/h	350					
Electrical Consumption (400 V, 50 Hz) ○ per Mixing and Metering Module approx. ○ per feeding pump approx. ○ per demin water pump approx.	kW	3 0,25 1,1					

**)Total media consumption is ~120l/h per lance and stays constant. The water consumption results in the difference between total amount and ammonia water.*
*(Demin water = Number of lances * 120 l/h – ammonia water)*

2.4 Design standards and regulations

The following legislation, guidelines and standards are being taken into account, in their valid versions and as far as applicable, during the planning and the construction of the system:

- EN 12952-14 common ammonia-specific design standard
- EN 13445 / EN 13480 for pressurized parts
- DIN EN 1092 for flanges
- All applicable DIN standards concerning design and construction of containers and pipelines
- VDE regulations concerning electrical work
- Accident prevention regulations as issued by the German employer’s liability insurance association (UVV)
- WHG (German water resource law)

3 Scope of supply

3.1 Unloading Station for Urea Solution

The unloading station consists of a filling pipe connected to the storage tank, shut-off valves, filling hose connectors and the necessary monitoring devices. The hose connection between the road tanker and the filling pipe belongs to the road tanker equipment and is not part of the delivery. The necessary pressurized air for unloading is produced by the tank trucks compressor.

Technical details:

Filling Pipe:	approx. 15 m Pipeline
Safety Device:	level-limit switch according to pertinent directive (WHG*)

Pcs.	Equipment
1	Ball valve, manual operation
1	Ball valve with pneumatic actuator, safety self-locking
1	Level-limit switch

**WHG: Wasserhaushaltsgesetz: German water resources law*

3.2 Storage Tank for Urea Solution

The storage area for urea solution comprises mainly a tank with following technical data.
The tank will be erected on a concrete foundation supplied by the buyer.

Technical details:

Number of tanks:	1
Tank type:	upright tank, double walled
Pressure:	pressureless
Location:	outside
Diameter:	approx. 3.400 mm
Height:	approx. 5.200 mm (without railing and top connections)
Contents:	40 m^3
Net weight:	approx. 3.800 kg
Material:	GRP with chemical resistant coating accord. to WHG
Media:	Urea Solution up to 45 wt.%

Pcs.	Equipment
1	Manhole for inspection, DN 800
1	Filling level measurement
1	Overfill safety device acc. to WHG
1	Temperature measurement
1	Leakage monitoring system
1	Ascension ladder made of hot galvanized steel
1	Roof edge railing made of hot galvanized steel
1	Heating and insulation
1	Local control panel for unloading (IP 66)
	All muffs required for operation and safety controls
	Tank vents

3.3 Feed Pumps (submersible) for Urea Solution

With the redundant Urea solution feed pumps, the reagent is circulated from the storage tank through a pipeline via a pressure control valve and back into the tank. From this pressurized loop a pipe branches off to the Mixing and Metering Modules.

Technical details:

Number of pumps:	2 (2 x 100%)
Type:	submersiblee pump
Main Material:	stainless steel
Capacity:	approx. 1,0 m³/h
Differential pressure:	approx. 10 bar
Drive capacity:	approx. 1,5 kW, 400 V, 50 Hz (per pump)

Pcs.	Equipment
2	Submersible feeding pumps
1	Pressure gauge (remote transmission)
2	Pressure gauges (local)
1	Pressure relief valve
	Miscellaneous valves

3.4 Mixing and Metering Module

The Mixing and Metering Module contains measurement devices for all mediums required to operate the SNCR system (reagent, dilution water, compressed air) as well as all settings (automatic and manual) of pressure and flow. This module also mixes the reagent and dilution water and distributes this mixture and the atomizing air to the injectors. All parts are mounted on a frame construction, which is installed in a cabinet with transparent doors to protect it against damages and dirt. The Mixing and Metering Module is placed nearby the injection level.

