Section 1
Health and Safety: Information Guidelines

The following health and safety procedures must be adhered to. The site owner / operator should also refer to http://www.hse.gov.uk/ to ensure compliance with applicable regulations.

- The anaerobic digestion process generates biogas; this biogas is made up of 3 primary gasses, methane, carbon dioxide and some hydrogen sulphide.
    - Methane (CH_4) present at approximately 60%, which is a highly flammable gas.
    - Hydrogen sulphide (H_2S) is flammable and toxic to humans. Dangerous to human health at 100 parts per million (PPM). Above 500 ppm will lead to death within a few minutes of exposure. H_2S is present inside the AD tank. If the tank must be entered breathing apparatus must be used. The Commissioning Agent must be contacted before attempting to enter the AD tank.
- No naked flames within 50 meters of the digester or gas holder.
- If a gas leak is suspected, shut off relevant pumps and valves. If this does not stop the gas leak shut of all electrical equipment and anything that can cause a spark, contact the local relevant authorities so the area is made safe to work in allowing the gas leak to be repaired.
- In addition to compliance with standard HSE guidelines, when working on the AD plant (AD plant refers to any equipment associated with the AD unit and energy production) it is the individuals responsibility to make sure that
    - the area they are working in is safe
    - that they can operate all equipment competently
    - that they know how to switch off equipment to prevent injury
- Often there will be heavy machinery working in close proximity to the AD plant, careful operating procedures of all machinery operators must be carried out to ensure that no damage is caused to the AD plant such that would cause a leak of gas etc.
- The AD Plant owner is responsible to advise/provide personal protective equipment (PPE).
- If working at heights, proper safety equipment must be worn.
- You also need to comply with:

Dangerous Substances and Explosive Atmosphere Regulations 2002 (DSEAR)

Pressure Systems Safety Regulations 2000

Confined Spaces Regulations 1997

Supply of Machinery (Safety) Regulations 2008

Electricity at Work Regulations 1989

Control of Substances Hazardous to Health Regulations 2002 (COSHH)

http://www.extension.org/pages/30311/anaerobic-digesters-and-biogas-safety

1.1 Substances Hazardous to Health

There are substances that are potentially hazardous to health within the anaerobic digestion site/process. It is imperative to fully understand the risks and control measures surrounding the safe use of and working within proximity to these substances. It is therefore necessary for all persons working on the plant to read and understand the following information.

1.1.1 Hydrogen Sulphide (H_2S)

Hydrogen sulphide is a colourless, flammable, extremely hazardous gas with a "rotten egg" smell. It can be produced by the breakdown of organic matter and human/ animal wastes (e.g., slurry). It is heavier than air and can collect in low-lying and enclosed, poorly ventilated areas such as mixing pits, pre-store tanks, post store tanks, slurry lagoons, manholes, slurry channels.

Detection by Smell

- Can be smelled at low levels, but with continuous low-level exposure or at higher concentrations you lose your ability to smell the gas even though it is still present.
- At high concentrations – your ability to smell the gas is lost instantly.

! DO NOT depend on your sense of smell for indicating the continuing presence of this gas or for warning of hazardous concentrations.

! DO NOT enter the mixing pit or emptied digester or post store without testing the atmosphere with a calibrated tester.

Health Effects

Health effects vary with how long, and at what level, you are exposed. Asthmatics may be at greater risk.

Low concentrations – irritation of eyes, nose, throat, or respiratory system; effects can be delayed.

Moderate concentrations – more severe eye and respiratory effects, headache, dizziness, nausea, coughing, vomiting and difficulty breathing.

High concentrations – shock, convulsions, unable to breathe, coma, death; effects can be extremely rapid (within a few breaths).

Before Entering Areas with Possible Hydrogen Sulphide

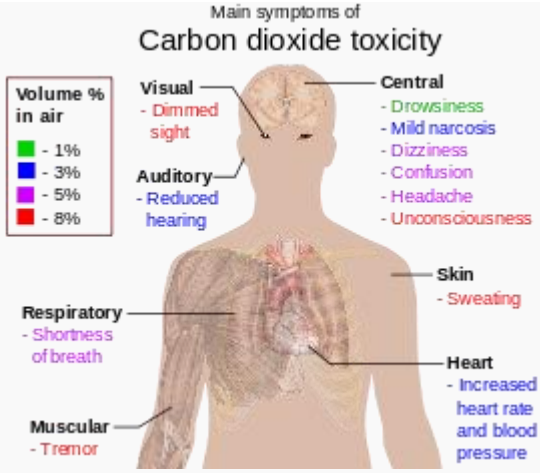
! The air needs to be tested for the presence and concentration of hydrogen sulphide by a qualified person using test equipment. This individual also determines if fire/explosion precautions are necessary.
! If gas is present, the space should be ventilated.
! If the gas cannot be removed, use appropriate respiratory protection and any other necessary personal protective equipment (PPE), rescue and communication equipment. Atmospheres containing high concentrations (greater than 100 ppm) are considered immediately dangerous to life and health (IDLH) and a self-contained breathing apparatus (SCBA) is required.

If you are in a potential risk area, testing for the presence of the gas should be maintained throughout. For example: If clearing a blocked slurry channel there may be gas behind the blockage which could flood in when the blockage is cleared. If breaking the crust or mixing in a pit, lagoon or channel gas may be present beneath the surface, when this is disturbed the gas may flood out.

1.1.2 Methane CH_4

Methane is nontoxic, yet it is extremely flammable and may form explosive mixtures with air. Methane is violently reactive with oxidizers, halogen, and some halogen-containing compounds. Methane is also an asphyxiate and may displace oxygen in an enclosed space. Asphyxia may result if the oxygen concentration is reduced to below about 16% by displacement, as most people can tolerate a reduction from 21% to 16% without ill effects. The concentration of methane at which asphyxiation risk becomes significant is much higher than the 5–15% concentration in a flammable or explosive mixture. Methane off-gas can penetrate the interiors of buildings near landfills and expose occupants to significant levels of methane.

1.1.3. Carbon Dioxide CO_2



Main symptoms of carbon dioxide toxicity, by increasing volume percent in air

CO_2 is an asphyxiate gas and not classified as toxic or harmful in accordance with Globally Harmonized System of Classification and Labelling of Chemicals standards of United Nations Economic Commission for Europe by using the OECD Guidelines for the Testing of Chemicals. In concentrations up to 1% (10,000 ppm), it will make some people feel drowsy and give the lungs a stuffy feeling. Concentrations of 7% to 10% (70,000 to 100,000 ppm) may cause suffocation, even in the presence of sufficient oxygen, manifesting as dizziness, headache, visual and hearing dysfunction, and unconsciousness within a few minutes to an hour.[84] The physiological effects of acute carbon dioxide exposure are grouped together under the term hypercapnia, a subset of asphyxiation. Because it is heavier than air, in locations where the gas seeps from the ground in relatively high concentrations, without the dispersing effects of wind, it can collect in sheltered/pocketed locations.

1.1.4. Ferrite Chloride

Iron (III) chloride is toxic, highly corrosive and acidic. The anhydrous material is a powerful dehydrating agent. Although reports of poisoning in humans are rare, ingestion of ferric chloride can result in serious morbidity and mortality. Inappropriate labelling and storage lead to accidental swallowing or misdiagnosis. Early diagnosis is important, especially in seriously poisoned patients.

