# A Review of Environmental Incidents at Anaerobic Digestion (AD) Plants and Associated Sites between 2010 and 2018

September 2019

We are the Environment Agency. We protect and improve the environment.

We help people and wildlife adapt to climate change and reduce its impacts, including flooding, drought, sea level rise and coastal erosion.

We improve the quality of our water, land and air by tackling pollution. We work with businesses to help them comply with environmental regulations. A healthy and diverse environment enhances people's lives and contributes to economic growth.

We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to create a better place for people and wildlife.

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# Introduction

The Environment Agency has responded to a significant number of incidents which have caused or had potential to cause pollution.  We have undertaken routine compliance visits that have identified serious failures which posed a serious risk of pollution or harm to human health. These have occurred at permitted, exempt and non-waste AD plants (non-regulated). These incidents ranged from partial or complete collapse of primary containment and associated loss of digestate, water pollution from storage of feedstock or digestate, significant odour, loss of biogas, fires and explosion.

The water industry has the longest historical experience in managing AD. However, these processes have also presented us with some challenging incidents despite the technical experience of the sector.

According to a leading AD plant insurer, *"Anaerobic digestion plants may experience significant loss events during operation resulting from damage to operational equipment, structural collapse, fire, flood or theft. These events can often result in lengthy periods of process downtime, with a consequential loss of revenue, clean-up costs, risk of local pollution and a resulting drop in local community confidence and support for the project; which can be difficult to rebuild.*

*It is essential that all plant operators, and those involved in its maintenance, fully understand the risks that are present on an AD plant, and why these safety and control features are provided. They need to be aware of the consequences of safety feature failures, incorrect plant operation and not following set procedures. Human error is often the root cause of many major loss or damage events."* [1]

This report includes the earlier EA documented review of incidents carried out between 2010 and 2013 and a sample of more recent incidents/compliance concerns up to 2018, including incidents at associated sites such as land-spreading locations.

This review has been produced to help our permitting and compliance officers identify the key areas relevant to the regulation of anaerobic digestion plants and associated facilities and support their site permitting and compliance work.

This is an internal document. However, it may be shared externally where appropriate in order to help industry understand root causes of failure so that they can review their own operations in order to prevent incidents and pollution.

*1 Anaerobic Digestion: Plant Operation Risk Management.  A Guide to Loss Prevention. HSB Engineering Insurance Limited. (Part of Munich Re). HSBEI-1728-0717*

# 1.0 Examples of Incidents - 2010

### November 2010 – Merchant Facility

About 300 cubic metres of digestate was lost from an overflowing underground storage tank, due to a pump being left on overnight. It is believed that 50-100 cubic metres escaped off-site, via the concrete pad, onto the road and then into the ditch and stream. Prior to the incident we had issued a site warning to the operator for a breach of their permit for failing to have over-fill alarms and protection devices on two tanks. There was no secondary containment.

After the incident a fail-safe actuated valve was fitted and high level alarms which provide text alerts have been installed. They also instructed security guards to visit the site twice a night and an electrical firm visit twice a week to do systems checks.

The operator was prosecuted and fined £5000.

### 2010 and 2012 Waste Water Treatment Works

A water company was ordered to pay £93,980 after losing its appeal over a fine for non-compliance. The company was originally fined £150,000 after pleading guilty to five breaches of regulation 38(2) of the Environmental Permitting (England and Wales) Regulations 2010. At an appeal hearing on 27 September, the crown court halved the fine to £75,000, in addition to £18,980 in costs. Investigators found that a unit to treat siloxanes – residues that build up in engines and reduce efficiency – had caught fire and exploded.

Further investigations showed the company had no formal procedures for starting or shutting down the siloxane plant, emergencies or maintenance.

# 1.1 Examples of Incidents - 2011

### October 2011 - Agricultural Facility

Complete loss of digester tank contents to ground. The site had been built without full planning permission or a permit and the site was discovered after the pollution incident.

The digester mechanical stirrer fixings failed causing a hole in the concrete digestate tank. Secondary containment not in place.

## October/November 2011 – Wastewater Treatment Works

An estimated 50,000M3 of biogas was lost to the atmosphere over 19 days as a result of the catastrophic failure (collapse) of the gas holder and the subsequent release of biogas via the pressure/vacuum release valves as a safety measure, between the above dates. The standby flare failed to operate and a temporary flare was not installed.

Three sets of guide wheels on the holder had disengaged, its limit switches had failed and sections of the guide rails were corroded. This led to the holder tilting dangerously and gas being released. The Fire Service had to be called because there was a risk of an explosion.

The Environment Agency estimated that the global warming potential of the incident was equivalent to 456.6 tonnes of $CO_2$. The company was fined £400,000 for polluting the air with potentially explosive biogas.

## 1.2 Examples of Incidents - 2012

### February 2012 - Merchant Facility

Following a member of the public reporting that a nearby ditch was full of 'green slime', our officers visited the nearby AD plant and found that the pollution had come from a pipe beside three large digestate storage lagoons.

The pipe had broken free while digestate was being pumped from the anaerobic digestion plant. Approximately 60 tonnes of liquid digestate was lost during the incident. Samples taken from the stream showed it was 'grossly polluted'. About 100 tonnes of liquid digestate is pumped to the lagoons each day.

The operator company was prosecuted and fined a total of £25,000 and ordered to pay £4,500 costs after pleading guilty to two charges under the Environmental Permitting Regulations 2010. A director of the company was also individually prosecuted, fined £2,500 and ordered to pay £1,000 costs.

A further incident occurred during June 2012 in which 3500m3 of digestate was over-pumped out of the digester.  The secondary containment which consisted of an earth surface and earth bund walls failed to hold the digestate.

## June 2012 - In-House Dairy Products AD Plant

The digester membrane roof was blown open and biogas was lost to atmosphere. Digestate lost was contained within the bund.

The pressure release system was found to be blocked by foam. Foam is a common occurrence and can be formed by a number of different factors including overloading, presence of detergents and high nitrogen content feedstocks.

The digester was fitted with a water spray to knock down any foam but this was found to have been turned off. There was no foam sensor system and the design of the gas pipework did not protect the pressure release valve from foam carryover. Human error and a management system failure was the root cause of the incident. Very little thought was given to the effects of foaming on the PRV and there was no critical alarm on the gas flow to the CHP.

The pipework was changed to protect the pressure release valve. Foam sensors were added to the catch pot.


The same plant experienced a second incident when 3500m3 of digestate was over-pumped out of the digester. Secondary containment, consisting of an earth surface and earth bund walls was breached.

### September 2012 – Merchant Facility

The membrane roof and steel sides of the digester were damaged due to foaming. The clean-up operation was extensive. Biogas was lost to atmosphere whilst the digestate was contained within the bund. The bunded area was graveled which made clean up difficult.

The pressure release system was found to be blocked by foam. In this case the excessive foam was caused by overfeeding the reactor i.e. operator error. The design of the digester did not cope with the amount of foam.  Fully trained and competent employees were not operating the plant at the time of the incident which meant VFA levels were not being monitored and led to over-feeding.

## 1.3 Examples of Incidents - 2013

### January 2013 – Merchant Facility

A spill of 40 m3 of digestate occurred due to a pipe seal failure on the digestion tank, however secondary containment held and safety systems in place minimised the impact.

There were 5 x 4500m3 digestion and storage tanks, made of concrete and having a leak detection membrane running underneath the base and up the sides to just above ground level (the tanks were sunk by about 1m into the ground) with detection chambers between the tank and liner. The secondary containment was a clay bund around the whole site, the base of the containment system was a mixture of concrete areas and impermeable clay areas around the tanks themselves. The permeability of the clay was tested during construction. The whole site area drained to storage tanks. The plant was equipped with a number of alarms, detecting pressure drops on pipework, loss of tank volume and presence of liquid in areas which should have been dry. The alarms notified several staff out of hours allowing a fast response - the computer control system could also be operated remotely.

## January 2013 – Agricultural Unregistered "Exempt" Facility

A 330 cubic meter glass fused steel digester tank violently burst open under pressure (luckily whilst the site was unattended). Biogas was lost to atmosphere and digestate lost to ground.

The inclusion of partially chopped/ macerated straw in a slurry feedstock with a low total solids percentage, especially in wet weather, led to a floating layer of material on the liquid in the tank. This may have disabled the correct operation of the float switch because it had to be inverted by its own buoyancy to operate. This meant the tank may have been overfilled by the feed pump. The floating layer would have obstructed the tank roof pressure relief valves, allowing hydraulic pressure to build within the tank. The topography provided secondary containment however this may not have coped if the digester storage tank had gone as well.

## February 2013 – Agricultural Facility

At least 750,000 gallons of digested slurry escaped from an above-ground digestate holding tank and retaining bund.

It appeared that the loss of containment had been due to a separation of the inner surface of the tank wall from the tank base and a loss of integrity of the mastic sealant between the two. Once the seal between the tank wall and the base lost its integrity there was a direct path for the digestate to leak to the outside. Once the inner contents had escaped the secondary containment feature i.e. the earth bund, failed to hold.

## March 2013 - Agricultural Facility Extended to Accept Pasteurised Food Waste

A large quantity of digestate escaped from a 3000m3 digestion tank, with an estimated 200 to 400m3 entering nearby ditches.

The seal around the agitator arm at the bottom of the tank failed, bolts were loose and the agitator was moving and making noise for several days. The partial secondary containment system was not a purpose built system. The majority of drainage from around the AD area flowed to the intensive pig farm, which had a drainage system leading to a series of storage lagoons. If livestock had been in their housing at the time of the incident they would have been fatally impacted.

### June 2013 – Wastewater Treatment Works Facility

A catastrophic foaming incident resulted in a sewage sludge digester losing a significant proportion of its contents (thought to be ca 2,000m3) into the secondary digested sludge holding tank which over-topped – this tank was uncovered and the resultant spillage covered an area of ground around the tank. There was no secondary containment for the tank. There was a large increase in odour complaints caused by the high odour levels of the sludge/foam that was spilt.

Following an annual shut-down, the digesters did not respond as usual to the feed sludge when feeding re-started. Methane content did not increase as expected and high VFAs were recorded with little change in alkalinity resulting in a reduction in sludge pH. These issues were accompanied by excessive foam in the digesters which was not controllable. On one occasion, partial emptying of one of the digesters occurred resulting in loss of the gas seal.

Samples of the sludge were not analysed for some time, as there was no on-site facility to do this. When it was eventually realised that there was a problem with sludge composition, samples were taken daily and taken for analysis at a nearby works. This allowed close monitoring and control to be resumed.

### September 2013 - Agricultural Facility

Operators released about 5,000 gallons of digestate liquid/foam from the digester tanks to the local environment. Foam created within the tanks had been causing blockages in the pressure relief valves thus causing a build-up of pressure within the tanks. The digestate was released as a last resort to relieve pressure within the tanks. The site had a sealed drainage system but no secondary containment for the digester or storage tanks. Digestate escaped from the site and travelled 120m, to within 30m of a main drain.  At the time of a site audit, the operatives were unaware of any written management system or written operating procedures.

## September 2013 - Merchant Facility

Approximately 700 m3 of its contents escaped from a digester.  An unknown quantity of the digestate entered a beck, causing pollution of about 3.6 kilometers downstream. A faulty agitator had torn a hole in the side of the tank. There was no secondary containment for the digester.

## 2013 - Merchant Facility

A leaking membrane on a digestate lagoon was discovered at a food waste AD plant. The operator had lined a hole in the ground to create a lagoon with HDPE and a geotextile membrane but there was no CQA plan and no oversight of the construction of the lagoon by a qualified engineer.

## 1.4 Examples of Incidents - 2015

### August 2015 - Agricultural Facility (Non-Regulated)

#### Incident Summary

Silage liquor escaped a silage clamp and drained into a nearby watercourse. The AD plant was not operational at the time however the silage clamps were storing feedstock.

Water pollution was spotted and reported to the local water company who investigated and found slurry in the land drain. Further investigation was done by the farmer who found a small leak on the silage pipe. The farmer was not sure when the leak started however the slurry tank was filled the previous month (July) and seemed to be running at that time. There was no indication of loss of flow. When the leak was discovered the farmer took immediate action by creating a sump to contain the slurry and prevent further pollution. He then emptied the slurry tank to prevent further impact.

#### Root Cause(s)/Learning Points

Poor infrastructure was the main cause of incident. The effluent leaked through a join in the concrete, into the ground then to a land drain before discharging into the watercourse. About 1km of watercourse was impacted resulting in a category 2 incident.

#### Action Taken/Learning Points

- The land drain was blocked to stop the flow of effluent.
- The joint in the clamp was cut, cleaned and resealed.
- Additional pipes were installed around the clamp as a precaution to direct effluent to an underground storage tank.
- A vacuum tanker was purchased by the operator in case of future emergency.

## September 2015 - Wastewater Treatment Works

### Incident Summary

A vacuum within a storage tank occurred leading to the tank buckling inwards. Fortunately there was no loss of containment.

### Root Cause(s)/Learning Points

The top hat PRV had rusted due to the acidic atmosphere and dropped down, creating a seal.  When the odour control unit began operating a vacuum was formed in the screened sludge storage tank resulting in the tank walls, which were made of steel, being drawn in under vacuum and buckling.

## September 2015 - Waste Water Treatment Works

### Incident Summary

A release of approximately 24,750m3 biogas from pressure relief valves on 3 digester tanks occurred as a result of a failed (leaking) gas storage dome.  Two storage domes were in situ on site but one was already out of service and had not been replaced/repaired.  The Environment Agency 'red-carded' the plant (i.e. did not visit because of potential H&S implications).

### Root Cause(s)/Learning Points

- Failing to identify and provide adequate contingency measures for the management of gas and sludge under abnormal operating conditions. Inadequate HAZOP assessment.
- Lack of maintenance and inspection and review of previous failures.
- Failing to react to indicators that the gas dome was failing.  Continued feed to reactors resulting in diversion to PRV for gas management.
- Failing to follow procedures.
- Pipe-work connections meant there was no ability to by-pass the gas-domes and send the gas directly to the flare or CHP's resulting in direct release to atmosphere from PRV's.
- Pipe-work was mostly underground making inspection for further leaks difficult.

### Action Taken/Learning Points

- Installation of temporary pipe-work to by-pass gas storage domes and enable gas flow to CHP & flare.
- Full root cause analysis undertaken.
- Full HAZID assessment.
- Replacement of gas storage domes.
- Review of procedures, in particular inspection & maintenance schedules and Accident Management Plan.
- Review of internal processes.

## December 2015 - Agricultural Plant

### Incident Summary

Pollution of a local watercourse within the proximity of an AD plant. The unlined surface water 'attenuation' lagoon associated with the AD plant was grossly polluted. The cause appeared to have been the result of the silage within the clamp 'slumping' over the top of the clamp walls, allowing leachate to enter the nominally clean surface water system.

### Root Cause(s)/Learning Points

A deficient management system was the primary cause; failing to regularly inspect the lagoon or surrounding watercourses and overloading the clamp.

### Action Taken/Learning Points

- The operator did not agree that the polluted water within the attenuation pond could have travelled through the soil into the watercourse; however, they could not argue that the polluted water would potentially impact on groundwater given the lagoon was unlined and given the nature of the local geology.
- The operator updated their procedures and management system.
- The surface water system was re-directed into the foul system therefore no longer needing the attenuation pond.

## 1.5 Examples of Incidents - 2016

### February 2016 - Waste Water Treatment Works

#### Incident Summary

Following reports of odour which could be detected over 3km away, the regulator inspected a permitted sewage sludge treatment centre and traced the source of the odour to a reactor tank which was visibly venting biogas from the top of the tank.

Sewage sludge inside the reactor tank is heated up to 55 degrees centigrade to kill off pathogens as part of the treatment process. The operator had already removed some of the insulation cladding, and based on the rust staining on the tank and on the remaining cladding, it appeared the tank had suffered from leaks at the point the lid of the tank meets the side walls.

The water company were aware of the uncontrolled release of biogas from the reactor tank for at least three weeks before the regulator attended the site and the company was already receiving complaints about odour directly from members of the public. Despite this, the water company did not notify the regulator as they should have done in accordance with their permit.

#### Root Cause(s)/Learning Points

Sewage sludge can be highly corrosive on steel tanks particularly at the point where the tank falls short of being full where liquid interfaces with the air/gas space inside the tank.

The tank had sustained some visible damage back in 2011 when it was over pressurised. Monitoring of the tank's condition since then was done by visual inspection alone and no informative structural survey was carried out to determine the future operational life of the tank. Cladded tanks can hinder the effective inspection of the tank walls themselves in spotting the early signs of corrosion occurring. Therefore, when installing cladded tanks consideration needs to be given to providing access to inspect the tank walls especially at the level of where a tank is normally filled to.

The odour problem was compounded by delays in sourcing and fitting specialist parts to enable the damaged tank to be fully isolated and bypassed.

The monitoring of the tank and whether it remained fit for continued use was not effective in ensuring that repairs were made or a replacement was installed before the tank started to vent biogas to atmosphere causing a significant and widespread odour problem.

**Action Taken/Learning Points**

– A drop off in biogas supply to Combined Heat & Power (CHP) plants or gas engines could be a strong indicator of biogas escaping from the system requiring immediate investigation and attention

– Retain critical and specialist parts in stock

– The tank was subsequently replaced with a new tank

## June 2016 - Digestate Spreading

### Incident Summary

Environment Agency officers responded to a report of water pollution and confirmed a category 1 incident due to the number of fish deaths. The operator of a permitted AD waste facility reported that digestate was entering a tributary to a main river during a digestate spreading operation. Ammonia levels in the river were high and believed to be the cause of fish deaths. Pumping and aeration of the watercourse was required.

### Root Cause(s)/Learning Points

The digestate from an operators AD process was being spread onto farm land when a hose broke and discharged digestate into a ditch which fed a tributary to a main river. There was no flow measurement or manual checks carried out during transfer of the digestate to land.

## September 2016 - Agricultural Plant

### Incident Summary

During maintenance to reconfigure pipework, a carbon filter was disconnected from the CHP engine leaving the inlet and outlet ports prone to air ingress. CCTV footage showed smoke being emitted from the isolated unit which eventually caught fire causing significant damage to the CHP system and building which is shown in the photo to the left. This caused significant downtime of the digestion process.

A second incident occurred at a gas upgrading plant. They injected oxygen into a carbon filter to increase the life of the activated carbon. Within 24 hours there was a fire in the activated carbon tank.

### Root Cause(s)/Learning Points

Activated carbon is usually processed charcoal which has a high surface area in comparison with other packing media. It is used in many industrial processes to adsorb organic chemicals including Volatile Organic Chemicals (VOCs) for example as a primary abatement, removing impurities from biogas to protect CHP engines or as a polishing 'tertiary' process.

It can be impregnated with a range of different chemicals for specific applications, for instance it is commonly impregnated with 5-10% caustic soda to improve the removal of hydrogen sulphide.

Organic chemicals in an airstream 'stick' to the activated carbon as they pass through it. The size of the carbon filter, concentration of pollutants and the airflow will determine how long the carbon lasts before it is saturated and requires replacing.

Adsorption onto activated carbon is an exothermic process generating heat. For certain classes of chemicals including organic sulphur compounds (e.g. mercaptans), aldehydes, ketones and some organic acids this reaction is more exothermic resulting in the generation of high temperatures.

Under normal operating conditions, the elevated temperatures do not pose a fire risk. When a carbon filter is operated at its design airflow rate, this flow of air dissipates the heat of adsorption meaning that temperatures required to start a fire cannot be achieved.

## Action Taken/Learning Points

Carbon filters can be fitted with fire prevention measures such as one way valves, vacuum relief valves and pressure relief valves. However, there generally appears to be little understanding of fire risk and it is therefore not clear how widespread fire prevention measures are understood or have been implemented.

As a minimum:

The operator should be able to demonstrate adequate design of the carbon filter. Assessment of pre-treatment requirements, grade of carbon, proposed airflow, composition of the airstream and residence time can used to estimate the required size of filter.

It is important that the operator can demonstrate how they monitor the effectiveness of the carbon filter to determine when the carbon needs replacing. This can be done by testing the carbon itself or monitoring the outlet gas.

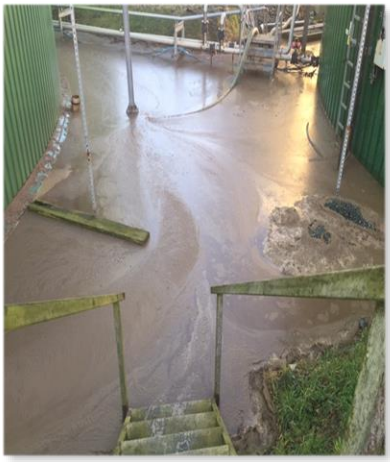
The operator needs to demonstrate what other monitoring is in place for the inlet / outlet gases, visual checks, airflow rate and residence time. Temperature monitoring may not be sensitive enough to detect localised changes in temperature whereas carbon monoxide monitoring is a much better early indicator.

The operator should demonstrate that they understand the risk of fire and outline what fire prevention measures are in place for the activated carbon filter, especially during maintenance and/or downtime.

*References: IChemE Symposium Series No. 141 – Thermal stability of activated carbon in an absorber bed*
*OSHA Hazard Information Bulletins – Fire hazard from carbon adsorption deodorising systems*
*Air & Waste Manage. Assoc 51:1617 – 1627 – Carbon bed fires and the use of carbon canisters for air emissions control on fixed-roof tanks*
*CPL Carbon link - Operating Guidelines for the Reduction of Fire Risk in Systems Utilising Activated Carbon*

## November 2016 - Food Waste Plant





### Incident Summary

177 tonnes of raw processed food waste was lost into the contained area of an AD facility.  No pollution to the environment occurred from the spilled digestate because of full containment being installed.

The level alarms for the tank did not activate because the rate of lowering was not steep enough to trigger them.

The clean-up was made difficult and time consuming due to the mixture of surfaces on site.

Shortly after the incident heavy rain accumulated on the contaminated ground of the site, flooding at the lowest point and compromising infrastructure such as the fans which maintain the gas storage dome. The rainwater was considered contaminated under APHA animal by-products rules which complicated disposal options.

### Root Cause(s)/Learning Points

A submersible mixer within the tank had moved and damaged the tank due to incorrect installation. The mixing tank had recently been brought back into service following a tank refurbishment.  There had been insufficient oversight of the process to re-commission the tank.

### Action Taken/Learning Points

- Immediate emergency steps were taken to lower the tank contents to stop the leak. This involved utilising an adjacent tank which was empty and open awaiting refurbishment.
- The operator was able to access additional storage (alligator bags, tankers, empty clamp, hired in skips) to hold liquids.  The ABP status meant these required disposal/further treatment.
- Consequences of flooding were reviewed and dome fans raised off the ground.
- Document review to address control of change and commissioning procedures.

## 1.6 Examples of Incidents - 2017

### November 2016 & March 2017 - Associated Storage Site




#### Incident Summary

Environment Agency officers responded to reports of water pollution on 2 separate occasions. Large maize storage heaps produced significant quantities of silage effluent during winter which pooled in the field and entered a land drain, discharging directly into a nearby watercourse. On a second occasion silage effluent flowed over a bank into a roadside swale which connected to the same watercourse. Land drainage routes had been highlighted as a possible issue to the operator (land tenant) prior to storage.

#### Root cause(s)/Learning Points

The maize silage was stored for an excessive period of time due to the anticipated AD plant identified to receive the silage not being built. This led to a build-up of effluent and there was inadequate containment to manage it. The operator wasn't aware of any land drains, but they hadn't done proper checks for them at the storage location.

#### Action Taken/Learning Points

The field heaps were eventually moved by the farmer and advice was provided to him with regards to storage and land-drain assessment. For incident 1, the watercourse was bunded off and tankered out and the land drain was blocked off. For incident 2, the swales and pools of effluent by the heap were tankered out.

## December 2017 - Agricultural Installation

### Incident Summary

Following complete loss of power, a digester suffered an over-pressure event leading to the release of biogas and over-topping of digestate through the top hatch and relief valves. This was the second over-pressure event at the plant.

### Root cause(s)/Learning Points

The over-pressure event occurred after the site lost power. Typically a generator provided back-up but this also served to provide power during insufficient electricity supply, e.g. start-up events. There was a momentary power loss event in the national grid whilst the back-up generator was running. This allowed the back-up generator to put power back into the national grid uncontrolled and therefore all the breakers tripped as a protection measure.

There was no uninterruptable power supply (UPS) for the router to enable remote access which meant off-site operators were unable to adequately assess the situation. Power to critical safety features such as the flare, dome inflation and process monitoring was not maintained because of failure of the back-up power generation system.

### Action Taken/Learning Points

- The Power Failure procedure was re-written and made live on the system.
- The router for the site was connected to the UPS.
- 24 hour manning was put in place.
- The electrical import value was increased to 500 KW on a permanent basis meaning the generator and mains transformer would not need to work in parallel.
- Tank inspection undertaken.
- Digestate spill (contained on-site) was cleaned up.

## 1.7 Examples of Incidents 2018

### Summary Case Studies: Waste Water Treatment Plants

June 2018

Case study 1 - Large holes due to corrosion midway down a sludge tank resulting in a pollution incident and loss of storage capacity.


July 2018

Case study 2 - Holes appearing in pre-treatment and pre-thickened buffer tanks due to Hydrogen Sulphide corrosion. Ineffective maintenance programme that ensured tanks were repaired or replaced before visible holes occurred.

November 2018

Case study 3 - Failure in the automated process where a pump filing a cake reception silo did not cut out and continued to fill the silo resulting in loss of containment and odour pollution.

## April 2018 - Agricultural Plant



### Incident Summary

Significant loss of silage effluent to ground from numerous points on site including the silage clamps, site drains and lagoon. Scale of the loss was estimated to be approximately 500m$^3$.  Ammonia levels averaged ~50mg/l and BOD ~700mg/l.

Significant risk to surface waters from contaminated surface water run-off and contamination of field drains.  Site within close proximity to a main river and located upstream of an abstraction point used for public drinking water supply.

### Root Cause(s)/Learning Points

Poor construction methods and CQA process.  Poor management and inspection of plant and equipment.

## April 2018 - Food Waste Installation


### Incident Summary

The AD plant has a biogas upgrading system for biomethane injection to the gas grid. The biomethane is separated from the rest of the gases in the biogas mixture by a water absorption system. The waste gases of mainly carbon dioxide, and low levels of hydrogen sulphide and VOC's are treated before emission to air.

The waste gas treatment system is made up of:

- A catalytic iron filter (CIF) which reacts iron oxide media with hydrogen sulphide gas to form iron sulphide which is then converted to sulphur.

- A ferrosorp tank which contains ferrosorp pellets and removes hydrogen sulphide.

- A UV treatment system to destroy VOC’s.

- 2 in-line carbon drums for final H2S and VOC removal.

In April 2018 the CIF unit caught fire. The gas upgrading plant had to be shut down as a result and fire service were on site overnight to extinguish the fire and subsequently keep the unit cool. The fire did not spread to other units in the waste gas upgrading system although the neighbouring ferrosorp tank did heat up. No other parts of the site were affected by the fire.

**Root Cause(s)/Learning Points**

Investigation into the cause of the fire concluded that the most likely cause was the formation of pyrophoric iron sulphide within the CIF. This can form if there is not enough oxygen to react with the iron sulphide.

The system had a constant air flow into the unit and it was not possible to block or bypass this as it would automatically shut the gas upgrading system. Also the media had to be water washed daily to remove sulphur build up and expose the media surface. This was completed automatically on a wash cycle. The system was operated in accordance with the manufacturers recommendations and the fire was thought to be an exceptional event.

Improvements to the system were identified after the incident. The CIF was replaced with two large ferrosorp units as these presented a reduced fire risk. Temperature monitoring and a firewater system was installed and additional in-line H2S monitoring put in between each stage.

## July 2018 - Food Waste Plant

### Incident Summary

A fire engulfed a control room and spread to nearby mixing and digester tanks and their associated pipework. Biogas holders above the tanks were completely destroyed by the fire and the biogas burned off to atmosphere. Damage was also caused to pipework and the concrete walls of the two affected tanks but they did not collapse and no digestate was lost.

### Root Cause(s)/Learning Points

An electrical fault in the control room sparked the fire. The control room was situated next to the tanks making spread of fire easier.

### Action Taken/Learning Points

- New concrete bund to provide secondary containment for all digestate tanks built to CIRIA c736 standard. (Gas engines kept outside the bund)
- All 'legacy' plastic pipework and fittings (only small number of these) replaced.
- Affected tanks replaced with new concrete tanks.
- CQA of existing tanks in place providing confidence in construction materials & methods
- Cladding on all tanks replaced with an alternative material with higher level of fire resistance.
- Additional gas alarms were installed on site.
- Revised Fire Response Plan (avoiding use of cold water on hot concrete)
- Improved liaison with the Fire & Rescue Service in AD matters.

## October 2018 - Waste Water Treatment Plant

### Incident Summary

A valve on a sludge line used for obtaining samples disintegrated during sampling and injured an employee's knee requiring them to have hospital treatment. Digestate escaped into the AD compound. The site had been previously 'red-carded' (deemed not safe to visit by EA) because of a lack of written procedures to demonstrate the site was being adequately managed at that time.

### Root Cause(s)/Learning Points

Equipment failure. Lack of inspection & maintenance. No pollution because digestate spilled was contained on site.

### Action Taken/Learning Points

- Equipment replaced
- The valve that failed was a standard type of valve used across the industry and rated for use in its application.
- Investigation carried out at sister sites - valves of the nature of the failed unit were found not to be utilised on any associated pipe work.
- Improved inspection and maintenance procedures

## October 2018 - Agricultural Facility (Non-regulated)



### Incident Summary

A lightning strike hit a digestate storage tank resulting in a fire which destroyed the inner and outer roof membranes. The strike hit at 01:30am so the site was unmanned at the time. The Fire Service attended and SCADA alarms alerted the operator. The tank had been mostly drained (~1m depth) of its digestate beforehand due to planned maintenance the following day. The gas supply had already been isolated from the rest of the tanks and gas was not being drawn from it. Minimal biogas lost to atmosphere and minimal environmental impact as a result however process downtime and costs associated with replacing the roof.

### Root Cause(s)/Learning Points

Lightning strike

**Action Taken/Learning Points**

- Operator logged in remotely immediately after being alerted and attended site within 15 minutes. Fire Service already present.
- Members of the local fire brigade who attended had received on-site AD awareness training by the same farmer/EA and therefore aware of the risks associated with the plant.
- The strike interrupted both solid feeders and various other electrical components but the flare and CHP reactivated so no venting of gas from other tanks. Strike affected internet supply in the upgrading plant and some hardware.
- Network Entry Unit damaged therefore CHP utilised.
- Full visual inspection of tank integrity (concrete) by independent structural engineer. No significant damage to tank walls, base or internal struts. Roof required full replacement.
- Full re-commissioning of tank
- De-brief between EA, operator & Fire Service

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