Technical details:

Number of boilers:	1
Modules per boiler:	1
Injection levels:	3
Lance outlets (per boiler):	24 (3x8)
Material:	316L (1.4404) / St 37 / glass
IP:	55

Pcs.	Equipment per Module
1	Flow meter with remote data indicator for reagent
1	Flow guard with remote data indicator for demin water
1	Flow meter for remote data indicator for compressed air
1	Pressure control valve for compressed air
1	Control valve with pneumatic drive for reagent
8	Local flow meter for lance outlets mixture
24	Pneumatic ball valves for lance outlets mixture
	Miscellaneous valves and strainers
	Miscellaneous pressure gauges (local)

3.5 Injection Lances Distribution System

The injection lance distribution system consists of the injectors with manual shut off valves and flexible hoses. With the injectors the diluted reagent is evenly distributed into the flue gas. Depending on the size of the cross section of the incinerator, several injectors are installed. Each injector enters the incinerator through an injector port with a flange connection and a rapid-action coupling.

The lances are equipped with an outer mixing chamber where the reduction fluid is atomized by pressurized air. The diluted reagent will pass one or more outlets at nozzle at the tip of the lance. The quantity and direction of these nozzles are designed according the injection geometry. The media (air/reagent-water mix) are transported to the lances through flexible steel hoses. This allows easy mounting and dismounting without removing pipe connections.

The injection lances are wearing parts because on the strength of the high strain / of the high thermal and chemical strain. They must be checked and cleaned regularly.

Technical details:

Number of lances	24
Material	1.4571 / 2.4602 / 1.4841 or similar Nozzle: 2.4602 or similar

Pcs.	**Equipment (per lance)**
2	Flexible hoses with manual shut off ball valve (for mixture and pressurized air) and rapid action couplings
1	Flange connection with rapid action coupling

3.6 Process Control System

All process-relevant data (flow rates, pressures, switching status, boiler data, etc.) are collected and evaluated in the customer's process control system.

Whereas the air flow rates are set manually during commissioning, the reducing agent volume is calculated on the basis of the flue gas volume, NO_X and O_2 content of the stack gas using programmed calculating formulae, then sent to the regulating valve as the set value. The control unit also realizes operating, blocking and adjustment (including power drives) for all system functions. The control unit also realizes operating, blocking and adjustment (including power drives) for all system functions.

At least 10% of I/O cards are considered as reserve.

Optional: Redundant CPU

Technical details:

Number of control cabinets	1
IP:	66
Process control and signal evaluation:	PLC, programmable logic controller S7 with signal exchange via bus (Profibus)

Process visualisation and operation:

- Operation via operation panel at the control cabinet (MMI/HMI) – Supplied by M&S
- Visualization in Clients DCS (Not scope of M&S)

With an optional temperature measurement system, the flue gas temperatures can be measured constantly close to the area where the injectors are installed. The temperatures of different sections of the cross section of the furnace are transferred to the PLC by means of 4 - 20 mA signals. Depending on the temperatures, each injector of the injection levels can be switched separately to follow the temperature changes in the respective section caused by load changes. With the process control based on temperatures the SNCR system can always be operated at optimum temperatures so that the consumption of reagent and the ammonia slip will be minimized.

3.7 Acoustic Gas Temperature Measurement (agam) - OPTION

The agam system is an online temperature measurement system which uses the temperature dependency of the speed of sound to provide a 2-D temperature profile. It basically consists of transceiver units located at the furnace openings, a control unit with an external signal processing unit and an evaluation unit for calculating and displaying temperature information, data archiving and data out-put to the plant DCS. The transceiver measure path temperatures between each other which are used to calculate the 2-D temperature profile.

The scope of supply includes:

- Configuration of the interface to the DCS. Various interfaces are available to provide all data (path temperatures and zone temperatures, averages, deviation of temperatures, alarms) as analogue outputs or digital values. Possible interfaces are for example 4-20 mA, Profibus, OPC, data file interface for graphic images or industrial ethernet. Integration or connection of an external monitor to display temperature information in the control room (details must be specified).
- Field services for final installation and system start up incl. expenses for travel and lodging. This includes the connection of the cables provided by the customer. It includes the delivery and installation of the cables from the piezo microphones and the solenoid valve to the transceiver enclosures. These cables will be installed in protection hoses. It is possible to start up and support the system set up via telephone modem, too.

