Environmental Visage

KRIGER 2.0 MW_{th} BIOMASS BOILER INSTALLATION
MCP/SG ENVIRONMENTAL PERMIT APPLICATION
JCG HALE LIMITED
JUNE 2019

Description of the Installation

JCG Hale Ltd proposes to install a biomass boiler at its new site on the outskirts of the Milland Road Industrial Estate, Neath. The installation will incorporate a Kriger 2.0 MW_{th} biomass boiler, supplying approximately 2.0 MW of thermal energy in the form of 125ºC hot water for use in space heating and drying operations carried out on site. The facility also incorporates an Organic Rankine Cycle (ORC) electrical generator, that will generate approximately 110 kW of renewable electricity for use on-site and for export to the local distribution network. The Kriger 2.0 MW_{th} biomass boiler and associated equipment will be located within an existing building that will be modified to accommodate the biomass boiler and ancillary equipment.

The Kriger 2.0 MW_{th} biomass boiler will burn virgin timber offcuts generated by on-site timber processing activities. The fuel feed-rate to the boiler will be approximately 525 kg/hr, depending upon the moisture content and calorific value of the fuel. Although the biomass fuel to be burned is classified as a waste, it is considered to be exempt waste under the Industrial Emissions Directive (IED), and the operation of the biomass boiler would ordinarily be subject to regulation by Neath Port Talbot County Borough Council as a Part B process. However, as the thermal rating of the boiler is greater than 1 MW_{th} and incorporates an ORC, the biomass boiler is also classified as a Medium Combustion Plant (MCP) and a Specified Generator (SG). Therefore, the operation of the boiler will be subject to regulation by Natural Resources Wales (NRW), and the application is submitted on this basis.

The biomass boiler will be supplied by Novalux Energy Solutions Ltd and its technology partner Woodtek Energy Ltd, and is based upon moving grate stoker-fired technology developed in the Ukraine by LLC Boiler Factory "Kriger", Zhytomyr. A copy of the biomass boiler technical brochure is appended to this document.

Regulatory Classification of the Kriger 2.0 MW_{th} Biomass Boiler Installation

The following discussion relates to the most apt description of the combustion process and the waste-derived fuel to be burned by JCG Hale Ltd.

DEFRA is currently consulting on new process guidance for the incineration of waste wood, and the following discussion incorporates certain aspects of the new draft guidance, which although is not currently implemented, it is expected to be formalised in the near future.

The new guidance no longer refers to categories of waste wood as Grade A, Grade B, etc., but instead refers to specific European Waste Codes (EWCs) that can be burned under a Part B environmental permit, as reproduced over page.

Table 4.1: Acceptable waste codes

European Waste Classification Codes	Description	Further restriction
02 01 03 02 01 07	Plant tissue waste from agriculture, horticulture and forestry	
03 01 01	Waste bark and cork from wood processing and the production of panels and furniture	No chemical treatments applied.
03 01 05	sawdust, shavings, cuttings, wood, particle board and veneer (1) other than those mentioned in 03 01 04	No chemical treatments applied. (1) Only veneer that is fixed to the board.
03 03 01	Waste bark and wood from pulp, paper and cardboard production and processing	No chemical treatments applied.
15 01 03	Wooden packaging	Visibly clean wooden packaging including pallets, no chemical treatments applied.
19 12 07	Wood other than wood containing hazardous substances (19 12 06) from waste management facilities	Source segregated visibly clean single waste wood streams such as pallets, where no chemical treatments have been applied.
		Post segregation of mixed waste wood streams from civic amenity sites or skip hire operators is not sufficient.

Boilers burning the wastes specified in the above Table are exempt from the requirements of Chapter IV of the Industrial Emissions Directive, as applied to waste incineration plant.

The guidance goes on to say that "*For the avoidance of doubt, any waste wood which has been classified as hazardous waste or any waste wood originating from construction and demolition works cannot be incinerated / combusted in a 5.1 Part B appliance.*"

The Kriger 2.0 MW_{th} biomass boiler will burn offcuts from on-site virgin timber processing activities, which are classified as EWC 03 01 05. None of the biomass fuel to be burned in the Kriger 2.0 MW_{th} biomass boiler will be sourced from off-site waste wood recycling operations, and only exempt wood waste generated on-site will be burned as fuel.

As the timber offcuts to be burned in the biomass boiler at JCG Hale Ltd is a waste, it will be subject to regulation under the Environmental Permitting Regulations (England and Wales) 2016, as a waste incineration activity.