1.1.5. Ammonia NH_4

The U.S. Occupational Safety and Health Administration (OSHA) have set a 15-minute exposure limit for gaseous ammonia of 35 ppm by volume in the environmental air and an 8-hour exposure limit of 25 ppm by volume. NIOSH recently reduced the IDLH from 500 to 300 based on recent more conservative interpretations of original research in 1943. IDLH (Immediately Dangerous to Life and Health) is the level to which a healthy worker can be exposed for 30 minutes without suffering irreversible health effects. Other organizations have varying exposure levels. U.S. Navy Standards [U.S. Bureau of Ships 1962] maximum allowable concentrations (MACs): continuous exposure (60 days): 25 ppm / 1 hour: 400 ppm Ammonia vapour has a sharp, irritating, pungent odour that acts as a warning of potentially dangerous exposure. The average odour threshold is 5 ppm, well below any danger or damage. Exposure to very high concentrations

of gaseous ammonia can result in lung damage and death.[49] Although ammonia is regulated in the United States as a non-flammable gas, it still meets the definition of a material that is toxic by inhalation and requires a hazardous safety permit when transported in quantities greater than 13,248 L (3,500 gallons). The toxicity of ammonia solutions does not usually cause problems for humans and other mammals, as a specific mechanism exists to prevent its build-up in the bloodstream. Ammonia even at dilute concentrations is highly toxic to aquatic animals, and for this reason it is classified as *dangerous for the environment*.

1.2 Hazard Assessment Biological/Mechanical/Electrical

Hazard Assessment

The basis for the development of a hazard assessment is to protect and to reduce the exposure to risk and hazards of employees. The employer must determine, evaluate, and minimize the hazards and must consider the acquired knowledge during design and selection of work tools, as well as the design of workplaces, work and production processes, work procedures, and interactions of all the above. The hazard assessment must be continuously updated according to the current state of knowledge and new operating conditions.

Hazardous substances according to the Ordinance on Hazardous Substances are substances that have hazardous properties. Hazardous properties are, for example, "harmful to health," "poisonous," "highly poisonous," or "caustic." Hazardous substances can be solid, in dust form, liquid, or can occur as an aerosol or as a gas.

Typical hazards

- ! Danger of asphyxiation and/or poisoning due to fermentation in gas/ biogas intake areas. Release of highly poisonous gases such as hydrogen sulphide.
- ! Hazards that occur particularly in systems that use additional substrates (waste, animal by-products) along with renewable raw materials, liquid and solid manure:
- ! Increased release of hazardous gases such as hydrogen sulphide, especially during mixing due to the reaction of the substances being used.

Hazardous Substances Assessment and protective measures

In principle, the development of hazardous gases must be prevented or minimized, to the greatest degree possible, or their release must be prevented or reduced. When using a chemical substance distributed by a supplier, the operator can use the material data safety sheet (MSDS) to assist the development of a hazard assessment. The MSDS is generally provided by the supplier of the chemical products. If mixing of different materials is required for operational reasons, no materials should be combined from which the generation of hazardous gas concentrations due to reactions (e.g., acid-base reactions, large differences in temperature) could result. In particular, hydrogen sulphide can be released due to the addition of acidic components; ammonia can be released due to the addition of alkaline components. In order to be able to assess such reactions, operators of biogas systems must request the following information from the producers of the additional substrates and document in the daily operations log:

Information about Substances Being Used

- Waste code number, essential ingredients or substances, chemical structure, pH value and additives, e.g., stabilizers, preservative agents, etc.,
- Origin information (e.g., from slaughterhouse, from the pharmaceutical production of Heparin….),
- Transport and delivery conditions (e.g. duration of transport, temperature …), and
- Possible hazards (e.g., "can release hydrogen sulphide with the addition of acidic substances").

If the generation of hazardous gases, especially H_2S (see section 1.1), cannot be excluded, their release must be prevented or reduced, e.g. by closed filling, spatial separation or their forced discharge.

Note: Hydrogen sulphide is a highly poisonous, colourless gas that smells like rotten eggs. It can be life threatening even at low concentrations. From a certain concentration, the sense of smell is disabled, and the gas is not perceived. Substances with high sulphur content are, for example:

- Slaughterhouse waste
- Biomass waste (mycelia) from biotechnical processes
- Rape-seed cake
- Feedstuff residuals (e.g., soy protein)
- Food leftovers
- Methionine from the animal feed (feedstuff additive)
- Residue from the generation of yeast
- Preservative agent sodium bisulphite
- Additives, e.g., iron sulphate

Biological Agents

In the Ordinance on Bio-substances, "biological agents" are defined as microorganisms that can cause infections or have sensitizing or toxic effects in humans. These are primarily moulds, viruses, and bacteria.

Typical Hazards

- Inhaling dusts or aerosols containing moulds, bacteria, or endotoxins, e.g., from moist silage or dry chicken manure.
- Additional hazards in systems using additional substrates (waste, animal by-products) along with renewable raw materials, liquid and solid manure: biological agents in co-substrate (e.g., pathogens), hand contact during sorting.

Operational Information

Workplace/Work Area: Biogas system, liquid manure pits, liquid manure ducts, liquid manure storage facilities, shafts, etc.

Activity: Stirring, flushing, pumping, transferring, removing liquid manure or substrate, repair and maintenance work, and presence in the liquid manure or substrate work areas

Risks

Liquid Manure and Biogases (Hydrogen Sulphide, Methane, Carbon Dioxide, Ammonia). Hazards for Humans and the Environment the gases are released especially through the movement of the liquid manure or substrate. In the process, hazardous gas concentrations can develop, which remain over long periods.

- ! Life threatening danger – hydrogen sulphide (H_2S) Caution: H_2S disables the sense of smell, higher concentrations are no longer noticed
- ! Danger of asphyxiation due to carbon dioxide (CO_2)
- ! Explosion hazard due to methane (CH_4)
- ! Health hazard due to ammonia (NH_4)

Protective Measures and Rules of Conduct

Never enter the digester, storage facilities, pits, shafts, etc., without protective equipment and risk management strategy`s. This applies even when the area has been cleared of liquid slurry. The atmosphere must always be tested with a calibrated meter and sufficient ventilation provided. Enter only with a breathing apparatus that is not dependent on the surrounding air, e.g., fresh air suction hose device and lifebelt, as well

as approved rescue apparatus. When working with liquid manure or substrate, any kind of ignition source must be avoided:

- Switch-off gas jet devices
- Smoking is prohibited
- No light test
- Do not perform any welding or thermal cutting – sparks and welding beads can fall also in pits that are far away (If such work is absolutely necessary, ensure good ventilation, e.g., using fans. Pits must be covered.)

Hazardous Machinery

DANGER AUTOMATIC MACHINARY MAY START WITHOUT ANY WARNING!

The Fre-Energy AD plant is a fully automated system. It is designed to perform operations as and when required by internal timers or sensors within the computer program. Therefore, all pumps, solenoid pneumatic valves, hydraulic valves, solid feed in system including walking floors and any other machinery involved in the system will operate automatically. It is critical that before work is carried out on any equipment it is isolated and locked off at the appropriate isolation switch/ circuit breaker. It is not recommended or acceptable to work solely relying on the Emergency Stop switch for protection.