Pcs.	Equipment	Description
8	Transceiver unit	Each transceiver includes waveguide (acoustic horn), piezo sensor, enclosure with preamplifier, solenoid valve, protection hoses with conduits for cables between waveguide and preamplifier enclosure.
8	Transition adapters	Conical adapters for each transceiver unit
8	Flexible Hoses	Flexible hoses for pressure air supply for each transceiver, 1m
1	Control unit	Siemens PLC S7-300. Controls the transceiver valves and records the acoustic signals from the preamplifiers of transceiver units. The acoustic signals are digitized and send to the signal processing unit. A switch with fibre optical serves for the connection to the signal processing.

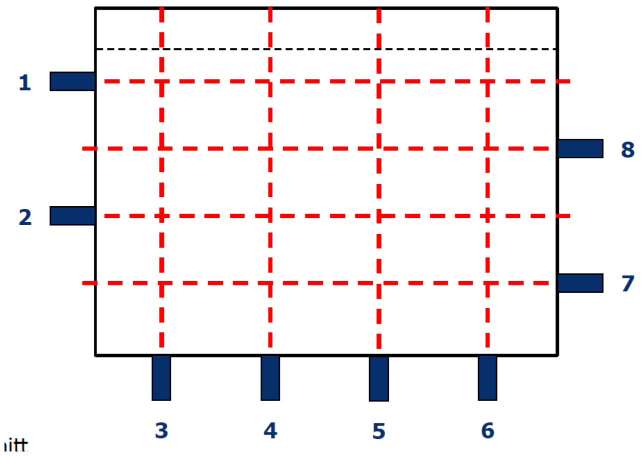
1	Signal processing unit	Industrial computer (Dell T/R 5600), which processes the signals from the control unit and computes the path temperatures by means of special correlation techniques. The unit serves for calculating, archiving and displaying temperature information e.g. path temperatures, zone temperatures, 2D temperatures profiles and calculated values.
1	Client PC (Scope of M&S)	Is connected to the signal processing unit and serves as interface for the control and diagnosis of the measurement system. Allows complete access to the data from the signal processing unit and is designed to be the human-machine interface of the system and also displays temperature information, two-dimensional profiles and status screens.

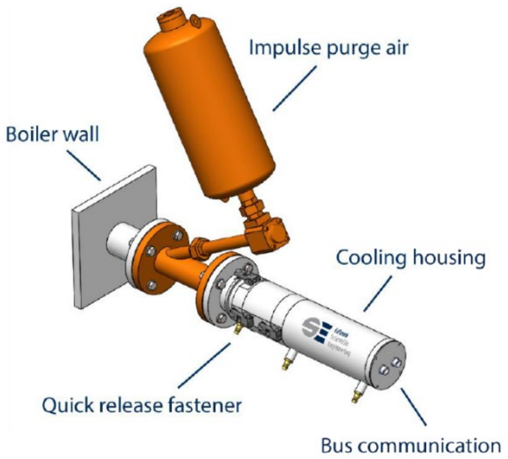
3.8 Optical Temperature Measurementn – OPTION

Optical temperature measurement systems determine the flue gas temperature by detecting and analysing the temperature depending radiation of CO_2 molecules in the flue gas.
Each pyrometer measures an average temperature which can be used to calculate a 2-D temperature profile or be used alone to control the injection lances.

The scope of supply includes:

Pcs.	Equipment	Description
8	Pyrometers	Sensors for measuring the flue gas temperature
8	Cleaning Devices	Compressed air tanks for cleaning the sensors and boiler openings of deposits by using periodically induced air blasts
0	Sensor Cooling	For ambient air temperatures higher than 60°C the pyrometers need to be cooled. The cooling device is integrated in the compressed air supply of each sensor.
1	Connector Box	Communication and signal converter for pyrometers to the interface unit
1	Media Supply Box	Microfilter and safety valves for compressed air
1	Interface Unit	Power supply and signal exchange with control room at the boiler
1	Client Terminal and 2D Software	Data acquisition, system control, visualisation and temperature mapping. Possibility for remote control access for quick support.





