(37)

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# Appendix 16

## Emergency Shutdown Procedure

## Potential Abnormal Operating Conditions

## Furnace Start-up and Shutdown Procedures

### 15.2.7 Emergency Shutdown Procedure

The emergency shut down will bring one or both incinerator lines to a safe status.

The main objectives of the emergency shut down procedure are as follows:

- To shut down the plant safely, avoiding injury to staff or damage to equipment
- to minimise emissions
- to prevent over pressure in the furnace
- to protect equipment from damage caused by temperatures which are too high.

The emergency shut down will be initialised by situations such as:

- An electric power failure
- Simultaneous occurrence of a flue gas temperature at the outlet of the boiler above 250°C and a failure of the water feed to the flue gas cleaning systems or a temperature at the inlet of the bag house filter of greater than 250°C
- Some plant interlocks including over-pressure in the furnace
- Manual alarm.

The experience of the operators of Indaver's plants in Flanders is that an emergency shut down is not a frequent occurrence. Over pressure in the furnace is the most common reason for an emergency shut down.



In case of failure of electrical power supply, motors and equipment required for the emergency shut down, will be powered by the emergency generator.

The emergency shut down will be automatically executed in two steps.

**Step 1** is the waste burn out. As soon as the emergency shut down commences all waste and fuel supply will be stopped immediately. The ID-fan will be stopped. The water supply to the spray tower and scrubbers will be stopped. An emergency supply may be provided for use in the spray tower, if the temperature of the flue gases exceed 250°C. This option will be decided at detailed design stage. A valve will be opened to supply water from the scrubber systems' emergency supply into the scrubbers in order to avoid overheating of the resin of the scrubbers.

The injection of activated carbon and lime will stop and may be reactivated by the operator, manually, once the reason for the shut down is known and it is determined that there will be no risk in doing so.

The inertia of the ID-fan will ensure that the flue gases will continue to be evacuated through the flue gas cleaning systems, prior to the start-up of the ID-fan via the auxiliary motor, which will be powered by the emergency generator.

In the grate furnace, air to burn out the residual waste will be drawn into the furnace because the inertia of the ID-fan will maintain under-pressure in the furnace. During this period the flue gas flow will drop quickly to less than 20 % of the normal flow. At this stage the waste in the furnace will be almost completely burned. Only a few bigger waste parts will still be smouldering. The auxiliary motor (with gear box) of the ID-fan will then be switched on and connected to the shaft by means of a clutch. The ID-fan, running on the auxiliary motor will continue for approximately 2 hours. The power of this motor will be enough to evacuate the remaining flue gas through the flue gas cleaning system. The water supply from the emergency water will then be stopped. The temperature in the scrubber will be measured. A fire water supply will be provided through an emergency nozzle, if the temperature is too high.

**Step 2** is the cooling step . A small heat vent after the boiler, in the line before the flue gas cleaning systems, will be opened and the ID-fan stopped. The function of the heat vent will be to evacuate heat (not combustion gases) from the furnace to the atmosphere instead of to the flue gas cleaning system. The vent release will not be pressurised. It is unlikely that the vent release will result in a visible plume. The filter cake in the bag house filter will act as a barrier between the hot and the cold part of the plant. The approximate heat emitted from the plant during this process would be subject to the detailed design of the plant but would be in the order of 3MW.

The plant will now be safely shutdown. The furnace will be cooling down slowly by the natural draft through the heat vent.

In no instance will the heat vent be opened while there is waste in the furnace. During any emergency shutdown, while there is waste in the furnace all the flue gases pass through the gas cleaning system and are emitted through the stack. As stated above, the ID Fan is kept operating during the shutdown by means of an auxiliary motor and an emergency generator. In the event of an emergency shutdown and failure of the emergency generator the inertia of the ID Fan would continue to draw the flue gases through the gas cleaning system for an initial period. The heat vent would not be opened but there may be overpressure within the furnace. It is highly unlikely that there would be both an emergency shutdown and a failure of the emergency generator at the same time.

When both lines are out of operation the ventilation of the waste bunker will not be guaranteed by forced draft. The ventilation will only be by natural draft through the smoke louvers in the roof. A potential explosion risk in the bunker area could arise if there was methane present. As methane is lighter than air it would be evacuated through the roof vents, thus removing any potential risk of explosion.

While step 1 of the shutdown sequence is underway, the combustion gases will continue to pass through the flue gas cleaning systems and the bag house filter and particulates will be removed as efficiently as during normal operations(except in the case of catastrophic failure of the baghouse). The activated carbon/lime mixture present on the sleeves of the bag house filter will continue to remove heavy metals, dioxins, HCl, HF and $SO_2$ from the combustion gases.

The combustion gases will pass through the reheater, which will heat the flue gases but not to a particular set point as during normal operation. The flue gases will then discharge to atmosphere via the stack, possibly with a visible plume.

In the event of a loss of mains power, key pumps, fans and other equipment required to ensure the orderly shut down described above, will be supplied with power from the emergency generator.

The fixed installed emissions monitoring equipment located on the stack will continue to monitor the emissions from the stack. In the event of loss of mains power, the monitoring equipment will be supplied with electricity from the Uninterruptible Power Supply (UPS) and emergency generator for a period of at least one hour.

A risk analysis will be carried out on this procedure during the detailed design phase of the project (in the form of a Hazard and Operability Study) during which the final details of the procedure will be decided. Indaver will submit the final procedure to the Agency during this phase.

## PLANT OPERATION DURING ABNORMAL OPERATING CONDITONS

### 1. WASTE ACCEPTANCE

#### Reception Hall And Waste Bunker

An abnormal occurrence in the reception hall or bunker, which could result in an emission, would be a fire in the bunker. A fire could occur in the waste bunker, due to localised heating because of decomposition of organic material or as a result of hot ash in the waste leading to isolated fires. Decomposition of waste can raise the temperature of the waste to 75 °C, drying the waste and causing it to smoulder. Incoming ashes from domestic fires wrapped in other waste can retain their heat. When waste in the bunker is moved these ashes could be exposed to air and could start to smoulder.

As the waste bunker will be permanently monitored by the grab crane operator, smouldering of waste as described above will be detected at an early stage. The grab crane operator will simply lift the smouldering waste into a hopper from where it will enter the furnace. This waste will then be covered by placing another layer of waste into the hopper.

Should the grab crane operator fail to detect smouldering waste and it develops into a flame and hence becomes a fire, the smoke detection system will activate an alarm in the control room to alert plant operators to the situation. The fire will then be put out using either one of two remotely controlled water cannons located above the bunker. The water used to extinguish the fire would be absorbed into the waste. If the volume of water used to extinguish the fire is large and cannot be absorbed, the concrete construction of the bunker will provide water retention until the water is pumped out and disposed of. Any smoke or fumes arising in the bunker will be drawn into the furnaces and thus through the flue gas cleaning system. There will be no emissions from the bunker in an abnormal situation, unless the vents in the roof above the bunker open. This would happen in a major fire or a build up of methane.

If the LEL detector triggers a higher level alarm, all electrically powered equipment in the bunker will be shut down, the vents in the roof over the bunker will open and methane gas or other volatiles will be emitted.

### 2. COMBUSTION PROCESS

#### Moving Grate Furnace

Each furnace will normally be maintained under negative pressure. There will be a number of reasons why there might be excessive air pressure in the furnace, for example, a blockage downstream of the furnace in the flue gas treatment systems or the sudden increase in the calorific value of the waste. Pressure sensors in the furnace will detect the high pressure in the flue gases. The computerised control system will increase the speed of the induced draught fan, which will control the velocity of the flue gases, to reduce the pressure in the furnace. If the fan reaches its full capacity without a corresponding drop in pressure in the furnace, the plant will automatically generate an alarm to reduce the waste feed. If there is a further increase in the pressure, the plant will automatically initiate an emergency shut down. The emergency shutdown sequence is described in Appendix 16

There may be the possibility that a pressurised object, such as a large gas cylinder, would enter the furnace undetected in the waste feed. It could cause an explosion which would result in damage to the refractory brick lining of the furnace. The furnace will be designed to withstand such incidents and continuous monitoring of the condition of the refractory bricks will be undertaken.

## 3. Energy Recovery

### Boiler

There will be no emissions to the environment from the boiler during normal operation.

As with the furnace, the boiler passes will normally be maintained under negative pressure. An abnormal situation would be excessive pressure. The reasons for this to occur will be the same as for the furnaces and the measures to be taken to rectify over pressure in the boiler will be the same as for the furnaces.

Another abnormal situation that could occur in the boiler would be a boiler tube leak, which would result in boiler feed water leaking into the flue gases. In the event of a major boiler tube leak, an emergency shutdown of the line will be initiated. A boiler tube leak will be detected by an abnormally high consumption of demineralised water and the water level in the boiler feed water tank will drop faster than expected. Use of anti-corrosion chemicals in the boiler feed water and preventative maintenance of the boiler tubes will reduce the occurrence of boiler tube leaks.

The steam flow will be controlled by valves, which will control the flow of the steam to the turbine. The system will be equipped with stop valves, which will interrupt the steam flow if the boiler operating conditions fall outside preset levels.

There will be no emission from the boiler in the event of an abnormal situation.

### Steam Turbine

There is no emission from the turbine during normal operation.

In the event of turbine or generator failure, the motorised isolation valve on the inlet to the turbine will close, the bypass line will open automatically and steam will be dumped directly into the condenser through a pressure reducing and de-superheating station. The plant will be able to continue operating in the event of turbine or generator failure until the corrective maintenance is complete.

### 4. Flue Gas Cooling

The main failure which could occur in the evaporating spray tower would be the failure of one of the nozzles or the rotary atomiser used to spray the liquid to cool the combustion gases. There will be sufficient redundancy to ensure reliability of the spray tower. Nozzles will be changed and cleaned weekly and the atomiser fortnightly to reduce the risk of nozzle or atomiser failure.

There will be no emissions to the environment from the evaporating spray towers during abnormal operations.

### 5. Ammonia Injection

An abnormal situation would be a dosage system malfunction, resulting in the injection of too much ammonia or urea, which would register as a drop in the $NO_x$ measured in the stack emissions, or too little ammonia or urea, which would result in a rapid rise in the $NO_x$ measured in the stack emissions. Injection of too much ammonia or urea would give an ammonia-like odour to the boiler ash. Upper and lower alarm levels will be set, to alert the plant operator to take corrective action



### 6. Activated Carbon/Lime Injection

An abnormal situation would be the failure of the injection of the activated carbon and lime. The second stage dioxin removal system would still be in operation and the emission limits for dioxins and heavy metals would not be exceeded.

### 7. Baghouse Filter

At temperatures greater than 180°C, heat may be generated due to oxidation of the carbon granules. The heat generated could cause hot spots in the bag house filter. If the quantity of carbon is relatively low, the probability of a hot spot is reduced. The use of lime mixed with the activated carbon, rather than pure activated carbon, will minimise the possibility of hot spots in the bag house filter. = Burn?

Operating with the flue gases at high temperatures for the long term could cause damage to the sleeves of the bag house filter. Operating with the flue gases at low temperature may cause wet sleeves in the bag house filter. The flue gases leaving the evaporating spray towers are monitored and maintained at circa 170°C to avoid either situation.

## 10. ID Fan

In the event of ID fan failure, overpressure would be generated in the waste to energy plant and an emergency shutdown sequence, described in detail in Appendix 16, would be automatically initiated. An emergency motor will be provided on the ID fan to keep it running in the event of failure of the main motor. The fan will be a critical item of plant and therefore will be inspected regularly. Vibration detection and thermocouples will also be provided on the ID fan.

CEM for dust?

Sleeves will be replaced as required, usually every 3 to 6 years. The rupture of a sleeve will be detected by very small dust peaks in the stack emissions. It will be possible to replace a sleeve on-line by closing off one module.

Dust accumulation in the bag house filter, due to a blockage in the discharge system, could lead to a sudden overpressure failure. Differential pressure indication will be provided on the bag house filter to reduce the risk of dust accumulation on the sleeves. The hopper, in which the dust from the bag house filter will be collected, will be fitted with a high level alarm to indicate either a blockage in the hopper or that the silo for the dust is full and needs to be emptied.

## 8. Scrubbers

In the event of loss of the scrubbing liquid to either scrubber, melting of the lining material in the scrubber would occur. Both low flow and no flow alarms will be provided on the scrubbing liquid supply and a back-up water injection system from the fire ring main will be interlocked to the loss of scrubbing liquid. In the event of loss of either scrubber in Option 1, the other scrubber could continue to operate to remove HCl, HF and $SO_2$ assuming that the first scrubber is still quenched. If the required emission levels cannot be reached, an automatic shut down will be initiated. In the event of loss of the single scrubber in Option 2, an emergency shut down will be initiated, if the emission levels of HCL, HF or $SO_2$ in the stack rise above a preset level, which will be below the licensed limit.

There will also be a dedicated emergency water supply to the scrubbing system. This may be fed from a tank at high level under the roof, which would supply the scrubbers by gravity, or a dedicated diesel powered pump. In the event of an interruption to the normal water supply due to an emergency shut down initiated by a power failure, there may be a brief interval before the diesel pump set of the fire main system cuts in. The emergency water supply will ensure that there will be a continuous water supply to the scrubbers in the interval.

## 9. Carbon Injection/ Carbon Bed

The activated carbon/lime mixture injection and bag house filter system would have similar potential problems to those described in sections 9.5.4 and 9.5.5.

Blockages could occur in sections of the carbon bed if the lignite cokes are not changed at the required frequency. The flue gases must pass through the entire carbon bed and therefore dioxins will still be removed. As the carbon bed will be at over pressure, a leak in the container of the bed would result in a leak into the main process building. The carbon bed will be a polishing step and such a leak would be of treated flue gas. A leak would be detected by routine visual inspection.

- The furnace line will have stopped incinerating waste for a number of hours, there will be no waste remaining in the furnace and consequently there will be no flue gases to be cleaned. Once the temperature at the stack is sufficiently low at approximately 60°C, the flue gas cleaning systems will be stopped.
- Some utilities to the line such as instrument air, etc. and the majority of the peripheral equipment will be shut-off.
- Other utilities such as electrical supply will continue operating as they will be required even when the line is shut down.

If both lines are shut down and there is waste remaining in the bunker, one ID fan will continue operating if possible at a lower capacity to ensure that the waste reception hall and bunker will be kept under negative pressure to prevent odours.

## Furnace Start Up and Shut Down Procedures

The start-up and shut down of the furnaces will be carefully controlled, in accordance with standard operating procedures. The procedures will be developed in detail prior to the commissioning of the furnaces. The procedures are outlined below.

The start-up sequence for a furnace line will be as follows:

- The computerised control system for the line will be started up, which will mean that measurements and interlock systems will be in operation.
- Utilities for the line such as water, electricity, instrument air, the firewater system and safety systems will then be started up.
- Monitoring of some of these utilities will be carried out, as certain conditions such as firewater availability must be satisfied before the start-up procedure can commence.
- Peripheral equipment, such as the equipment to supply chemicals to the plant, to receive the process stream from the plant and the stack emissions monitoring equipment will then be started up.
- After verification of process parameters such as liquid levels, pressures, steam cycle etc., and adjustment as necessary, the flue gas cleaning systems will be started up.
- The ID-fan will commence running and pre-ventilation of the line for a pre-set time period of 20 minutes will occur.
- The gas-fired burners, to initiate the combustion in the furnace, will be started up and the flue gas temperature will be raised to 850°C at a gradient of 50°C per hour.
- Once the temperature in the furnace has stabilised, the supply of waste will then commence and gas firing will be stopped.



The shut down sequence for a furnace line will be as follows:

- The waste supply to the furnace will be shut off
- To ensure complete combustion of the waste remaining in the furnace, the gas burners will be re-started to ensure that a temperature of 850°C, as appropriate, will be maintained for a period of up to 1 hour.
- The ID fan of the flue gas cleaning system will remain operating to ensure that the flue gases will be treated to the emission limits during the operation.
- The furnace will then be allowed to cool down to a temperature of 200°C at a gradient of 50°C per hour (a period of circa 13 hours) which will be controlled by supplementary firing.