There are several hazardous machines/processes on site. Great care should be taken to manage or remove the risk involved with working on and around this equipment.

Top Drive

Risks The hydraulic arms that rotate the top drive operate automatically. They work off timers set in the PLC. They will only stop when the set max pressure is reached, or timer has expired. Therefore, if a person were to put themselves in a position between the arms and the top drive the rams would continue to operate until an extremely high amount of force had been applied which would result in significant injury or death to the individual. When observing the operation of the rams stay clear of them at all times.

Preventative Isolate and lock off the top drive at the rotary isolators for both hydraulic pumps before starting work. Never place yourself in danger when observing the operation of the equipment. Do not adjust the equipment when it is running.

Gas Mixing Pumps

Risks The gas mixing pumps operate automatically from timers in the PLC and will therefore start without warning. Before attempting to carry out any maintenance on the pumps or belts they must be isolated and locked off at the Gas Mixing Panel main isolator in the control container. There is no local isolator near the pumps as this is an Atex Zone. Care should be taken to allow the pumps to cool for a short period before work commences to prevent the risk of burns.

Preventatives Before working on gas mixing pumps always isolate and lock off at the Gas Mixing Panel Isolator. Allow enough time for pumps/ pipes to cool.

TT Chopper Pump

Risks TT pumps should be lifted out of the mixing pits before maintenance is carried out. There is a risk of dangerous fumes inside the mixing pits. All TT pumps are wired to a local Isolator with a 3-phase socket for easy removal. Make sure the plug is removed and coiled up prior to removal to prevent damage to the cable. The TT chopper pump may start without warning.

Preventatives Isolate and remove plug. Remove from Mixing Pit.

Orbinox Pneumatic Valves:

Risks Entrapment/Crushing could occur if maintenance on or around the valves was carried out without isolating first. The force of these valves is such that serious injury could occur if a person was to place themselves in the way of them as they operate. To isolate and make the Orbinox valves safe and ready to work on press the emergency stop and turn off the compressor isolator. Empty the compressor via the drain tap until the pressure gauge reads 0 psi/empty.

CHP

Follow supplier's safety recommendations.

Electrical Hazards

All electrical works on site should be carried out by a qualified electrician/engineer. Visual checks should regularly be carried out to ensure the integrity of all electrical equipment is maintained. Any signs of damage, water ingress or malfunction should be remedied as soon as possible to maintain the safe condition of the site. Electrical connections in control panels and in equipment which is in areas with high vibration levels should be checked periodically to ensure a good connection is maintained. This should be carried out every 6 months to reduce the risk of an electrical malfunction/fire. Safe Isolation Procedure must be performed when needing to disrupt the electrical system for both mechanical and electrical alterations. An Electrical Installation Condition Report is recommended to be carried out every 3 years by a suitably qualified electrician to ensure the wiring/installation is still in a satisfactory condition.

1.3 COSHH Assessment

What Is a COSHH Assessment?

A COSHH assessment is a systematic examination of a task or process that involves using a potentially hazardous substance. The COSHH Assessment is carried out for the purpose of:

- Identifying the substances that you use that are potentially **hazardous** (a hazard
- is something that has the potential to cause someone harm or ill health).
- Deciding whether the precautions you have already taken reduces the risk of someone being harmed to an acceptable level, and if not:
- Deciding on what further **control measures** you must take to prevent or control the exposure to an acceptable level.

What COSHH requires

To comply with COSHH you need to follow these eight steps:

Step 1. Assess the risks: Decide what the risks to health are from hazardous substances used or created by your work.

Step 2. Decide what precautions are required: Do not carry out work which might expose your employees to hazardous substances.

Step 3. Prevent or control the exposure: First try to prevent exposure to hazardous substances, if this is not possible you must control the exposure to defined limits.

Step 4. Maintaining the standards: Make sure any control measures are used and maintained.

Step 5. Monitoring: Monitor the exposure of the substance to your employees where a risk assessment has deemed it necessary.

Step 6. Health surveillance: Carry out health surveillance where your risk assessment has shown it to be necessary.

Step 7. Prepare an emergency plan: Draw up plans to deal with emergencies such as spillages etc.

Step 8. Training: Make sure your employees are properly informed, trained and supervised.

Example COSHH Form

This assessment ***only addresses the risk of harm to health*** from the substances listed. Additional risk assessments may be required to control the risk from other hazards associated with this work/ the procedures used.	
Assessor (print)(1)	Employer/Supervisor (2)
Assessment Date (3)	Dates reviewed (4)

HAZARDS IDENTIFIED If the substance has a R45 or R49 risk phrase or a H350 or H350i hazard statement, it must also be registered on your personal carcinogen return (at Occupational Health) *where exposure is not adequately controlled*.

Substance (5) *(Name of Chemical, etc. as appropriate)*	Hazardous Properties (6) *(Provide details of how the substance could cause harm, e.g. harmful by inhalation, skin contact, flammable, carcinogen, allergen, etc.)*	Quantity (7) *(Indicate how much of the substance will be used)*
Additional information (8) Workplace Exposure Limits: R-phrases: S-phrases: H and P statements:		
Emergency Procedures (9) Eye contact: Inhalation: Skin contact: Ingestion: Spill procedure:		
What will the chemical be used for? Who may be exposed? (10)		

METHODS OF PREVENTION OR CONTROL OF EXPOSURE (select all that apply by circling/ticking/highlighting the appropriate statement)	
1. Engineering controls required (11) total containment fume cupboard local exhaust ventilation blast screen	**2. Access control (12)** restricted to competent personnel special containment facility (give specific area):
3. Special procedures (13) Standard Operating Procedure (SOP) required ☐ Code of practice, local rules, etc. ☐	**4. Approved PPE** (14) *(Note: PPE is to be used as the 'last resort' when controlling exposure)* gloves etc. (specify type) eye protection (specify type) laboratory coat/overalls (specify type) other PPE (specify)
Disposal procedures (15) Are chemicals with risk phrases R50-R59 or hazard statements H400 – H413 (environmental hazards) involved? Yes / No	
TRAINING REQUIREMENTS (16) (List any specialised training requirements before work can begin)	
HANDLING AND STORAGE REQUIREMENTS (17) (Note any special requirements e.g. ventilation, chemical incompatibility, flash point, etc)	

ASSESSMENT OF RISK USING CONTROLS DETAILED ABOVE (18)
(Are the hazards/risks suitably controlled, using the control measures detailed above? If not, state the further actions required, e.g. Requirement for a standard operating procedure (SOP), etc.).

Authorisation by Employer/Supervisor (19)

I confirm that I have considered and understand the chemical to be used and the associated hazards. I am satisfied that all of the hazards have been identified and that the control measures to be followed will reduce the risks to as low a level as reasonably practicable.

Print name: Signed:

Date:

Declaration by Employer/Supervisor (20)

I confirm that I have read this COSHH Assessment and that I understand the hazards and risks involved and will follow all of the safety procedures stated.

Declaration by employee (21)

I confirm that the employee who has signed below is competent to undertake the work. My counter-signature indicates that I am happy for the work to proceed.

Name (please print)	Signed	PI countersignature	Date

Guidance notes for COSHH assessment form

This form must be completed for every hazardous chemical used within the company. The form must be signed by the employee and their employer/supervisor before the work starts.