3.9 Interconnecting Piping (by client)

The interconnecting piping includes the following (not in scope of supply of M&S):

- unloading pipeline from the unloading station to the tank (DN65 PN10)
- Circulation pipeline from storage tank to the Mixing and Metering Module with a loop back to the storage tank (DN20 PN10, stainless steel). The circulation pipeline is equipped with all necessary armatures and measuring instruments
- Supply pipeline for demin water (DN20 PN10, stainless steel) and pressurized air (DN25 PN10, steel or stainless steel) between the deposit position and the Mixing and Metering Module.
- Supply pipes from Mixing and Metering Module to the injectors for atomizing air and reducing agent.

<u>Note</u>

- The piping inside the Mixing and Metering Modules is in the scope of supply of M&S.
- All necessary armatures and measuring devices, which have to be installed in the pipelines, are delivered by M&S.
- Flexible hoses between the pipelines (urea solution, compressed air) and the injection lances are in the scope of supply of M&S.

3.10 External Cabling (by client)

Only the cabling inside the Mixing and Metering Module is in the scope of supply of M&S.
All cabling between field devices and sub-distributors, sub-distributors and terminal box and power supply to the drives are in the scope of supply of the client.

The boiler control signals (NO_X, O_2, temperature, boiler load, etc.) as well as the power supply will be delivered and connected to the PLC by the buyer (if applicable).

4 Scope of Services

4.1 Basic Engineering

The following documents will be provided during Basic Engineering:

- Description of process and system
- Injection geometry
- Technical specification of system components
- Lists of electrical consumers, valves and instruments
- I/O list
- Interface list
- Time schedule with all important project phases
- Safety data sheets plus handling and safety information pertaining to reagent

4.2 Detail Engineering

The documents described above will be updated and completed during detail engineering. In addition, the following documents will be provided:

- Definition of the injection level, based on temperature measuring or calculation
- P&I scheme with measurement point list
- Dimension sheets for all main components
- Operating handbook in English*
- Logic diagram / Control philosophy
- Electrical drawings
- 2D/3D drawings of equipment
- Support for civil design (loading data)
- Support for HAZOP via remote (Teams, Zoom etc.), works at site at daily rates.

** Final revision of operations handbook shall be written up following completion of commissioning*

4.3 Erection supervision

This item includes the supervision for assembly and installation of all deliveries under chapter 3. Mounting aids such as hoists, working platforms, stages, etc. are not included in the scope of services rendered by the clien.

Should the assembly period extend for reasons M&S is not responsible for, the additional costs must be borne by the client.

4.4 Commissioning

Commissioning of the SNCR system is divided into four main phases:

- Test runs of individual system components
- Test run and flushing of entire system with water and air
- Commissioning of the system with reagent
- System optimization

Following system optimization, the acceptance test begins, during which guarantees concerning emissions and consumption values stated in chapter 2 are to be confirmed. The duration of the acceptance test is to be coordinated with the client.

5 Exclusions

The delivery and performance items not covered in chapter 3 and 4 are not included in the scope of delivery of the seller.

These items include in particular:

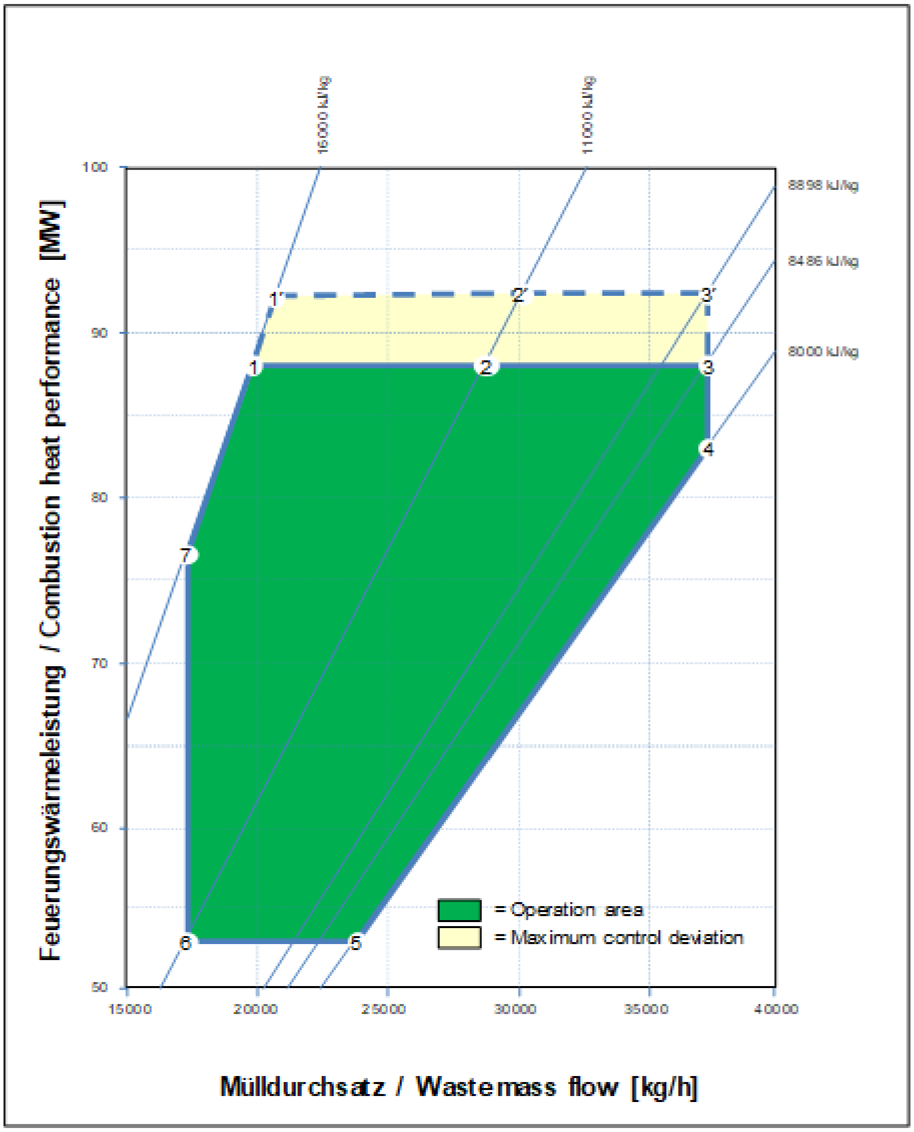
- All earth, foundation and construction work
- Steel constructions, pipeline bridges and stairway constructions
- Interconnecting piping
- Interconnecting cabling
- Insulation and heating of pipes
- Installation and erection at site
- Required openings in boiler
- Mounting aids such as hoists, working platforms, stages
- All emission measurement and analysis devices
- Earthing and lightning protection equipment
- Wear and Replacement parts
- Fire extinguisher and other related equipment
- Lighting and electric outlets
- Ventilation, heating and air-conditions systems
- Applications for submission to authorities as required
- Ordering of necessary expertise
- Payment of test fees, personnel and material costs for 3rd party test institutes, permitting agents and alike
- Sanitary facilities
- All operation media such as reagents, process water, electricity and pressurized air
- Telephone extension / ISDN / DSL or the like
- Charges because of special fabrication requirements
- Signs for armatures and instruments
- All items not mentioned in our offer
- Delivery (ex-works)

6 Drawings

P&ID Storage Area	Drawing no.:	20052RF TL001_Rev.00
P&ID Mixing and Metering Module	Drawing no.:	20052RF MM001_Rev.00

MITSUBISHI POWER	Combustion diagram Study Load Increase WtE Newport	Date: 15.09.2022 Rev.: 00.00 Page: 1

Dok.-Nr.:



Load point Lastpunkt -	Heat value Heizwert [kJ/kg]	Throughtput Durchsatz [kg/h]	Performance Leistung [MW]	Load Last [%]
1	16.000	19.800	88,0	100
2	11.000	28.800	88,0	100
3	8.486	37.332	88,0	100
4	8.000	37.332	83,0	94
5	8.000	23.760	52,8	60
6	11.034	17.226	52,8	60
7	16.000	17.226	76,6	87
1´	16.000	20.724	92,1	105
2´	11.000	30.197	92,3	105
3´	8.898	37.332	92,3	105

Projekt: **Study Load Increase WtE Newport**

Projekt-Nr.: