

OTNOC

Introduction

The TEGCO Immingham Ltd Installation at Netherlands Way, Stallingborough, Grimsby, DN41 8DF is an Energy from Waste (EfW) process. The installation is designed to consume 320,000 Te/yr of Refuse Derived Fuel (RDF) based on 10 MJ/kg (LHV), producing: -

- 12 MW electrical export,
- 51 MW thermal export (60 Te/hr) as steam (no condensate return).

The installation is a Combined Heat & Power (CHP) plant sized and is designed to replace the steam and electricity currently generated by an existing CHP plant on an adjacent industrial plant. The existing CHP plant is reaching the end of its operational life and will be decommissioned when the installation is operational.

The need to continue to take waste in the event that steam and/or electricity cannot be exported (e.g. customer is shutdown), the installation is designed such that all steam generated at normal waste feed can pass through the turbine and condenser resulting in 24 MW electrical export.

A proportion of the RDF is sourced from local waste management companies and transported to the installation by road. The remaining is sourced from further afield and transported by rail to 1 of 2 local railheads and the final transfer from the railhead to the installation is by road.

The installation will operate continuously (24 hr/day & 7 day/week) for >8,000 hr/yr.

The installation consists of 2 off 20Te/hr incineration lines (combustor, boiler & feed-water system) and a single turbine and air cooled condenser.

The installation is designed not to generate any waste water from the process during normal operation.

The installation is designed to be fully compliant with the 2019 European BREF for Waste Incineration (JRC 118637) and the associated BAT Conclusions published in the Official Journal of the European Union on 3rd December 2019.

OTNOC

The Directive and BAT (BAT Conclusions 5 & 18) require that periods of “Other Than Normal Operational Conditions” (OTNOC) resulting from systems/equipment that impacts or the monitoring of emissions from the incineration process are: -

- Reviewed and assessed including: -
 - Potential root causes of failures identified (i.e. critical equipment),
 - Critical equipment is appropriately designed and specified,
 - Critical equipment is subject to appropriate preventative maintenance regime.
- Records are kept of periods of OTNOC including :-
 - When they occur and duration,
 - Emissions are suitably monitored/estimated,

- These records are routinely reviewed/assessed and the :-
 - Frequency & duration of periods of OTNOC identified,
 - Level & impact of emissions during periods of OTNOC are assessed
 - Corrective actions taken to reduce frequency, duration and emissions of periods of OTNOC.

Periods on OTNOC are limited by the directive as follows: -

- Maximum of 4 hours duration per event,
- Maximum of 60 hours per year,
- These limits apply per incineration line

Periods of OTNOC can be excluded when assessing compliance against the ELVs

The table below summarises the initial OTNOC review, identifying the relevant operational system, critical equipment, design/operational features to minimise risk of adversely affecting emissions and shutdown interlocks.

This will be updated following final design/HAZOP studies etc. and again as part of commissioning program.

System	Relevant Equipment	Design/Operational Measures to minimise OTNOC	Interlocks/Time to Plant Shutdown
Post-delivery fuel blending	Cranes in RDF Receipt & Storage Hall	2 Off 100% capacity cranes each capable of supporting full throughput and maintain mixing.	Failure of both cranes initiates shutdown of both incineration lines. In the event of extended crane outage, 1 incineration line can be stopped or throughput reduced if required
		Planned preventative maintenance program (using vendor approved contractors).	
Grate System	Vendor supplied system from feed chutes to grate discharge	Selected vendor has numerous demonstration plants that have demonstrated reliable operation.	Combustion control system will monitor operational status of relevant equipment and initiate shutdown in the event of equipment failure and/or process deviation from operational envelope.
		Onsite spares holding as recommended by equipment vendor.	
		Plant maintained as recommended by equipment vendor using vendor approved contractors as required.	
Support Fuel	Mains and onsite gas supply system	Gas supply is direct from National Grid ensuring continuous availability.	National Grid will notify if gas supply is to be interrupted.
		Control system monitors gas supply pressure and incorporates a loss of pressure interlock.	Initiates shutdown of incineration lines and/or inhibits start-up.
		Control system monitors gas supply pressure and incorporates low pressure interlocks	Inhibits start-up of incineration line(s) Initiates shutdown of incineration lines if pressure is below burner design operational range.
			If burner cannot support required temperature in combustion chamber, this will also initiate shutdown of affected incineration line(s)

System	Relevant Equipment	Design/Operational Measures to minimise OTNOC	Interlocks/Time to Plant Shutdown
		<p>Onsite spares holding as recommended by equipment vendor. Plant maintained as recommended by equipment vendor using vendor approved/certified contractors as required.</p>	
		Planned preventative maintenance program.	
	Burner	<p>2 off 100% start up burners Burner control systems interlocked with combustion control system.</p>	<p>Combustion control system will monitor operational status of relevant equipment and: - Issue with 1 burner will inhibit start-up of relevant incineration line. Issue with either/both burners will initiate shutdown of relevant incineration line.</p>
		Burner control systems interlocked with combustion control system.	As above
		<p>Onsite spares holding as recommended by equipment vendor. Plant maintained as recommended by equipment vendor using vendor approved/certified contractors as required.</p>	
SNCR	Urea Injection System	Selected vendor has numerous demonstration plants that have demonstrated reliable operation	

System	Relevant Equipment	Design/Operational Measures to minimise OTNOC	Interlocks/Time to Plant Shutdown
		<p>System incorporates duty & standby urea injection pumps (with auto start/changeover). 21 injectors (3 rows of 7) allows continued (although potentially suboptimal performance) in the event of individual injector/injector valve blockage etc.</p> <p>Injection rates based on proven algorithms and are optimised using input from relevant CEMs.</p>	<p>Combustion control system will monitor operational status of relevant equipment (Urea pumps, total Urea flow, control valves, chamber temperature, etc.)</p> <p>Issue with both pumps/excessive valve/injector issues, low total Urea flow initiate shutdown of relevant incineration line.</p> <p>Exceedance of 2 consecutive relevant ½ hr ELV will initiate shutdown of the relevant incineration line unless overridden by operator.</p>
		<p>Urea injection system control system integrated with combustion control system.</p>	<p>Combustion control system will monitor operational status of relevant equipment (Urea pumps, total Urea flow, control valves, chamber temperature, etc.)</p> <p>Issues with both pumps/excessive valve/injector issues, low total Urea flow (i.e. deviation from acceptable operational envelope) initiate shutdown of relevant incineration line.</p> <p>Exceedance of 2 consecutive relevant ½ hr ELV will initiate shutdown of the relevant incineration line unless overridden by operator.</p>
		<p>Onsite spares holding as recommended by equipment vendor.</p> <p>Plant maintained as recommended by equipment vendor using vendor approved/certified contractors as required.</p>	
		<p>Planned preventative maintenance program.</p>	

System	Relevant Equipment	Design/Operational Measures to minimise OTNOC	Interlocks/Time to Plant Shutdown
	Urea System	System incorporates duty & standby demin water pumps (with auto start/changeover). System incorporates duty & standby Urea solution feed pumps (with auto start/changeover).	Failure of either set of duty/standby pumps will initiate shutdown of both incineration lines. Extreme low level in each both tanks will initiate shutdown of both incineration lines Interlocks at level to ensure adequate supply for shutdown period
		Planned preventative maintenance program.	
		Onsite spares holding as recommended by equipment vendor. Plant maintained as recommended by equipment vendor using vendor approved contractors as required.	
		Planned preventative maintenance program.	
Boiler (Prevention of de-novo synthesis etc.)	Preheater, economiser & evaporator tubes	Selected vendor has numerous demonstration plants that have demonstrated reliable operation	
		Boiler designed using CFD to optimise heat transfer (minimising flue gas residence time & area of heat transfer surfaces in critical temperature range). Boiler designed using CFD to optimise gas path and minimise impingement/dropout of entrained solids on heat transfer surfaces.	Boiler performance parameters monitored and acceptable performance envelope and monitoring regime to be developed during commissioning. Monitoring regime incorporated into control system to generate notifications that boiler performance is sub-optimal and cleaning is required (operator initiated).

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		Boiler incorporates 3 off online cleaning systems, each matched to fouling found in relevant part of boiler. “Shower Clean” system can use high pressure nozzles if excessive slagging is experienced. Online and Offline cleaning regime as recommended by equipment vendor.	
		Boiler design to allow straightforward & rapid removal/refit of boiler tubes for Offline cleaning.	
		Onsite spares holding as recommended by equipment vendor.	
		Planned preventative maintenance program.	
FGC (Acid Gas Abatement)	Reagent Injection (Hydrated Lime)	Injection system on each incineration line incorporates: - <ul style="list-style-type: none"> • 2 off fixed speed screw conveyor, • 2 off surge hopper, • 2 off metered surge hopper discharge (conveyor and rotary valve) system, • 2 off lean phase conveying system. These operated as duty/standby (with auto start/changeover). Control system (integrated with combustion control system) and single injector, complete the system on each incineration line. Injection rates based on proven algorithms and are optimised using input from relevant CEMs.	Failure of any part of injection system prompts standby injection system to be started. Failure of both duty & standby systems will initiate shutdown of relevant incineration line. Extreme low level in both surge hopper(s) will initiate shutdown of relevant incineration line. Extreme low level in hydrated lime silo will initiate shutdown of relevant incineration line. Interlocks at level to ensure adequate supply for shutdown period. Exceedance of 2 consecutive relevant ½ hr ELV will initiate shutdown of the relevant incineration line unless overridden by operator.

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		<p>Onsite spares holding as recommended by equipment vendor. Plant maintained as recommended by equipment vendor using vendor approved contractors as required.</p>	
		<p>Planned preventative maintenance program.</p>	
	<p>Reagent Injection (Activated Carbon)</p>	<p>Injection systems are fed from a common silo with a single outlet connected to a handling system consisting of: -</p> <ul style="list-style-type: none"> • A fixed speed screw conveyor, • A surge hopper with variable speed agitator, • Metered surge hopper discharge (screw conveyor and educator or “jet pump”), • Injection system (pneumatic conveyor) into the venture stage of the reaction chamber). <p>Control system is integrated with combustion control system. Injection rates based on proven algorithms and are optimised using input from relevant CEMs. The activated carbon handling system used has proved to be reliable.</p>	<p>Failure of any part of injection system will initiate shutdown of relevant incineration line. Extreme low level in the surge hopper will initiate shutdown of relevant incineration line. Extreme low level in the silo will initiate shutdown of both incineration lines. Interlocks at level to ensure adequate supply for shutdown period. Exceedance of 2 consecutive relevant ½ hr ELV will initiate shutdown of the relevant incineration line unless overridden by operator.</p>
		<p>Planned preventative maintenance program. Onsite spares holding as recommended by equipment vendor. Plant maintained as recommended by equipment vendor using vendor approved contractors as required.</p>	

System	Relevant Equipment	Design/Operational Measures to minimise OTNOC	Interlocks/Time to Plant Shutdown
FGC (Dust Abatement)	Bag Filter	<p>Selected vendors have demonstration plants that have demonstrated reliable operation on incineration process.</p> <p>Bag filter on each incineration line is subdivided into 4 isolatable compartments. Bag filter is circa 35% oversized to allow operation at full capacity with 1 compartment isolated.</p> <p>Each compartment is fitted with “burst bag detection” allowing relevant compartment to be identified and isolated in the event of a split or badly seated bag.</p> <p>Bag filter is not bypassed during start-up and shutdown periods.</p> <p>Bag cleaning is sequenced to minimise disruption of flue gas flow through the filter and to ensure all bags undergo the same number of cleaning cycles resulting in consistent wear.</p> <p>Onsite spares holding as recommended by equipment vendor.</p> <p>Plant maintained as recommended by equipment vendor using vendor approved contractors as required.</p>	<p>Burst bag detention produces alarms identifying the compartment(s) that are not performing.</p> <p>Exceedance of 2 consecutive relevant ½ hr ELV will initiate shutdown of the relevant incineration line unless overridden by operator.</p> <p>Extreme high dust level in a compartment activates an alarm and the control system initiates isolation of the compartment (to prevent internal damage).</p> <p>Extreme high temperature in the compartment hopper activates an alarm and the control system initiates isolation of the compartment (to extinguish potential fire).</p>
		Planned preventative maintenance (including bag changes) program.	

System	Relevant Equipment	Design/Operational Measures to minimise OTNOC	Interlocks/Time to Plant Shutdown
		<p>Process monitoring by operational staff.</p> <p>In addition to CEMs data, there are alarms for high dust levels in each compartment. Bags are pulsed in rows, with minutes passing between each being pulsed allowing spikes to be related to the row being cleaned.</p>	<p>Issues with elevated emissions usually develop over a period of time (e.g. holes developing in bags due to wear) and are detectable by rising averages (e.g. ½ hr or daily) and/or “spikes” following bag cleaning.</p> <p>Operator interventions include :-</p> <ul style="list-style-type: none"> • Inhibiting cleaning on specific row of bags (experience is bags then self-seal due to build-up of dust with little impact on overall filtration rea), • Isolating a compartment, • Isolating compartment and changing bag(s) within 8 hours.
		<p>Monitoring of pressure drop across bags/cleaning cycles.</p>	<p>Excessive rise in pressure drop and/or cleaning frequency suggests: -</p> <ul style="list-style-type: none"> • Bag blinding and operator will initiate load reduction or shutdown to prevent potential failure of internal components. <p>Excessive falls in pressure drop and/or cleaning frequency of the bagfilter units indicate: -</p> <ul style="list-style-type: none"> • Flue gas bypassing bags or bag faults and operator will initiate load reduction or shutdown to prevent excessive emissions

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Emission Monitoring	CEMS (general)	<p>Selected vendor has numerous demonstration installations that have demonstrated reliable operation on incineration plant.</p> <p>CEMS & data handling system are MCETS certified and suitable ranged (demonstrating proven reliability).</p> <p>CEMS calibrated etc. to BS14181 to demonstrate consistent performance over time.</p> <p>CEMS integrated with combustion control system.</p>	<p>Exceedance of 2 consecutive relevant ½ hr ELV will initiate shutdown of the relevant incineration line unless overridden by operator.</p> <p>Fault on CEMS system (e.g. failure to complete zero/span check) will initiate shutdown of the relevant incineration line(s) after 60 minutes unless overridden by operator/"hot standby CEMS" switched to monitor stack.</p>
		Common "hot standby CEMs" installed.	If no CEMS available on a stack (i.e. primary and "standby") then shutdown of the relevant incineration line is initiated.
		<p>Onsite/bonded spares holding as recommended by equipment vendor.</p> <p>Plant maintained as recommended by equipment vendor using vendor approved/certified contractors as required.</p>	
		Planned preventative maintenance program.	
	TOC & CO		CEMS interlocked with combustion control system and failure will result in shutdown of relevant line(s). (See common "hot standby CEMS" above.
Process Monitoring	Combustion Chamber (CO)	Vendors CO monitor proven in this duty on incineration processes.	Interlock (to be set during commissioning) initiate shutdown of relevant incineration line after 60 minutes (e.g. to avoid unnecessary shutdowns due to "noise" in control signals etc. allow initial investigations).
		Onsite spares holding as recommended by equipment vendor.	

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		Planned preventative maintenance program.	
		Calibration/Testing regime in place.	
		CEMS CO provides surrogate parameter	Automatic shutdown if operation not restored within 4 hours?
	Combustion Chamber (O ₂)	Vendors O ₂ monitor proven in this duty on incineration processes.	Interlock (to be set during commissioning) at low O ₂ concentrations initiates shutdown of relevant incineration line after 60 minutes (e.g. to avoid unnecessary shutdowns due to “noise” in control signals etc. allow initial investigations).
		Onsite spares holding as recommended by equipment vendor.	
		Planned preventative maintenance program.	
		Calibration/Testing regime in place	
	Combustion Chamber (Temperature)	CEMS O ₂ reading provides surrogate parameter	Automatic shutdown if operation not restored within 4 hours?
		Vendors Temperature probe proven in this duty on incineration processes.	Interlock (@≥850°C) initiates shutdown of relevant incineration line after X minutes (to avoid shutdowns due to “blips” in control signal). “X” To be determined during commissioning.
		Low temperature (set point to be determined during commissioning) initiates support fuel burn.	If issue with gas supply, support fuel system (e.g. burner does not fire up at required temperature), combustion control system initiates shutdown of relevant line(s).
		Onsite spares holding as recommended by equipment vendor.	
		Planned preventative maintenance program.	
		Calibration/Testing regime in place	
		SNCR temperature data provides surrogate parameter	Automatic shutdown if operation not restored within 4 hours?