(1) Assessor: Insert the name of the person doing this assessment

(2) Employer/Supervisor Insert the name of the Employer/Supervisor.

(3) Assessment Date: Insert the date that the assessment form is completed. The assessment is valid for a maximum of 1 year. It must be reviewed after 1 year, or if a significant change occurs (change of lab, pregnancy, etc.).

(4) Dates reviewed: all COSHH assessments must be reviewed annually (as a minimum). The review date should be entered here, and signed by the assessor to confirm that the assessment is still valid.

(5) Substance: insert name of the chemical to be used. NB. Biological hazards must not be assessed on this COSHH form.

(6) Hazardous properties: insert details of all the hazardous properties of the chemical – egg. Flammable, explosive, carcinogen, harmful by inhalation, etc.).

(7) Quantity: insert quantity to be used (mg, g, ml, etc.)

(8) Additional information: Include details of any additional information, including any workplace exposure limits. Detail fully all R/S phrases and H and P statements (it is not sufficient to simply stat R45, full details are needed).

(9) Emergency procedures: provide full details of emergency procedures to be employed following contact with the chemical (skin contact, eye contact, inhalation and ingestion) – such as use of diphoterine, administration of emergency oxygen, etc. Also include details of emergency spill procedures.

(10) What will the chemical be used for? Who may be exposed? Insert title of experiment or experimental procedure that the chemical is to be used in, and detail who may be exposed (individual worker? People in close proximity? Cleaners? Engineers?).

Methods of prevention or control of exposure

Sections 11-14 detail the methods for preventing or controlling exposure to the chemical. The COSHH hierarchy of control measures should be used when determining the methods to be used to prevent/control exposure, with engineering and group control measures being employed in preference to individual measures (such as individual PPE).

(11) Engineering controls required: identify the control measures necessary to prevent/control exposure, such as use of a fume cupboard, LEV or blast screen, by circling/ticking/highlighting the appropriate statement(s).

(12) Access control: In order to prevent/control exposure, is it necessary to restrict access to competent personnel? Are special containment facilities required? Please circle/tick/highlight the appropriate statement(s).

(13) Special procedures: please identify any special procedures necessary to prevent/control exposure. This might include the need for an SOP to be developed, or for local rules to be drawn up. Please circle/tick/highlight the appropriate statement(s).

(14) Approved PPE: PPE is to be used as the 'last resort' when preventing/ controlling exposure. Please detail the PPE to be used when handling the chemical. Please circle/tick/highlight the appropriate statement(s) and include details of the type of gloves to be used etc.

(15) Disposal procedures: Identify whether the chemical is an environmental hazard; Detail fully how the chemical waste is to be disposed of (down sink, by specialist contractor, etc.)

(16) Training requirements: detail any specialised training requirements that must be met before the work can begin – eg. Attendance on a gas safety course, etc.)

(17) Handling and storage requirements: Note any special requirements e.g. ventilation, chemical incompatibility, flash point, etc.

(18) Assessment of risk using controls detailed above: Are the hazards/risks suitably controlled, using the control measures detailed above? Provide details; If not controlled, state the further actions required, eg. Requirement for a standard operating procedure (SOP), etc.

(19) Authorisation by Employer/Supervisor: the employer/supervisor must sign and date the assessment, to confirm that they have considered and understand the chemical to be used and the associated hazards, and that they are satisfied that all the hazards have been identified and that the control measures to be followed will reduce the risks to as low a level as reasonably practicable.

(20) Declaration by employee: the employee must sign and date the assessment to confirm that they have read the COSHH Assessment, understand the hazards and risks involved and will follow all of the safety procedures stated.

(21) Declaration by Employer/Supervisor: the employer/supervisor must sign and date the assessment, to confirm that the researcher is competent to undertake the work.

1.4 Properties of Bio-Gas

Biogas consists essentially of methane (50 to 80% vol.), carbon dioxide (20 to 50% vol.), hydrogen sulphide (0.01 to 0.4% vol.), and traces of ammonia, hydrogen, nitrogen, and carbon monoxide. The occurrence of particulate matter must be factored in. Example: Methane 60% vol., carbon dioxide 38% vol., residual gas 2% vol.

	Biogas	Natural Gas	Propane	Methane	Hydrogen
Heating	6	10	26	10	3
Density (kg/m³)	1.2	0.7	2.01	0.72	0.09
Density Ratio to Air	0.9	0.54	1.51	0.55	0.07
Ignition Temperature (°C)	700	650	470	595	585
Maximum Flame Propagation Speed in Air (m/s)	0.25	0.39	0.42	0.47	0.43
Explosion Range (% Vol.)	6-12	4.4-15	1.7-10.9	4.4-16.5	4-77
Theoretical air requirement (m³/m³)	5.7	9.5	23.9	9.5	2.4

1.5 Explosion Risk Management

ATEX Zone Assessment

Potentially explosive areas are to be classified into zones. On site potentially explosive areas are identified at their entrances by appropriate signage with black lettering on a yellow background.

For example: 

Classification of the Zones

Potentially explosive areas are spaces in which a dangerous, potentially explosive atmosphere can occur due to the local situation and the operating conditions. Potentially explosive areas are classified into zones according to the frequency and duration of the occurrence of hazardous, potentially explosive atmospheres.

For areas that are subject to explosion hazards due to gases, the following applies:

Zone 0 is an area in which hazardous, potentially explosive atmospheres are present constantly, over long periods, or frequently, as a mixture of air and combustible gases, vapours, or mist.

Zone 1 is an area in which during normal operation a hazardous, potentially explosive atmosphere can occasionally form as a mixture of air and combustible gases, vapours, or mists.

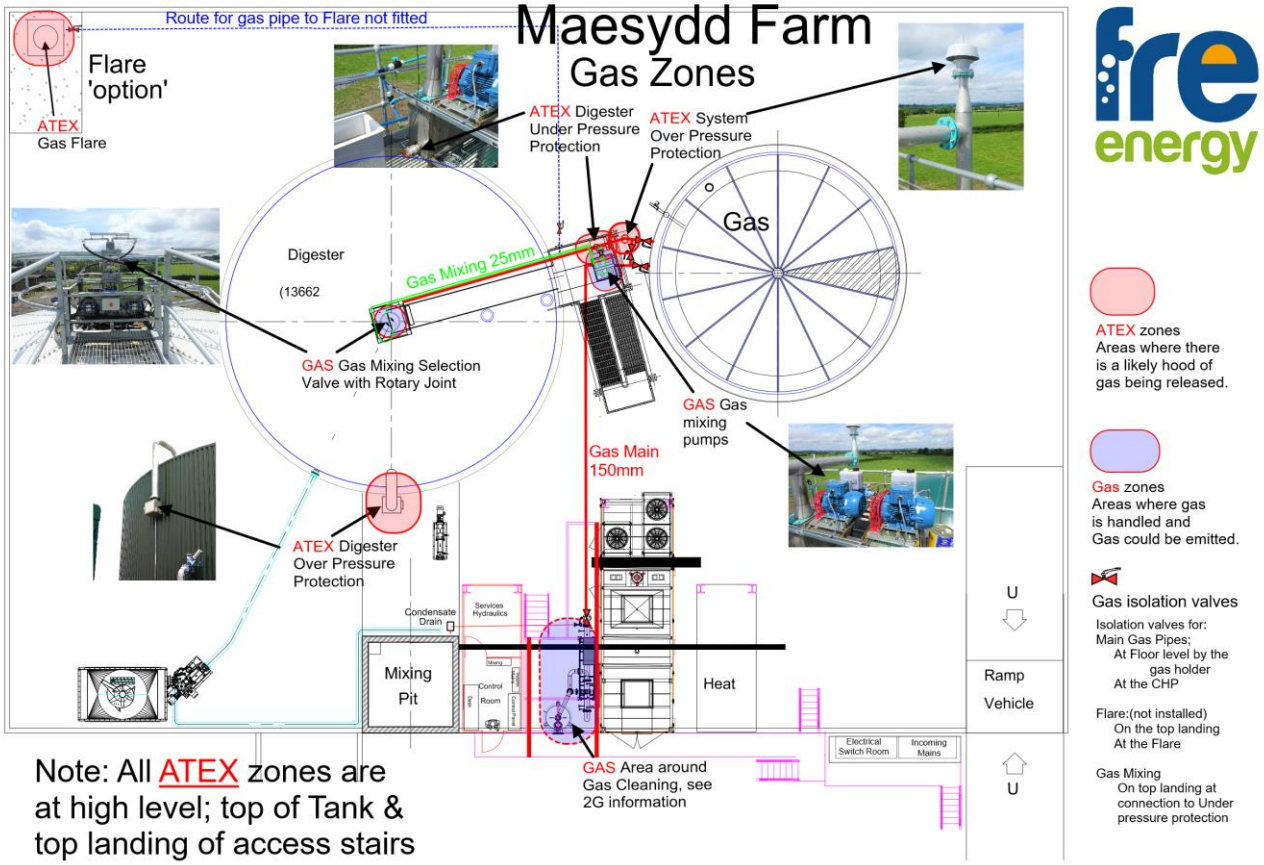
Zone 2 is an area in which during normal operation a hazardous, potentially explosive atmosphere as a mixture of air and combustible gases, vapours, or mists does not normally occur, or occurs only briefly.

The following site drawing outlines the zones where there can be a potential for an explosive/fire risk environment to exist. When operating in these areas you must not produce any ignition sources.

Explosion Hazards Ignition Sources

- Hot surfaces (Example: > 500°C (turbocharger)
- Open flames (Example: Fire, flames, cigarette embers)
- Mechanically generated sparks (Example: Rubbing, beating, grinding)
- Electrically generated sparks (Example: Switching operations, loose contacts, equalizing currents)
- Exothermic reactions (Example: Spontaneous ignition of dusts)
- Lightning
- Electrostatic discharges Explosion hazards must be determined and assessed. It must be determined where potentially explosive atmospheres can occur.

Example schematic



Gas processing

Desulphurization with iron-containing compounds or activated carbon

If biogas is desulphurized by means of iron-containing compounds, or by activated carbon, there exists a danger of self-heating during the regeneration. The safety information from the manufacturer, particularly information about the exchange of biogas treatment media, must be followed.

Desulphurization by air injection in the gas room over the digester

The air-dosing pump we use is selected such that it delivers at most a volume flow of 6 per cent of the biogas generated in the same time period. The air dosing even under a fault condition cannot force the area above the digester a potentially explosive region. Under no circumstances should the specification of the air dosing

pump be changed without a detailed consultation, failure to do this could lead to a hazardous environment being created in this space.

Hazards Due to Work Equipment and Systems Requiring Monitoring in Potentially Explosive Areas

The Ordinance on Industrial Health and Safety regarding systems requiring monitoring applies also to operations without employees, if there is a need for monitoring. This rule applies to biogas systems, due to the danger of biogas explosion. Systems in potentially explosive areas require monitoring, if they are, or contain, equipment, protection systems, or safety or control equipment. Any adjustments after a change/essential modification of a biogas system must be documented and tested and deemed safe by a competent person. This includes any change from the supplied standard equipment used on the initial construction of the site.

1.6 Safety equipment, overpressure protection

All Fre-energy supplied gas tight containers are equipped with at least one safety device against exceeding acceptable pressure. It is possible to shut off the gas containers individually and to shut them off from each other if there is more than one at your site at isolation valves local to the main off take pipe at the top of the digester. Foam formation inside the digester represents a disruption of the operation, and it must be prevented by operational measures. Destruction due to the formation of foam is prevented, via the foam alleviation tank/weir system. The foam alleviation tank must be topped up with water daily. As the tank is required to be in a submerged state, it must not run empty, dry, or freeze. There are ATEX approved heating elements inside the tank to prevent it from freezing should the external temperature drop below freezing. The foam alleviation tanks are dual purpose as they also provide overpressure protection for the digester. The weifferink gas holder overpressure system requires checking the level of antifreeze/water levels weekly. This system should not require topping up frequently like the foam alleviation system on the digester and if it does lose its level this should be followed up with a investigation into what is causing this. Follow manufacturer's instructions regarding periodic changing of antifreeze levels. Do not top up with water.

1.7 Operating Instructions Initial Start-up/Restart of a Biogas System

The initial start-up of a biogas system is a special operating state, which requires special actions. Care should be taken in the areas specified in the gas zones and isolating valves document. Also, regarding the atmosphere inside the digester and post store.

1. During the initial start up, a hazardous, potentially explosive atmosphere can occur in the gas space of the digester container and post store. Ignition sources must be avoided (e.g., Under no circumstances operate the submerged propeller in the post store before any liquid is covering the propeller).

2. The empty digesters are initially blocked from the gas collection system.

3. The digesters are connected to the atmosphere via the operationally ready overpressure protector and the exhaust lines.

4. The digesters are filled within a short time period with substrate that is as active as possible, until all inlets and outlets (liquid valve closure disks) are sealed with substrate.

5. The fermentation substrate is heated.

6. During the start-up/heating of the system, the system should not be fed above the top of the heat exchangers unless specifically instructed to do so.

7. The gas generated during the starting of the digestion process discharges via the foam alleviation (gas overpressure protection) into the open air and displaces the air that is present in the digester.

8. After testing the gas quality, biogas fills into the gas system and the gas storage. The gas quality is sufficient and there is not explosion hazard if the methane content of the gas is greater than 30% and the oxygen content is < 3%.

9. The CHP units are turned on. They automatically draw the gas from the gas storage along with the pressure of approximately 3-6 mbar generates from the weifferink roof. Sufficient biogas quality can be determined by gas measurement.

All safety equipment must be checked for the proper function.

1.8 Operation Under Normal Conditions

The operating instructions of the manufacturer of all individual components must be observed, such as the CHP unit, pumps, mixer, membrane storage, under-pressure monitor, room air monitor, etc..

In general

- During filling and emptying, pay attention to pressure fluctuations and ensure good accessibility to the operating equipment.
- Avoid ignition sources, in the zones according to the Gas Zone Protection Document Daily:
- Record the gas meter reading and operating hours of the motor.
- Check the motor oil level.
- In the control room, at the control box, check whether the malfunction lights are illuminated.
- Check the water pressure in the heating system.
- Check the air-dosing pump of the desulphurization system for operability.
- Monitor the digester temperature.
- Check the de-gritting arm is operating so that no layer of scum/sediment layer develops.
- For all inlets and outlets, assure that the liquid manure/substrate flow is maintained according to the process regulations.
- Check the fill levels in the digester and end storage.
- Check the membrane connectors (e.g., attachment hose at the membrane gas storage).
- Check the water levels in foam alleviation and anti-implosion box

Weekly

- Check the submerged pump function; observe whether vibrations are present.
- Visually inspect the motor and the lines.
- Check the gas magnet valve for function and contamination.
- Check the intermediate space of the self-closing gas shutoff valve for tightness.
- Monthly:
- Actuate all scrapers a few times so that they are not stuck.
- Possibly remove the oil deposits in the CHP unit and clean the oil catch basin.

Twice a year

- Check the ventilation and exhaust in the machine room of the CHP unit.
- Inspect the electrical systems for damage.
- Check the under-pressure monitor of the gas system for function.

- Check the function of the gas sensors, fire detector (if present).

Annually

- Check the gas-carrying system parts for damage, tightness, and corrosion.
- Calibrate the gas sensor with suitable test gas.

1.9 Operation Instructions in Case of a Malfunction

The operating instructions of the manufacturer of all individual components must be observed.

Gas storage room

Shut off gas supply

Empty the gas storage

Avoid ignition sources

Entry for authorized personnel only after and with sufficient ventilation, while being accompanied by a second person (who remains near the opening to the storage) and being secured, e.g., with a rescue apparatus and lifebelt (harness)

Heating, hot running machines and parts, substrate or oil becoming hot

Avoid contact with hot surfaces, fluids, gases, ...

Caution with hot water discharge: potential scalding hazard! Machine room and combined heat and power unit

Shut off gas supply outside of the machine room

Activate the emergency off switch outside of the machine room

If necessary, force ventilation (e.g., in the case of gas odour)

If there is a gas odour, avoid ignition sources, e.g., non-EX-protected light sources, open flame, or formation of sparks. Danger of explosion!

If the gas alarm comes from a gas-warning device, separate operating instructions must be created and followed Electrical system

Work on the electrical systems must be performed only by a skilled electrician

Get rid of blockages immediately

In the case of malfunctions in the pump system: shut off all scrapers after the pumps are stopped pumps and mixer

Switch off the electrical supply, and secure the switch against unintentional actuation

After malfunctions, all safety equipment must be checked for the proper function. Before entry and while in the pits and ducts, it must be guaranteed that there is no hazard of poisoning, as well as that sufficient breathable air is present. Operating equipment must be reliably secured against switching on. Ensure that there is sufficient ventilation. In the case of insufficient ventilation, there is a danger of asphyxiation, fire, and explosion.

1.10 Operating Instructions for Shutting Down a Plant

The shutdown of a biogas system is a special operating state that requires special actions. The zones outlined in the gas zones and isolating valves drawing, consider the operating state based on various conditions. Therefore, these hazards are considered separately in the operating instructions.

1. Stop the substrate supply into the digester container; the substrate removal from the container continues to occur. The quantity of the substrate removed must not be greater than the quantity of generated gas in the digester to prevent a potentially hazardous atmosphere.

2. If the quantity of substrate removed can become greater than the quantity of gas generated, the digester container is locked against the gas capturing system, and the connection to the atmosphere is created, e.g., by emptying the sealing liquid supply. By adding air, a potentially explosive atmosphere can develop in the digester. Ignition sources according to EX Zones must be avoided.

3. The digester container must be blocked from the gas capturing system in order to avoid a backflow of gas.

4. A potentially explosive atmosphere can form around outlet openings. Ignition sources, e.g., according to EX Zones, must be avoided.

5. Before entry into and while in the digester container, it must be guaranteed that the danger of asphyxiation, fire, and explosion has been safely prevented by sufficient ventilation and that sufficient breathable air is present. Operating equipment (e.g., pumps and agitators) must be secured against being switched on (lockout procedures).

1.11 Visitor and Contractor Control: Risk Assessment

What is a Risk Assessment and How do I Complete One?

A risk assessment is a systematic examination of a task, job or process that you carry out at work for;

- Identifying the significant hazards that are present (a hazard is something that has the potential to cause someone harm or ill health).
- Deciding if what you have already done reduces the risk of someone being harmed to an acceptable level, and if not:
- Deciding what further control measures that you must take to reduce the risk to an acceptable level.

Who should do risk assessments?

Risk assessments should always be carried out by a person who is experienced and competent to do so, competence can be expressed as a combination of Knowledge, Awareness, training, and experience. If necessary, consult a more experienced member of staff or external professional help to assist with the risk assessment. Remember competence does not mean you must know everything about everything, competence also means knowing when you know enough or when you should call in further expert help.

When should risk assessments be done?

A separate risk assessment should be carried out for all tasks or processes undertaken by your organisation, they should be carried out before the task starts, or in the case of existing or long running tasks, as soon as is reasonably practicable. Risk Assessments should also be reviewed on a regular basis; monthly, annually, bi-annually, depending on risk, or if something changes i.e. a new worker, a change of process or substance etc.

Non-Compliance

The penalties for failing to carry out risk assessments can be strict, The Health & Safety Executive can issue improvement or prohibition notices, this is likely to happen where an inspector find a situation with the potential to cause harm, for example an unguarded machine. If you are prosecuted and found guilty for more serious breaches i.e. one of your staff has been seriously injured, then in the magistrate court you can be fined up to £20,000 and imprisoned for up to 6 months, in Crown court fines are unlimited and prison sentences can be up to 2 years. The lack of suitable risk assessments will weigh heavily against you.

What about Method Statements?

A Safety Method Statement, sometimes called a "safe system of work" must be produced for all jobs or tasks that contain some measure of risk, contractors are more and more noticing that Method Statements are

being requested by their clients, the request for a Method Statement can come at any time, Pre-Tender, Tender, Pre start of contract and sometimes after the contract has started, so it is best to be prepared..

How do I Complete a Risk Assessment?

The following paragraphs describe the process and methodology for carrying out Risk Assessments, when carrying out Risk Assessments.

Risk Assessment Methodology

There are 8 steps to carrying out a risk assessment

1. Identify the hazards
2. Identify those at risk
3. Identify existing control measures
4. Evaluate the risk
5. Decide/Implement control measures
6. Record assessment
7. Monitor and review
8. Inform

Identify the hazards

A hazard is a situation or a condition with the potential for harm!

Find out what the significant hazards associated with the task or processes are. There are several ways of identifying hazards; by observation, experience and talking to those who carry out the job you can also consult the following:

- Workforce
- Accident, ill health and near miss data
- Instruction Manuals
- Data sheets – COSHH
- Hazard Crib sheets
- Workplace inspections

Look for the hazards that you could reasonably expect to result in significant harm, for example:
slipping and tripping hazards from poorly maintained floors, Fire hazards from flammable materials etc.

Identify those at risk

Think about individuals or groups of people who may be affected e.g.

- Maintenance personnel
- Members of the public
- Machine operators
- Site Visitors

Attention must be paid to disabled staff, lone workers, temporary staff and young inexperienced workers.

Identify Existing Control Procedures

Examine how you already control the risks; it is unlikely that your workers are getting injured daily, so you must have some controls in place already. To decide if those existing control procedures are adequate, and to evaluate the risk, complete a risk ranking which will determine the residual risk.

Evaluate the risk

A risk is defined as the likelihood that a hazard will cause harm

I.e. Risk = Likelihood x Severity - below is an example of a simple 1-5 risk ranking system.

How likely is it that the hazard may result in harm? Is it:

1. Highly Unlikely
2. Unlikely
3. Possible
4. Probable
5. Certain

If the hazard does result in harm, how severe would the injury be?

1. Scratch (trivial)
2. Cut (Minor injury)
3. Fracture (Major injury - Over 3-day injury)
4. Amputation (Major injury)
5. Death (Death)

To carry out a risk ranking simply multiply the likelihood by the severity,

Severity \ Likelihood	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Likelihood		Severity	
1	Highly Unlikely	1	Trivial
2	Unlikely	2	Minor Injury
3	Possible	3	Over 3 day injury
4	Probable	4	Major injury
5	Certain	5	Incapacity or Death

After the multiplication, you will be left with a number from 1 to 25 which you can match against the following table to get the Residual Risk i.e. the risk that remains after the controls are in place.

Priority	
1	Urgent action – (Risk no 15 – 25)
2	High Priority – (Risk no 10 – 12)
3	Medium Priority – (Risk no 5 – 9)
4	Low Priority – Risk no (2 – 4)
5	Very Low Priority– No Action reqd (Risk no 1)

The risk ranking will now give you your residual risk either Low, Medium, or High. If the risks are acceptable (Low Risk) then you may wish to skip the next part, if the risk are still Moderate/High (Medium/High Risk) then you must do something to bring the risk to a "tolerable" level, you can also prioritise your actions from 1 - 5.

Decide and Implement new control measures

If the risk is not adequately controlled decide which new control procedures are required and ensure these procedures are implemented. The control measures are the actions performed to reduce either the probability of the accident happening or the severity of the outcome, and where possible both. When considering what measures to put in place it is important to consider both severity and likelihood, in order to minimise the overall risk.

When deciding what new control measures will be required, it is helpful to work through the 'hierarchy' of controls. The hierarchy is as follows:

1. Elimination – get rid of the risk altogether
2. Substitution – exchange one risk for something less likely or severe
3. Physical Controls - separation/Isolation, eliminate contact with the hazard
4. Administrative controls - safe systems of work, rules in place to ensure safe use/contact with hazard
5. Information, instruction, training & supervision – warn people of hazard and tell/show/help them how to deal with it
6. Personal Protective Equipment – dress them appropriately to reduce severity of accident

Control measures should be practical and easy to understand (what to do and why they are doing it), applicable to the hazard, able to reduce the risk to acceptable levels, acceptable to the workforce and easy to operate. After you have implemented the new control procedures, then re–rank the risks as above to determine the new residual risk, you should aim to get the risk to as low as is reasonably practicable until it is at a tolerable level.

Record the assessment

Keep copies of the assessments for your records and for inspection by the HSE should they ever be requested

Monitor and review

You must ensure that the control measures are achieving the desired level of control. You must review the assessment on a regular basis or if anything changes e.g. new staff, change in machinery or process.

Inform

You have a legal duty to relay the findings of the assessment to everyone who is affected by it. You must also provide information to the workforce on any new control measure implemented, any emergency procedures that have been developed and their duties as employees

Risk Assessment Template

Assessors Name	Assessors Signature	Persons Affected By This Risk Assessment

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking = a x b

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking (= a x b)

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking (= a x b)

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking (= a x b)

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking (= a x b)

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking (= a x b)

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking (= a x b)

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking (= a x b)

Hazard / Consequences	Control Procedures	Likelihood (a)	Severity (b)	Risk Ranking (= a x b)

	Likelihood		Severity		Priority
1	Highly Unlikely	1	Trivial	1	Urgent action – (Risk no 15 – 25)
2	Unlikely	2	Minor Injury	2	High Priority – (Risk no 10 – 12)
3	Possible	3	Over 3-day Injury	3	Medium Priority – (Risk no 5 – 9)
4	Probable	4	Major Injury	4	Low Priority – Risk no (2 – 4)
5	Certain	5	Incapacity or Death	5	Very Low Priority– No Action required (Risk no 1)

Additional Users	Signature	Date

1.12 Method Statement – Hot Work Permit- Confined Space

What is a Method Statement? A work method statement, sometimes called a "**safe system of work**", is a document that details the way a work task or process is to be completed. The method statement should outline the hazards involved and include a step by step guide on how to do the job safely. The method statement must also detail which control measures have been introduced to ensure the safety of anyone who is affected by the task or process.

How do I write a Method Statement? The first task is to carry out a **Risk Assessment** detailed in the previous section. A Risk Assessment will highlight the significant hazards and control measures required to prevent injury or ill health whilst carrying out the task and will provide details to add to your method statement document.

Section1 of your method statement document is the header information and should be used to provide information to your staff or operatives this section might include:

- A Title e.g. Work Method Statement, or Standard Operating Procedure
- A brief description of the works, task or process
- Your company details, logo, name, address etc.
- Start date, completion date
- Site address
- Site contact details including emergency numbers etc.
- Document author, H&S contact
- Document number, issue date, revision date, revision number etc.

Section 2 can be used as a summary of the main hazards that are present and the control measures that must be implemented, this section should also be used to list the Personal Protective Equipment that must be used, the information for this page will be extracted from your risk assessment document. Section 2 can also be used to detail any Environmental or Quality procedures that must be taken during the task.

Section 3 is used to describe the task in more detail and relevant generic information such as:

- Staff, Training, and PPE
- Permits to work
- Machinery shutdown and lock off procedures
- Site Access and Egress
- Material Handling
- Scaffold & Access to height
- Background and preparation
- Welfare and first aid

Section 4 is the step by step guide, use this section to explain in detail the steps that must be taken to ensure the task is carried out safely, include all relevant details in the order that you expect them to be carried out.

Example Anaerobic Digester Method Statement

Site Address:
Tel:
Mobile:

Project/Contract	
Contractor	
Site Address	
Works Start Date	
Expected Duration	
Projected Completion Date	

	Name	Title	Signature	Date
Document Author				
Authorised by				
Authorised by				
Authorised by (for Client)				

Emergency Contact Details	
Contact	
Telephone No.	
Mobile No.	

Staff Information Sheet: The following method statement has been developed to provide a safe system of work and must be adhered to at all times, any significant deviation from this system must first be authorised by your manager or safety representative. Please read the entire sheet before beginning the procedure, if you have any questions please contact your manager or safety representative.

The main hazards to your safety and health are:
Preventative Measures you must take:
Personal Protective Equipment you must wear:
Environmental Protection Measures you must take:

Quality Control:
Task Description:
Staff & Training:
Preparation & Site Induction:
First Aid:

For all the above titles enter what control procedures you either have in place or will put in place to ensure the safety of workers, visitors and anyone else who is affected by your operations

Describe in detail the step by step the tasks or process someone must follow to ensure the task is completed safely.
Task Description. Step by step procedure: 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15.

Confined Space Access

What is a 'confined space'?

A confined space is a place that is substantially (although not always entirely) enclosed where there is a risk of death or serious injury from hazardous substances or dangerous conditions (e.g. lack of oxygen). Very often, injuries and deaths occur because of work being carried out such as welding, painting, flame cutting, use of chemicals. Places can also become confined spaces during construction work, fabrication or modification.