Part A(1) activities are regulated by the Environment Agency and include the following processes:

> *Part A(1)*
> *(a) The incineration of hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 10 tonnes per day.*
> *(b) The incineration of non-hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 3 tonnes per hour.*
> *(c) The incineration, other than incidentally in the course of burning landfill gas or solid or liquid waste, of any gaseous compound containing halogens.*

The timber offcuts to be burned as fuel in the Kriger 2.0 MW_{th} biomass boiler is non-hazardous, but with a maximum burning rate of about 525 kg/hr it falls below the threshold for a Section 5.1 Part A(1)(b) waste incineration or waste co-incineration plant. The corresponding Part B scheduled activities, that are subject to local authority regulations include the following:

> *(a) The incineration in a small waste incineration plant with an aggregate capacity of 50 kilogrammes or more per hour of the following waste;*
> *(i) vegetable waste from agriculture and forestry;*

> *(ii) vegetable waste from the food processing industry, if the heat generated is recovered;*
> *(iii) fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and the heat generated is recovered;*
> *(iv) cork waste;*
> *(v) wood waste with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coatings;*
> *(vi) animal carcasses.*

The timber offcuts to be burned as fuel in the Kriger 2.0 MW_{th} biomass boiler will not contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coatings. Furthermore, it will comprise waste wood with an EWC that is acceptable for use in a Section 5.1 Part B combustion/incineration appliance.

Accordingly, as only this material will be burned as fuel then the Kriger 2.0 MW_{th} biomass boiler should be classified as a Section 5.1 Part B(a)(v) waste incineration plant.

None of the fuel to be burned in the Kriger 2.0 MW_{th} biomass should be classed as non-exempt biomass, and the Kriger 2.0 MW_{th} biomass boiler should not be classified as a Schedule 13 small waste incineration plant (SWIP), described as follows.

> *1.—(1) This Schedule applies in relation to -*
> *(a) every small waste incineration plant, and*
> *(b) every new waste incineration plant or new waste co-incineration plant, to which Chapter IV of the Industrial Emissions Directive applies, except those which are operated as a domestic activity in connection with a private dwelling.*
> *(2) It applies from 7th January 2014 in relation to every existing installation that is a waste incineration plant or waste co-incineration plant and to which Chapter IV of the Industrial Emissions Directive applies, except those which are operated as a domestic activity in connection with a private dwelling.*

Part B waste wood facilities are regulated by the local authority and are subject to the requirements of Secretary of State's Guidance Note PG 5/1(18). Emissions from the Kriger 2.0 MW_{th} biomass boiler must also comply with emission limit values specified in PG 5/1(18) for the following pollutants:

- Oxides of Nitrogen (NO_X);
- Sulphur Dioxide (SO_2);
- Particulates;
- Carbon Monoxide (CO); and,
- Volatile Organic Compounds (VOCs).

The Kriger 2.0 MW_{th} biomass boiler has been designed to be fully compliant with the technical requirements of PG 5/1(18).

However, as the thermal rating of the boiler is greater than 1 MW_{th}, the biomass boiler is also classified as a Medium Combustion Plant (MCP), and the incorporation of an ORC generator means that in addition, the plant is a Specified Generator (SG). As such, the operation of the boiler will be subject to regulation by Natural Resources Wales (NRW). The emission limit values in PG 5/1(18) were revised in the draft version of the Process Guidance Note to bring them in line with the requirements of Annex II, Part 2, Table 1 of the Medium Combustion Plant Directive (MCPD), and as the emission limit values for SG are less stringent, it is anticipated that the limit values specified in PG 5/1(18) will prevail.

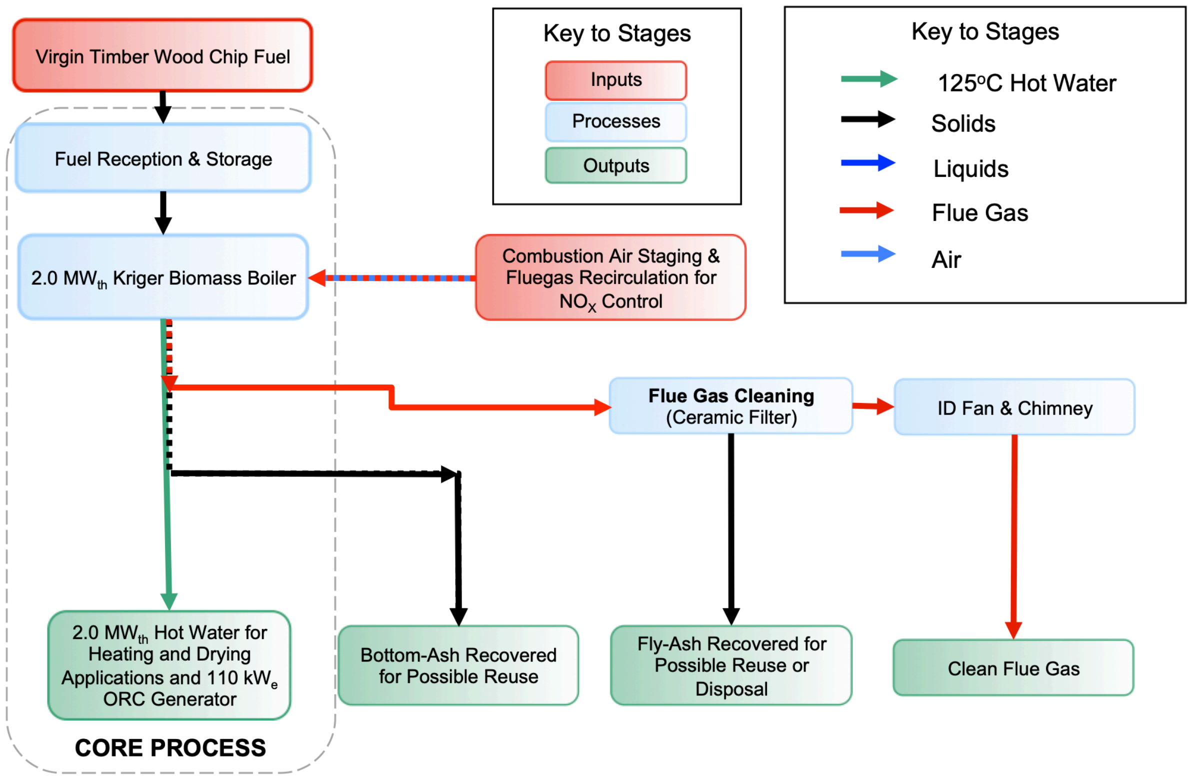
Activities Associated with the Operation of the Kriger 2.0 MW_{th} Biomass Boiler

The principal activities carried out within the Installation are as follows:

- Virgin timber offcut collection and chipping;
- Wood chip fuel reception, storage and handling;
- Combustion of biomass fuel with associated recovery of heat in the form of 125ºC hot water for distribution to the associated on-site buildings and the ORC generator:
- Flue gas clean-up to remove particulates (high efficiency ceramic filter);
- Emission to atmosphere via a 16 metre high chimney;
- Collection of bottom ash and fly ash for subsequent utilisation or disposal; and,
- 110 kW_e Organic Rankine Cycle (ORC) power generation unit.

The main activities associated with the operation of the Kriger 2.0 MW_{th} biomass boiler is summarised in the following process flow diagram (PFD).

FIGURE 1 – PROCESS FLOW DIAGRAM

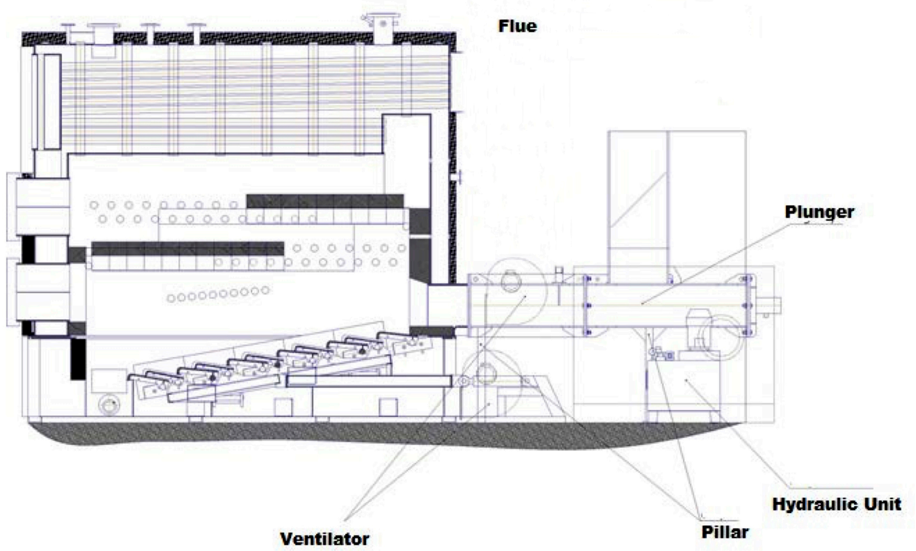


The key features of the Kriger 2.0 MW_{th} biomass boiler are summarised below:

- Moving grate combustion system to ensure even processing throughout the combustor for improved efficiency;
- Computer control to ensure stable combustion at low and high output levels, and to facilitate automatic turndown to as little as 30% of design capacity;
- Self-cleaning heat exchanger to ensure that the biomass boiler works at optimum efficiency at all times;
- Combustion air staging to minimise the formation of Oxides of Nitrogen;
- Flue gas recirculation system to control combustion temperatures and minimise the formation of Oxides of Nitrogen;
- High efficiency ceramic filter to control particulate emissions;
- Independently verified thermal efficiency of 87.8% ±2%;
- Provision of both forced draught (FD) and induced draught (ID) fans to ensure stable, efficient combustion conditions;
- Supply of 125°C hot water to a 110 kW_e ORC power generation unit, with associated supply of 125°C hot water to on-site space heating and process operations;
- A 16-metre high chimney to ensure effective dispersion of pollutant emissions.

A schematic representation of the Kriger 2.0 MW_{th} biomass boiler is provided in the following figure.

FIGURE 2 – SCHEMATIC REPRESENTATION OF THE KRIGER 2.0 MW_{th} BIOMASS BOILER



The Kriger 2.0 MW_{th} biomass boiler will be installed within an existing building on site that will be modified to accommodate the biomass boiler and ancillary equipment, as shown in the layout plans appended to the application.

The Kriger 2.0 MW_{th} biomass boiler has been designed to comply with the principles of Best Available Techniques (BAT) for the combustion of biomass fuels, and incorporates a range of monitoring and control features to optimise combustion and the associated recovery of thermal energy from the wood chip fuel, while at the same time minimising pollutant emissions and the generation of solid residues.

Fuel Reception, Storage and Handling

Wood chip fuel for the Kriger 2.0 MW_{th} biomass boiler will be prepared on site by chipping the virgin timber offcuts generated by the on-site manufacturing processes. The wood chip fuel will be prepared within the fully enclosed main process building and then transferred to the fuel store, which incorporates a walking floor and moving bulkhead storage area. The fuel storage bay has a capacity of up to about 100 tonnes.

The whole area within the building housing the boiler and its ancillary equipment, including the fuel storage area, will be laid to concrete to provide an impermeable base which prevents the ingress of moisture into the base of the fuel stockpile. Site personnel working in this area will be provided with relevant personal protective equipment (PPE) to minimise exposure to airborne dust generated by the handling of the wood chip fuel. The fuel storage area will have sufficient capacity to store enough fuel for up to a 7-day period, assuming continuous 24-hour operation of the biomass boiler at full load.

It is envisaged that the maximum period of time that fuel will be stored on site will be for about three months, however, as the fuel will be undercover and dry, there is a very low potential for anaerobic degradation to take place during extended storage.

Fuel is extracted from the fuel storage area via moving floor conveyor. Sweepers placed on the storage floor beams, pick up fuel and transfer it to the conveyor which then feeds the fuel into the boiler. The fuel recovery and delivery rate are controlled as required and specified by the PLC controller.

A plunger, driven by a hydraulic ram at certain time intervals pushes fuel into the feed channel. Fuel delivery frequency is defined automatically according to the boiler load factor. Fuel transition through the feed channel (always filled) is the final stage before fuel combustion in the furnace. In the normal position, the plunger moves forward to close the feed channel to prevent penetration of flame from the combustion chamber into the fuel storage. For loading, the plunger first moves back to make room for a portion of fuel in the channel; it then pushes fuel up to the "forward" mark.

When the plunger moves backwards, the protection against flame penetration is performed by a shutter, which is located on the plunger chute immediately after the conveyor. The shutter is driven by a simple cylinder and in a default position it is closed. Closure of the shutter is performed by a counterweight, which ensures a fire barrier, even in the absence of electrical supply.

Two infrared level sensors ensure that there is a sufficient amount of fuel in the plunger chute, then the conveyor stops and the shutter closes. The level sensors are periodically cleaned with compressed air.

Biomass Combustion

The wood chip fuel feed system and the combustion process within the boiler is controlled by a programmable logic controller (PLC) in accordance with the measured and calculated values from a number of sensors, via control and safety logic. A schematic representation of the internals of the Kriger 2.0 MW biomass boiler is shown on Page 4 of this document.

Primary air is blown from beneath the grate to different sections of the grate in accordance with the different phases of fuel transformation associated with drying, pyrolysis and combustion of carbonaceous residues.

Primary combustion air is delivered at the front end of the boiler beneath the grate, while secondary combustion air is introduced above the grate via a series of channels in the refractory lining prior to entry into the first section of smoke tubes, to obtain the correct air-to-fuel ratio, as determined by a residual Oxygen (lambda) sensor located in the boiler exhaust.

The wood chip fuel is ignited initially by manual ignition. Once combustion is established, the fire bed is self-sustaining. The Kriger 2.0 MW_{th} biomass boiler is fully modulating, both in terms of fuel and air feed-rates, and can operate down to about 30% of maximum continuous rating (MCR) without any significant loss in efficiency. It should be noted that the planned usage for the Kriger 2.0 MW_{th} biomass boiler is expected to be at 100% of MCR when in use, or switched off when not required.

The Kriger 2.0 MW_{th} biomass boiler utilises a step grate system to transfer the fuel along the length of the primary combustion zone of the boiler. Wood chip fuel is introduced to the front end of the boiler where moisture is initially driven off and the temperature increases to about 350ºC where de-volatilisation of the wood chip fuel begins to occur.

Smoke emissions from the chimney during the initial ignition phase are minimal due to the low combustion air volumetric flowrates, and control of the available Oxygen levels by the lambda probe, which in turn modulates the speed of the exhaust fan. The burning fuel continues to move along the grate and the volatiles that are released burn above the bed of fuel and pass into the secondary combustion zone of the boiler, while the resulting char passes on down the grate where it is exposed to higher concentrations of Oxygen (a higher air:fuel ratio) to promote complete combustion of the less reactive char. At the end of the grate the bottom ash residue falls into an ash quench zone, with an ash chain conveyor, that extracts the ash from the boiler and deposits it into a closed metal receiver for disposal.

Combustion gases rise from the grate and are mixed with secondary air to ensure complete combustion prior to discharge from the boiler. The internal dimensions of the secondary combustion zone of the biomass boiler provide a residence time of about 3.5 seconds, based upon the volumetric flowrate of the flue gas generated by the combustion of the wood chip fuel. A copy of the residence time calculation is appended to this document. From here the gases pass through a three-pass heat exchanger. A water jacket surrounds the boiler and provides the initial recovery of heat, with the fire tube heat exchanger providing second and third stage heat recovery from the system.

Flue gas exits the heat exchanger at a much reduced temperature and then passes to a high efficiency ceramic filter where virtually all of the fine particulate matter is removed. The filter is provided with a differential pressure monitor across the filter and will automatically clean down the filter elements as required. If the pressure monitoring detects a fault with the filter, either blockage or failure of a filtration element, then the PLC initiates a “Critical Alarm” and the boiler is shut down automatically, and will lock-out the boiler preventing restart. The operator will be advised by an appropriate alarm text on the control panel, and must take appropriate action and then positively confirm this alarm before the boiler can be placed back into service.

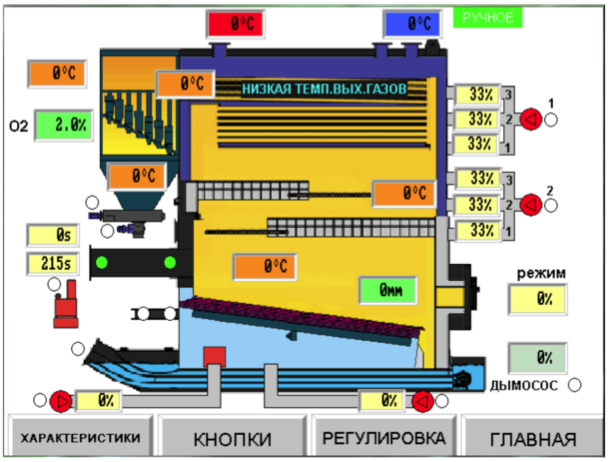
Flue gas exiting the ceramic filter passes through an induced draft exhaust fan and then into a twin-wall insulated chimney. The induced draft fan ensures correct volumes and pressures into the chimney (and hence efflux velocity) whenever the boiler is in operation. The chimney has been designed to provide effective dispersion of pollutant emissions produced by the combustion of the wood chip fuel. The 16-metre height of the chimney was confirmed by a D1 chimney height calculation and detailed atmospheric dispersion modelling, the reports for which are appended to the application.

During shutdown of the boiler, flue gas will continue to be discharged via the ceramic filter until the wood chip fuel is completely burned out, or the temperature falls below the dewpoint temperature where condensation of water vapour may occur. During a controlled shutdown, the fuel feed is stopped, but the boiler continues to operate the induced draft and combustion air fans to fully burn out the fuel while the boiler is still at operational temperatures. During shutdown, the wood chip fuel will have completed the de-volatilisation stage while the combustion chamber refractory temperatures are significantly elevated, which will ensure the complete combustion of any material evolved from the grate. While the combustion chamber temperatures are elevated, virtually no visible smoke emissions will be present. There should be little to no fuel remaining in the boiler by the time the combustion chamber temperatures reduce to levels where visible smoke would be produced and hence the period over which smoke may be discharged will be very limited.

The boiler has an automatic cleaning system which cleans the heat exchangers by means of compressed air, to blow the ash deposits from the heat exchange surfaces, with the ash falling into the de-ashing system.

The operation of the Kriger 2.0 MW_{th} biomass boiler is fully automated. In the event of any faults occurring with the boiler or associated equipment, the boiler will automatically shut down to a safe condition and await attendance by a trained operator to restore the boiler into service. Various safety circuits and fail-safe devices continuously monitor the boiler state and provide control and safety response to any developing issues. The boiler is controlled via a full colour touch screen interface, providing the operator with detailed current and historic information on operating conditions.

FIGURE 3 EXAMPLE OF THE TOUCHSCREEN INTERFACE CONTROL



The Kriger 2.0 MW_{th} biomass boiler will generate approximately 2.0 MW_{th} of hot water at a temperature of 125ºC for distribution to on-site heating and drying applications, and approximately 110 kW of renewable electricity in the directly associated ORC electrical generator.

Organic Rankine Cycle (ORC) Power Generation Unit

ElectraTherm's SS-6500 Power+ Generator produces emission-free power from low grade waste heat using the Organic Rankine Cycle (ORC) and proprietary technology. A copy of the SS-6500 technical brochure is appended to this document. The principal components of the Power+ Generator are the twin-screw expander, the induction generator, and the non-toxic, fully-enclosed, system working fluid.

Twin Screw Expander

The SS-6500 Power+ Generator uses a twin-screw expander as its power block; which effectively is a compressor operating in reverse. The twin-screw expander design is robust and simple. The operating speed of the SS-6500 Power+ Generator is relatively low (< 5,000 RPM) and does not require a gearbox to drive the generator.

A significant advantage of the twin-screw expander is the ability to operate in two phase, or "wet" conditions. This two-phase operation means that the refrigerant does not have to be 100 % vapour. The ability to operate in a range of working fluid conditions from superheat to wet vapour allows the SS-6500 Power+ Generator to follow variable heat loads and produce power over a wide range of input conditions.

Induction Generator

An induction generator is electro-mechanically similar to an induction motor. In the case of the SS-6500 Power+ Generator, the induction generator is based on a 70 to 100 horsepower (approximately 50 to 75 kW) squirrel cage motor with some internal optimisation to make it more efficient as a generator. In the event of a loss of the grid connection, the unit will automatically shut down, and cannot be re-started until line conditions return to normal.

Working Fluid

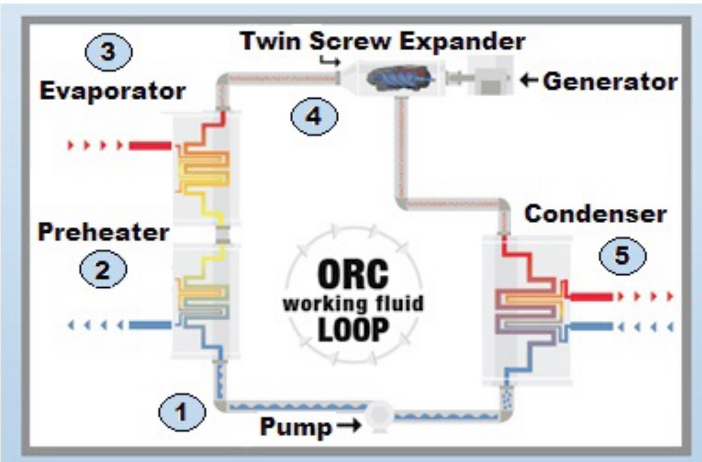
The working fluid used in the SS-6500 Power+ Generator is the compound HFC-245fa (1,1,1,3,3 Pentafluoropropane). HFC-245fa is an EPA-approved member of the Hydro-Fluorocarbon (HFC) family of refrigerants, permitted under the Montreal Protocol. This non-flammable, low toxicity, environmentally safe fluid boils at approximately 15.5°C, at atmospheric pressure. HFC-245fa is ozone safe and generally safe to handle. The oil used for lubrication is contained in the working fluid as part of ElectraTherm's proprietary in-process lubrication.

System Operation

The SS-6500 Power+ Generator ORC system operation can be broken down into five steps, which are represented in the diagram below. These steps are:

1. Working fluid is pumped to higher pressure and transferred to the preheater.
2. The temperature of the working fluid is increased in the preheater and sent to the evaporator.
3. Heat captured by the evaporator boils the working fluid into pressurised vapour.
4. The vapour flows through the twin screw expander, spinning an electric generator to produce power.
5. The vapour is cooled and condensed back into a liquid in the condenser to repeat the cycle.

FIGURE 4 POWER+ GENERATOR ORC SYSTEM



Foreseeable Emissions

The Kriger 2.0 MW_{th} biomass boiler has been designed to modulate between full output and 30% of maximum continuous rating (MCR), although planned usage will involve the boiler operating predominantly at 100% MCR, and emissions will be fully controlled and minimised.

The boiler will operate under the terms and conditions of a Part B environmental permit which requires compliance with the following pollutants, as specified in Table 5.4 of Secretary of State's Guidance Note PG 5/1(18) for the combustion of waste wood, which are identical to those in the MCPD.

Table 5.4 Emission limits values for plants with a rated thermal input of 1 MW or more, but less 5 MW

Substance/ Parameter	Emission Limit Value (mg/Nm^3)	Type of plant	Minimum monitoring frequency
Carbon Monoxide	225	All plant	Annual Extractive
Dust	90	Existing plant until 31st December 2029 (1)	Annual Extractive
	50	New plant and existing plant form 1st January 2030 (2)	Annual Extractive
Oxides of Nitrogen	600	Existing plant	Annual Extractive
	500	New Plant	Annual Extractive
TVOC	30	All Plant	Annual Extractive
HCN (3)	7.5	All Plant	Annual Extractive
Formaldehyde (4)	7.5	All Plant	Annual Extractive
Smoke	Ringlemann Shade 1	All Plant	Daily when in operation

(1) Existing plant – means a combustion plant put into operator before 20th December 2018.
(2) New plant – means a combustion plant put into operation after 19th December 2018.
(3) Only applicable when melamine faced woods are in the fuel.
(4) Only applicable when plywood, chipboard and fibreboard woods are in the fuel.

The reference conditions for these emission limit values are, 273.15 K, 101.3 kPa, dry and 6% O_2.

The emission limit values for HCN and Formaldehyde don't apply to the JCG Hale Ltd biomass boiler as the fuel to be burned is virgin timber wood chip, generated from on-site manufacturing processes.

The combustion of the virgin timber wood chip fuel will give rise to the conventional pollutants that are associated with all combustion processes, namely, Oxides of Nitrogen (NO_X), Particulates, Carbon Monoxide (CO) and Volatile Organic Compounds (VOCs). The latter two are enhanced when conditions of incomplete combustion occur, however, the monitoring and control systems incorporated into the Kriger 2.0 MW_{th} boiler will ensure that combustion efficiency is maximised at all times, and the formation of CO and VOCs is minimised.

The principal pollutant emissions associated with the combustion of the virgin timber wood chip fuel are expected to be NO_X and Particulates.

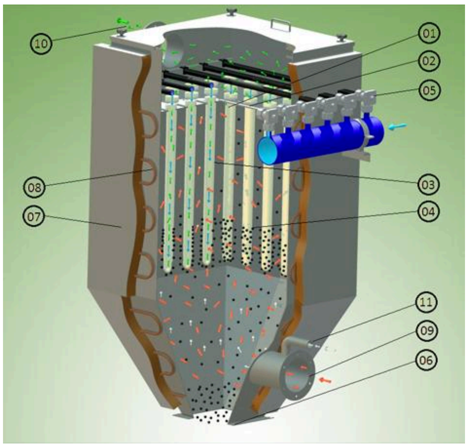
Emissions Control

The Kriger 2.0 MW_{th} boiler is equipped with control systems to minimise the formation and subsequent release to atmosphere of all pollutants prescribed for control by Secretary of State's Guidance Note PG 5/1(18) and the MCPD. Effective preventative maintenance and cleaning of the boiler internals will contribute to achieving compliance with emission limit values.

The secondary combustion zone is provided with side headers for distributing the combustion air to enhance the combustion process - (for minimising emissions of CO which might otherwise occur due to low oxygen combustion). This "air staging" also assists in minimising the formation of NO_X, and is controlled by the O_2 lambda probe when the boiler is operating across the range of firing rates. Flue gas recirculation also assists in controlling combustion temperatures on the grate, as well as minimising the formation of NO_X. This will ensure that concentrations of NO_X are at all times within the 500 mg Nm^{-3} emission limit value. The Kriger 2.0 MW_{th} boiler will operate primarily at 100% MCR, and whenever the boiler is producing heat, the fuel supply will be continuous.

Particulate emissions from the process will be minimised by means of a high efficiency ceramic filter on the exhaust from the biomass combustor. The ceramic filter is illustrated schematically below, and further details are appended to this section.

FIGURE 5 SCHEMATIC OF THE CERAMIC FILTER SYSTEM



- The ceramic filter element (1) hangs vertically from header plate (2) within the filter vessel. The header plate separates the filter's clean and dirty compartments.
- Hot gas is drawn through the filter medium (3) from outside to inside.
- Particulates and dry scrubbing sorbents are collected on the outer surface (4) of each filter element. These consist of the PM_{10}, $PM_{2.5}$ size ranges, and these agglomerate.
- The particles are removed from the element by reverse jet cleaning (5). This reversal of air flow causes the accumulated solids to be detached from the outer surface of the ceramic filter elements.
- The particulates and spent dry-scrubbing sorbents are discharged through the hopper outlet (6) for collection and disposal.
- The filter body can be protected with insulation (7) and can be trace heated (8) to prevent the formation of condensation when the equipment is not in use.
- Incoming gas stream (9) and sorbent (if required).
- Outgoing cleansed gas stream (10)

The ceramic filter is capable of reducing incoming particulate emissions by as much as 99.9 %, ensuring that there are no visible emissions of smoke or dust from the biomass boiler. The filter will be equipped with a differential pressure sensor that will detect blockages or potential damage to the filtration media, which will trigger a visual and audible alarm on the control panel if the pressure deviates outside of pre-set control parameters that will be defined at the commissioning stage.

If the pressure monitoring detects a fault with the filter, either blockage or failure of a filtration element, then the PLC initiates a “Critical Alarm”, requiring the immediate attention of an operator. In the event that the operator does not respond then the boiler will be shut down automatically, and will lock-out the boiler preventing restart. The operator will be advised by an appropriate alarm text on the control panel, and must take appropriate action and then positively confirm this alarm before the boiler can be placed back into service.

The ceramic filter will be supplied with a performance guarantee, stating that it is capable of controlling particulate emissions to within 10 mg Nm^{-3} limit at all times. A copy of the performance guarantee will be available for inspection if required. A copy of the manufacturer’s brochures for the ceramic filter are appended to this document.

The chimney of the Kriger 2.0 MW_{th} biomass boiler has been designed to provide effective dispersion of pollutants generated by the combustion of the wood chip fuel. The dimensions of the chimney were determined in line with a D1 calculation, to determine the height, diameter, and associated efflux velocity, to ensure that emissions are not entrained by any building downwash effects that may be generated by the passage of the prevailing winds over the adjacent buildings. Regular cleaning of the flue and associated ductwork will be undertaken to minimise the build up of deposits.

The results from detailed atmospheric dispersion modelling confirmed that a chimney height of 16-metres would provide effective dispersion of emissions from the chimney of the Kriger 2.0 MW_{th} biomass boiler. A copy of the results from the D1 calculation and detailed atmospheric dispersion modelling assessment is included in Appendix 3.

Instrumentation

The Kriger 2.0 MW_{th} biomass boiler is equipped with a number of instruments to monitor temperature and flue gas Oxygen concentration at strategic locations throughout the system. Instruments are installed to provide continuous information to the facility's PLC (Programmable Logic Controller) which monitors and adjusts key operational parameters to ensure efficient combustion of the virgin timber wood chip fuel at all times.

The instruments supply data to the PLC-based process control system overseen by SCADA supervisory control. This controls the process and derives key metrics for optimisation and monitoring of the combustion process by shift personnel.

Monitoring

The concentration of Oxygen is monitored continuously in the duct exiting the combustion chamber in order to monitor combustion efficiency of the wood chip fuel. The Oxygen concentration is measured using a lambda Oxygen sensor.

The lambda probe is based upon a Zirconia probe measurement technique that is used routinely for measurement of Oxygen concentrations in flue gas associated with a wide range of combustion processes. The output from the lambda probe is monitored continuously by the PLC controller, and deviation above or below set limits initiates an adjustment to the dampers to increase / decrease the availability of combustion air to the fuel burning on the moving grate and the above-bed combustion of volatiles released by the burning of the wood chip fuel.

In line with the anticipated requirements of their Environmental Permit, JCG Hale Ltd will rely on periodic measurements undertaken every year to demonstrate compliance with the prescribed emission limit values. To enable compliance check monitoring to be undertaken, the chimney of the Kriger 2.0 MW_{th} biomass boiler will be equipped with sample ports comprising two 4" BSP sockets complete with screw caps and installed at 90 degrees to each other. The sample ports will be installed at a location in the chimney that is at least 5 x the flue diameter downstream of the nearest bend, and more than 2 diameters from the exit of the chimney. This is in accordance with the requirements of Environment Agency Technical Guidance Note M1 and British Standard BS-EN15259.

The location of the sample ports will ensure that a full traverse on both sampling planes can be achieved during the annual compliance monitoring programme that will be a condition of the Environmental Permit. Temporary sampling platforms will be erected to enable full and unfettered access to the sample ports by the specialist contractors appointed to undertake the compliance monitoring programme.

Training

On-site staff will be trained for routine interventions and response to alarm conditions from the boiler, which involves checking the boiler operating status and alarm status. Training will be conducted by the boiler commissioning engineers, details of the personnel involved will be recorded and operator training certificates will be issued.

Any detailed interventions required will either be conducted by Novalux Energy Services Limited trained personnel, or a suitably trained third-party agent. If using a third-party agent, this person will have detailed training by the commissioning engineers, and a certificate will be issued. The boiler's PLC will be password protected with different permitted access according to the user level, such that untrained personnel will be unable to operate the boiler.