Examples include:

- chambers
- tanks
- silos
- vats
- pits
- trenches
- sewers
- drains
- flues
- ductwork
- unventilated or poorly ventilated rooms.

What are the risks of working in confined spaces?

Every year, a number of people are killed and others seriously injured working in confined spaces across a wide range of industries in the UK, from those involving complex plant to simple storage vessels. Those killed include not only people working in confined spaces but those who try to rescue them without proper training and equipment.

Dangers can arise in confined spaces because of:

- lack of oxygen
- poisonous gas, fume or vapour
- liquids and solids suddenly filling the confined space, or releasing gases into it when disturbed
- fire and explosions
- residues left behind which can give off gas, fume or vapour
- dust
- hot working conditions.

Legal duties and obligations relating to confined spaces

As well as the moral duty of employers to protect employees and members of the public, General Health and Safety Legislation covers all employers and workplaces. The Management of Health and Safety at Work Regulations, 1999 require that a suitable and sufficient assessment of the risks for all work activities is carried out for the purpose of deciding what measures are necessary for safety. For work in confined spaces this means identifying the hazards present, assessing the risks and determining what precautions to take.

In most cases the assessment will include consideration of:

- the task
- the working environment
- working materials and tools
- the suitability of those carrying out the task
- Arrangements for emergency rescue.

You may need to appoint competent people to help manage the risks and ensure that employees are adequately trained and instructed. You may be the best person to do this, or you may need to train someone else to manage risks or engage the services of a competent person for additional help. If your assessment identifies risks of serious injury from work in confined spaces, such as the dangers highlighted above, the Confined Spaces Regulations 1997 apply.

Reducing risks from working in confined spaces

The Confined Spaces Regulations 1997 contain the following key duties:

1. Avoid entry to confined spaces

Ask yourself if the work is necessary, or if it can be done in some other way that avoids the need to enter the confined space?

2. If entry to a confined space is unavoidable, follow a safe system of work

The results of your risk assessment should help to identify the necessary precautions to reduce the risk of injury, depending on the type of confined space, the associated risk and the work involved. The safe system of work should be implemented, and everyone involved should be trained and instructed.

3. Put in place adequate emergency arrangements before the work starts

The preparation of suitable and sufficient measures to be taken to ensure the safe rescue of a person in an emergency are required before a person enters a confined space. These arrangements should also consider the safety of rescuers, first aid procedures and liaison with emergency services.

Company name/logo

Confined Spaces/Hot Works

Permit to enter No [Reference No.]

Job Details	
Special Tools	
Job Location	

This section is only valid when all green sections are completed. If you are in doubt or don't fully understand then you must ask. Remember all accidents are preventable and it is people who get hurt or suffer pain. Please use this permit in the spirit intended to protect yourself and others. Please ensure that you sign this permit to work. Do not proceed with your work until this permit has been authorised by the relevant member of staff.

HAZARDS AND PRECAUTIONS TO BE TAKEN

Primary Hazards: Fumes, Electrics, Gases, Liquids, Sludge, Radiation, Moving Parts

PLEASE ANSWER THE FOLLOWING QUESTIONS TRUTHFULLY	YES	NO
Are you trained/qualified to undertake this work?		
Has the confined space been isolated from all connected pipework?		
Has the confined space been purged with steam/water/air?		
Has the confined space been electrically isolated and locked out?		
Is the confined space below 30 degrees on full cooling?		
Is a supply of safe air assured/ventilation required?		
Is it acceptable means of access to escape from the confined space?		
Is breathing apparatus at hand in good condition?		
Is the safety/tripod/harness and any other back up equipment to hand?		
Are there any adequate emergency arrangements in place?		
Other specific hazards please detail below		

Time of Test 1: Time of Test 2:

OXYGEN		OXYGEN	
CARBON MONOXIDE		CARBON MONOXIDE	
CARBON DIOXIDE		CARBON DIOXIDE	
HYDROGEN SULPHIDE		HYDROGEN SULPHIDE	
OTHER/SPECIFY		OTHER/SPECIFY	

Company name/logo

AUTHORISATION AND ACCEPTANCE

I confirm that I have verified the above information and ensured that necessary precautions have been taken. It is safe to carry out the work as defined above and the permit information has been explained to all workers involved, I accept responsibility for this work.

Person in Charge		
Company		
Signature		
Authorised Person	Date:	Time:
Expires	Date:	Time:

HANDBACK AND CANCELLATION

I confirm that the work has been completed/partially completed* checked by myself and the area left in a safe and tidy condition (*delete as appropriate)

Person in Charge	

I have inspected the completed/partially completed work* and herby cancel the permit (*delete as appropriate)

Authorising Signature		Date:	Time:

ON-SITE RESCUE PLAN

Confined Space Name/Location: **Identification #:** **Date:**

Attendant: **Employer:**

Employer: _____ **2)** _____

On-Site Rescue Personnel/Designation: **3)** _____

1) _____ **4)** _____

Methods of Communication: Attendant to Rescue Personnel:- O Phone O Audible Signal O Radio O Intercom

Attendant to workers: O Phone O Radio O Intercom O Audible Signal O Visual Hand Signal O Rope Signal

Methods of Rescue: O External (Retrieval) O Internal: _____ O Congested: _____

O Hauling System Required: _____ O Patient lowering system required/lowering area: _____

O Anchor overhead: _____

Anchorage: O Beam O Stairwell O Support Strut O Support Column O Other: _____

Pre-Rigging required? O Yes O No

Rescue Equipment Requirements (check ✔ where applicable below and indicate quantity needed):

O Hauling Systems:_____	O Carabiners: _____	O Pulleys: _____	O Shock absorbers/lanyards: _____
O Anchor Straps: _____	O Webbing: _____	O Ascenders: _____	O Body Harnesses: _____
O Rigging Plates: _____	O Safety Lines: _____	O Main Lines: _____	O Wrist/Ankle Harnesses: _____
O Fire Extinguishers: _____	O	O	O

Rescue Equipment Inspections

Identified rescue equipment inspected by competent worker: _____ Employer: _____

Record of inspection(s) attached O Yes

Medical Equipment Requirements (check ✔ where applicable below and indicate quantity needed):

O First Aid Kit: _____ O Packaging Device: _____ O O

Additional PPE Requirements (Indicate what is needed):

O High Visibility Vests O Hearing Protection O Safety Boots O Hard Hats O Safety Glasses/Goggles O Gloves

O Face Shield O O

Description of Space (include location of attendant):

Diagram of Space (Use Back of Page if needed):

Completed by: _____ O Entry Supervisor O Attendant O Other: _____ **Date:**

1.13 Emergency Procedure Fire or Explosion & Accident

In the unlikely event of a fire or explosion the following steps should be taken:

- Remove yourself from the danger area immediately .
- Call 999 emergency services for assistance.
- If possible isolate the electrical and gas supplys externally from the digester only if sufficiently removed from the danger area.
- Ensure all persons signed in to the plant are accounted for at the meeting point if they are not inform emergency services as soon as possible do not go back into the danger area yourself.

Conduct in Case of an Accident

If required Call 999 for assistance

After breathing liquid manure gas or biogas, provide fresh air.

Unconscious person: Establish breathing and place victim on their side.

Contact the physician immediately! Provide information about poisoning due to hydrogen sulphide.

First Responder:

Physician:

Emergency:

Date:

Employer's signature: