EXECUTIVE SUMMARY

This document is about the fire and gas mapping that is involved with the BBL site in Bacton gas terminal, Shell.

The document will go into depth about the different types of detectors that can and are being used at Bacton, Types of fires that can happen, false alarm stimuli, explosive limits, HVAC system, existing infrastructure, locations, relocations and benefits and adjustments. The document will go into full detail in these subjects explaining why certain devices are needed and are crucial for safety along with which types of detectors are the best and most efficient in their field of detection allowing the possible chance to improve the old devices.

Overall, this document is a detailed report about fire and gas devices that can improve the BBL site at Bacton.

CONTENTS

1. TYPES OF FIRES

- **Gas Jet Fire**
  These types of fires are momentum driven. They can generate immense heat when produced along with the fire being able to travel a significant distance. The fire has an outstanding travel distance.
- **Flash Fire**
  A flash fire is a combustion of a flammable gas/air mixture and no overpressure is generated. This can lead to damage solely caused by thermal fire and not the pressure energy. This implies and shows that this type of fire is not as damaging as VCE (vapour cloud explosion).
- **Fireball**
  A fireball is a burning fuel air cloud where energy is emitted primarily in the form of radiant heat. The inner core of the cloud consists almost completely of fuel, whereas the outer layer consists of a flammable fuel air mixture. As the buoyancy of hot gases increase, the burning cloud tends to rise, expand and assume a spherical shape.
- **BLEVEs**
  1.External heat source-----Heat from external fire increases temperature of liquid/gas. Pressure increases approaching a point where the vessel cannot contain it.
  2.Vessel rupture-----The vessel ruptures.
  3.Explosion-----Detonation occurs.
  (Certain types of BLEVEs can result in a fireball)
- **Spray Fire**
  A momentum driven fire similar to gas jet fire but the hight intensity heat output can develop into a pool of fire if pressures in the vessel decrease-----2 phase fire.
- **Pool Fire**
  Flammable liquids pools can spread over large areas and result in fires with high radiant heat outputs.
- **LNG Pool Fire**
  An LNG pool fire can ignite with ease; flammable vapours can also flash off from the pool before ignition.

2. FIRE DETECTORS

27 UV FLAME DETECTOR

These devices are used to monitor the presence of flames, particularly in combustion processes. This enables a rapid response to possible fire threats. This device works through a flame emitting ultraviolet (UV) light. The UV flame detector will contain a UV sensor that is sensitive to the UV radiation. This will trigger a response which is sent straight to the

control system allowing control to send out people to deal with the situation. (FGD-Flame detectors, n.d.)

In most situations the UV sensor will filter out any other light sources such as natural light or artificial lighting to cut down false alarms, but potential other light sources may affect this system. (Protex Systems, n.d.) (ForumAutomation.com, n.d.)

27 SINGLE FREQUENCY IR FLAME DETECTOR

A single frequency IR flame detector is commonly used for facilities that process hydrocarbon gas or liquids, fires or other fuels, such as hydrogen, may be impossible for the sensors to see or very poorly detected, such as methanol.

The pyro-electric detector would respond to changes in IR radiation and will be sensitive between two and twenty meters. Once the sensor has detected the radiation it will send a trigger to the control room initiating a response to a potential fire. However, as it is an infrared flame detector that operates in the four-to-five-micron range are subject to binding due to a build-up of water drops or ice. False alarms can also be made through vibration or chopped hot black bodies.

27 MULTI FREQUENCY IR FLAME DETECTOR

Multi frequency IR flame detectors uses multiple IR sensors to help reduce false alarm activations. This is through a large number of variants available for different sensitivities or fuel types like hydrogen specific.

To determine a fire the device looks for a relationship between signals of each sensor. If a similar relationship of signals is present the device will send a signal back to the control room detecting a fire initiating a protocol to stop the fire. But, in particular, water unbalances this relationship causing false alarms to be sent out or in more dangerous cases the device would not be capable of sending out responses for an incident.

27 VISUAL IMAGING FLAME DETECTION

Visual flame detection will process live video images to detect hydrocarbon flames. It will utilise digital signal processing and flame detection algorithms. Once the visual detection captures hydrocarbon flames, the device will send a signal straight back to control to begin following safety procedures to prevent the situations from becoming worse.

However visual flame detection will not detect or respond to flare reflections which can response in a fire outbreak not detected due to the reflections of the fire not being responded to by the detectors leading to a loss in money and time and poses a threat to life.

Maintenance with visual imagining flame detection involves:

- Test the detector from eight metre distance.
- Near IR/Visual Flame Simulator
- LED Pulse frequency - pattern associated with a fire.

- Meets demands of companies and certifying bodies.
  test requirements.

27 MAINTENANCE ISSUES

Each type of flame detector will have its own specific type of maintenance. However, these are some of the issues that occur to these certain types of detectors when maintenance is performed. (Anaparts, n.d.)

Detector Type	Maintenance Issue
Point (Ion, Optical, Heat)	Function Testing
Beam	Clean optics
High Sensitivity	System testing
Linear Heat (Tube, wire etc...)	Leak Prevention

3. GAS DETECTORS

27 GAS DETECTOR DEVICES

- **Catalytic Bead**
  This type of gas detector is mainly used on older installations and is no longer approved by the HSE. The device will burn gas and measure the temperature rise in a sensor. Beads are electrically heated platinum wire coil. Gas diffuses through a sintered disk, and a combustible mixture passes over the hot catalyst surface. Combustion then occurs, heat evolved increases the temperature of the bead. Resistance measured using the coil as the temperature thermometer standard bridge circuit. (Rockall Safety, 1995)

  They are used to detect non-hydrocarbon gases, for example hydrogen. However, the sensor may drift resulting in required regular calibration. The catalyst also may become poisoned as well. Both of these faults can lead to failed responses if a potential hazard of gas leaks occurs.

- **Laser Open Path**
  This type of gas detector uses the addition of laser sensors to perform its function. The laser open path detector does this through physical contact between the laser and gas where the gas will block the laser from reaching the other point this will then in return send a signal to control reporting a gas leak allowing the site to follow correct measurements and procedures.

  These devices have a very fast response time, they are very precise targeted detection-immune to most contaminants, capable of ppm level detection and the laser diode is not

affected by the sun. Having said that, these devices are extremely expensive, and they may have a limitation of path length.

Maintenance with this device is fairly light. The device does not need calibration, only a function checking. It isn't normally practical to use gas to test open path detectors as it is difficulty with optimal alignment and the volume of gas required may cause a hazard. So, a clear plastic film will absorb IR and is a convenient function test.

- **Point IR Gas Detection**
  Infrared gas detection (IR) is based on the unique IR absorption pattern associated with hydrocarbon gas and vapour. These devices emit infrared radiation through a gas sample, the amount of light absorbed at specific wavelengths indicates the concentration of gas present. These devices typically have two beams, an active beam that passes through any gasses and a reference beam that does not interact with the gas.

  Space or congestion prohibits the use of open path gas detectors so point IR gas detectors can be supplemented in. It also needs the detection of spot flammability at a particular location which is required.

  Maintenance for point IR gas detectors involve using test gas where air movements are slow or for areas like HVAC, special glass filters with an absorption that matches gas sufficiently well for a function test.

27 FUTURE OF FIRE & GAS DETECTION

- **Wireless Gas Detection**
  Wireless gas detection devices involve gas detection devices without the long electrical cables that join the equipment to the system. This means there is less installation time and a money saving device as no electrical wires are needed to be bought along with the cost of labour for them to be installed. However, these devices will be connected via Bluetooth. This poses the threat of potential risks of systems that could be hacked and put down and if done so no devices would be able to monitor gas leaks or fires resulting in an increased risk of hazards putting people in danger.

- **Ultrasonic (Acoustic) Gas Detection**

Gas leaks emit ultrasonic energy when they occur, an ultrasonic gas detection device will detect the noise and send a signal back to control to allow them to find a solution. The device does not require a line of sight and can still function even if the release is dispersed. In spite of that, the device is heavily influenced by background noise, it cannot differentiate between air and hazardous gas and will depend on gas flow rates (hole size and pressure).

The maintenance for this device involves a test. This test source should be provided at a distance of five meters away from the detector for gas leak simulation.

Leak simulation equipment used for testing:

- maximum 0,1 kg/sec (0.22 pound/sec) leak rate from a standard fifty litre
- nitrogen bottle.
  • 4-metre-high pressure hose with regulator, valve and nozzle (2 or 4mm)

27 TOXIC GAS

- **Electrochemical Cell**
  Electrochemical cell is used to detect toxic gasses in the ppm range. The electrodes are separated by electrolytes and are enclosed in a small plastic housing which are connected to an external electronic circuit. The gas diffuses into the sensor through a permeable membrane, and a small current is generated by an electrochemical reaction.

  The electrochemical cell has an excellent linearity and repeatability along with a requirement for very little power for it to operate. But the device has a short life span of only two years, and it can be affected by changes in temperature and humidity.

- **Semiconductor sensor**
  Electronic conductivity is affected when gasses are absorbed onto a semi-conductor surface. Resistance changes in the semi-conductor material when exposed to gasses other than air. They are converted into an electrical signal proportional to the concentration of the gas.

  Semi-conductors will have a long life along with ppm level detection. But the device can have a non-linear output meaning it could “go to sleep,” it has a large cross sensitivity to other gasses and is slow to respond and recover after exposure to an outburst of gas.

Types of Gas at Bacton

- Propane
- Methane

Types of Gas

- Heavy Gas------Falls to the ground
- Light Gas-----Rises.

4. FALSE ALARM STIMULI

27 SEA CORROSION

Corrosion can be caused by spray off the ocean from large waves from dangerous environmental conditions. This spray can come in physical contact with the camera and not only physically erode the camera from physical force but also the salt water from the ocean can corrode the cameras material down along with mixing within the electrical system causing electrical faults with the camera.

27 WIND

Strong wind can lead to items being blown around along with potential gas being blown in a certain direction if in contact with the wind. Items being blown around can result in visual cameras being covered or perhaps false detections of fire and gas due to other objects disrupting cameras. Furthermore, if gas is being blown in a certain direction where there is less camera coverage, it can result in undetected leaks which could cause extreme dangerous situations and large losses in money.

27 ANIMALS

Animals can come in contact with these cameras such as birds and spiders. These species can set up nests and homes within these cameras which can result in potential triggers and false alarms through nests blocking cameras or the movement of the animals being detected and false alarmed as a leak.

27 DUST

In dusty conditions the particles can end up on optical sensors of the gas and fire detector devices. This can interfere with the detection capability causing false alarms or missing gas and fire leaks. When the dust gets on the lens of the devices it blocks the path of light beams in flame detectors or obscuring infrared sensors in gas detectors, significantly reducing their sensitivity as well.

27 RAIN

Rain can also heavy damage the sensors in multiple ways. Firstly, the water can obstruct the camera becoming blurry resulting in reduced detection range increasing the risk of fire and gas leaks. Furthermore, the rain can also damage the devices physically depending on how harsh the rain and environment is which can lead to corrosion as well.

27 SNOW/ICE

Snow and ice are similar to rain and how it can interfere with these detection devices. Snow/ice can physically interfere with the cameras of these devices by physically obstructing view. By obstructing views this can also lead to false alarms of reduced

coverage. It can also trip open path gas detectors by interfering with the sensors causing false alarms.

27 SUN

The sun can affect detector devices depending on what time of year it is. During early months of the yar the sun can be low but extremely bright, this can cause cameras to pick up a light source from the sun instead of a potential fire. This can cause false alarms to happen, or visual cameras may not be able to pick up fire hazards due to the sun dazzling the screen. Furthermore, the heat the sun gives off can also trigger the cameras. During the hottest times of the year the sun can produces extreme heat and if picked up by the detectors it may trigger false alarms causing a loss in money and time.

27 SUN GLARE

Sun Glare is caused by the reflection of sun off the ocean. This can lead to a strong dazzling light by reflected towards detectors. This is more common at offshore sites; however, it can happen at Bacton due to its location near the beach. This is similar to the low sun in early months of the yar as it can visually trick the cameras into giving out false alarms.

27 REDUCING FALSE ALARMS

There are many methods to reduce false alarms from occurring from gas and fire detectors. To begin with, ensuring all devices obtain the correct maintenance needed. Without maintenance devices become warn down and less reliable in detecting. This can lead to false alarms. To prevent this, devices need to be frequently maintained ensuring they are up to standards and in great condition reducing the chances of false alarms.

Next, Installation. This method is a crucial step in gas and fire mapping. Ensuring you have installed the correct device that is fit for monitoring a certain area. Areas can alter in how sparce or compact they are with multiple obstacles getting in the way with certain devices. This can affect specific detectors, and they will give off false alarms. To prevent this from happening companies can check certain conditions needed for each detector making sure they have installed the correct detector for that location. This will result in a decrease in false alarms.

Furthermore, regular testing and monitoring. This method helps to introducing testing. This could be done through a practice false fire to see if the detector will pick up the hazard. Along with regular monitoring to ensure the detector hasn’t picked up any false alarms and is still reliable without the need of maintenance. If regular testing and monitoring isn’t carried out there is an increase chance of false alarms occurring.

27 FALSE ALARMS SUMMARY

Bacton Site

Stimuli	Type of Detector That it will Effect	Time of Year	Damge	Probabilty at Bacton
Sea corosion	Fire and Gas	Winter		
Wind	Fire and Gas	Winter		
Animals	Fire and Gas	All Year		
Dust	Fire and Gas	Summer		
Rain	Fire and Gas	Winter		
Snow/ice	Fire and Gas	Winter		
Sun	Fire and Gas	Summer		
Sun glare	Fire and Gas	Summer/winter		

Damage	Colour
No Damage	
Minimal Damage	
Large damage	

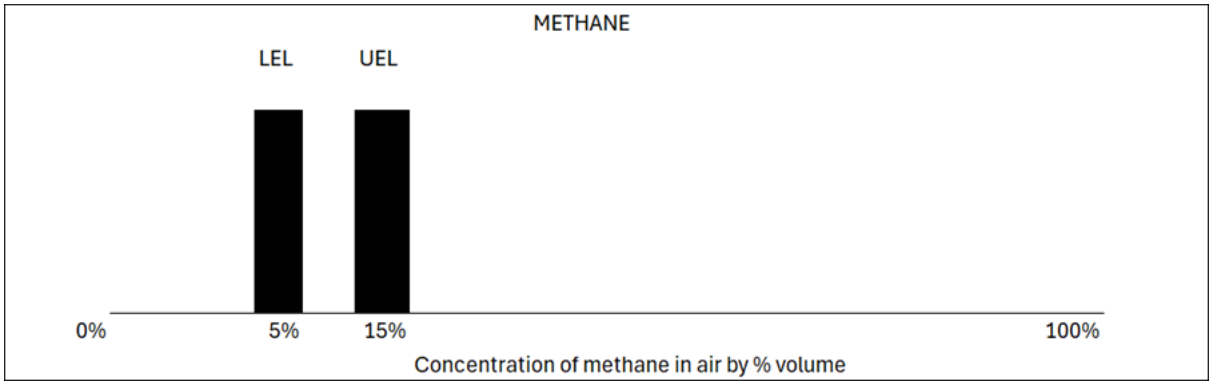
Probability	Colour
Unlikely	
Possibility	
Likely	

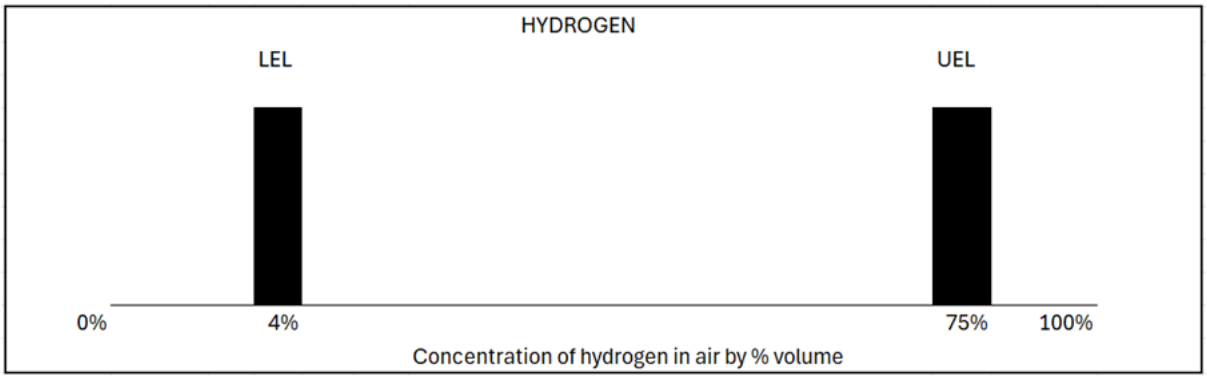
Many different environment conditions can set off false alarms leading to a loss of money and time when dealing with them. The main stimuli at Bacton are the corrosion of the sea, animals such as spiders, rain and the sun. All these factors contribute to false alarms or a lack of coverage which could increase the risk of more dangerous hazards occurring. These conditions need to be considered when deciding for the gas and fire detectors.

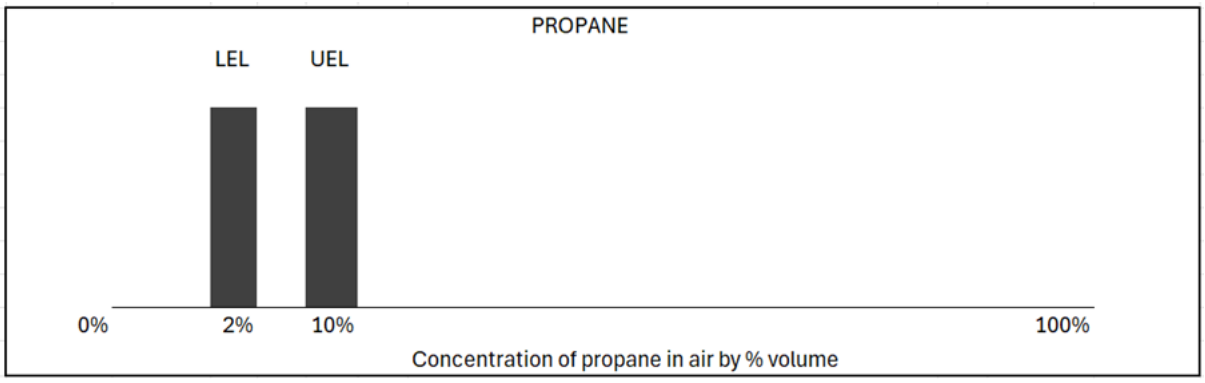
5. EXPLOSIVE LIMITS

LEL-----Lower Explosive Limit-----The minimum concentration of a flammable gas or vapour in the air that can ignite in the presence of an ignition source.

UEL-----Upper Explosive Limit-----The highest concentration of a gas or vapour in the air that can ignite and cause an explosion when exposed to an ignition source.







(These graphs show the LEL and the UEL of different types of gasses that could be exposed on at Bacton.) (Winson, n.d.)

6. HVAC

A HVAC system works by heating, cooling and maintaining indoor air to maintaining comfortable temperatures, humidity and air quality throughout a specific building. This is crucial for certain buildings that contain anything flammable or gas related, as this system can help remove gas and the emissions produced from the fire out of the building. This can help protect anyone in the building and potential stop the gas or emissions coming into contact with something that can pose a larger risk such as an explosion.

Requirements of HVAC systems are:

Fast Response Infrared Gas Detection Required at the HVAC air intake

• Set Points of 10%LEL and 20%LEL

• Detectors arranged to anticipate a non-uniform distribution of gas

• 2oo3 voting degrading to 1oo2d to initiate shutdown of HVAC and closure of dampers

• Transit time of Gas > time for gas detection + control system + dampers. To be verified by calculation and

onsite testing

Areas without HVAC systems will require gas detection devices to minimalize risk as much as possible. Encase of a gas leak, the site will have mustard points to take temporary refuge away from any gas leaks and fires. This is to try ensuring everyone is far away as possible from the hazards.

7. EXISTING INFRASTRUCTURE

The BBL site consists of many different infrastructure that may need to be monitored through detectors. If these sites are not monitored risks of fires and gas leaks increase. If fires and gas

leaks occur it puts peoples likes and health in threat and also poses a large danger to any infrastructure as it could be destroyed in a fire or an explosion leading the company to lose a source of income and money.

The BBL location consists of five different areas. The process area, metering area, field auxillary room, analyser house, generator and compressors and the gas/pig receiver. All these locations help to transport gas from the Netherlands/Holland over to the onshore site at Bacton and they enable it to be processed ready to go over to national grid.

8. GRADINGS

Fire gradings are classifications of materials and systems based on their fire resistance and performance, crucial for ensuring safety.

Grade	Area definition
B	Hydrocarbon processing, with normal to high sensitivity.
C	Hydrocarbon processing, with low sensitivity.
D	No hydrocarbons, with protection of human life.
E	No hydrocarbons, with protection of special equipment.
F	No hydrocarbons, with general coverage.
S	Special risk, for which no other grade is appropriate.
T	Special risk, with gas turbine and other engine enclosures.
V	Special risk, with ventilation air intakes.

This table shows the different types of gradings certain areas can have relating to the risk of fire breaking out. These gradings are used to rate certain locations and areas allowing employees to know what type of detectors will be needed in that locations along with how many based on the type of hazards that are in that area.

The BBL site at Bacton will be listed between grade B and C for the main processing areas which are the process area, the metering and potentially the generator and compressors. This is due to the gas that it processes (Methane) being a hydrocarbon. Some areas of these two locations however may contain a normal to high sensitivity or a low sensitivity.

Other locations such as the analyser house and field auxillary room will not be near grade C or B as they do not process hydrocarbons. These would likely fall under grade D, E, F or V. This is due to theses rooms having special equipment inside the building and sometimes employees may be working inside of them.

9. VOTING

Voting is a process where key decisions are made to decide whether a certain location has enough fire or gas detector coverage.

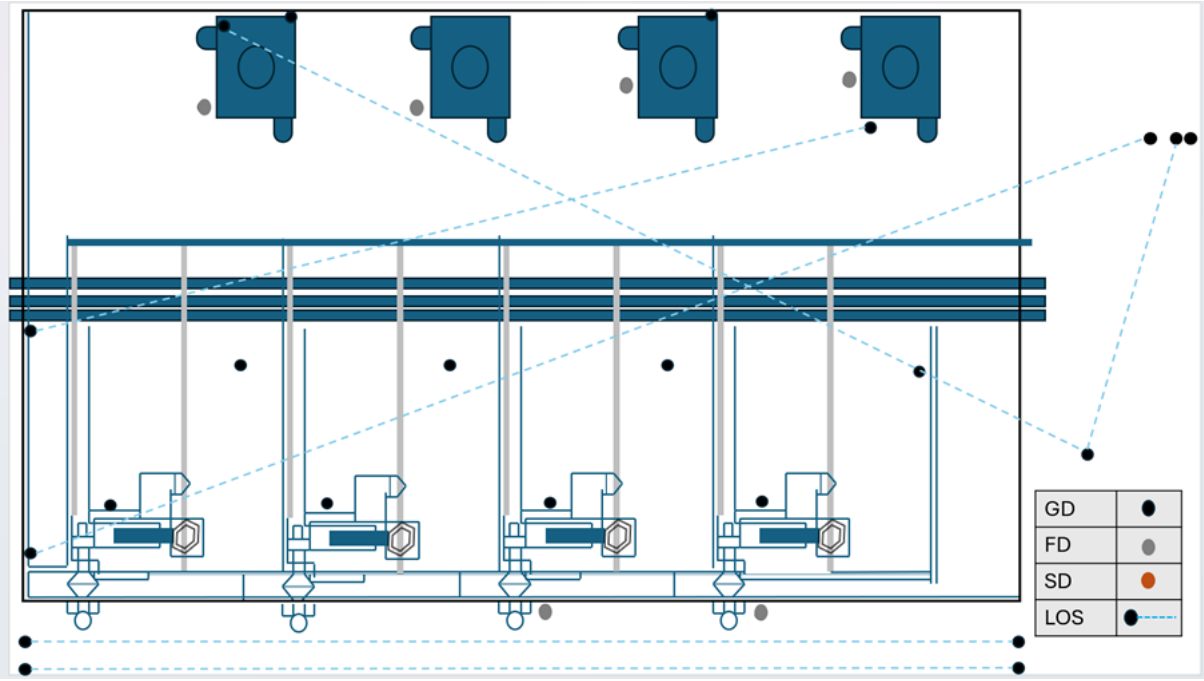
Voting is measured through 1ooN, 2ooN and 3ooN. 1ooN stands for one detector activates meaning action will occur even in the event of a false alarm or either two detection devices activate, an action will occur such as going to mustard points.

2ooN will stand for, both detectors out of two must activate for a following action to occur or any two detectors out of three must activate for an action to occur. Finally, in a 3ooN voting system a any three out of the four or five detectors must activate to allow an action to occur.

The higher the number of detectors in a specific location, the more accurate the responses are and will result in reduce false alarms and an increase in safety related to fire and gas leaks. Typical offshore voting for an area like Bacton would use an alarm only or 2ooN voting

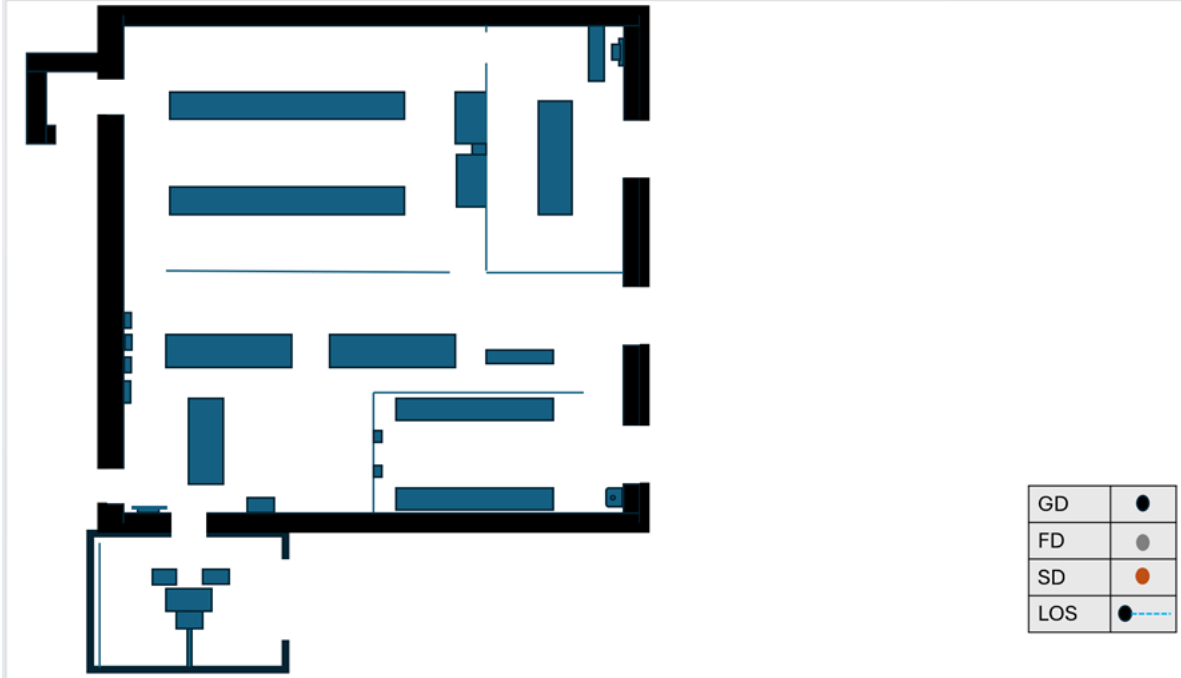
10. LOCATIONS

27 PROCESS AREA



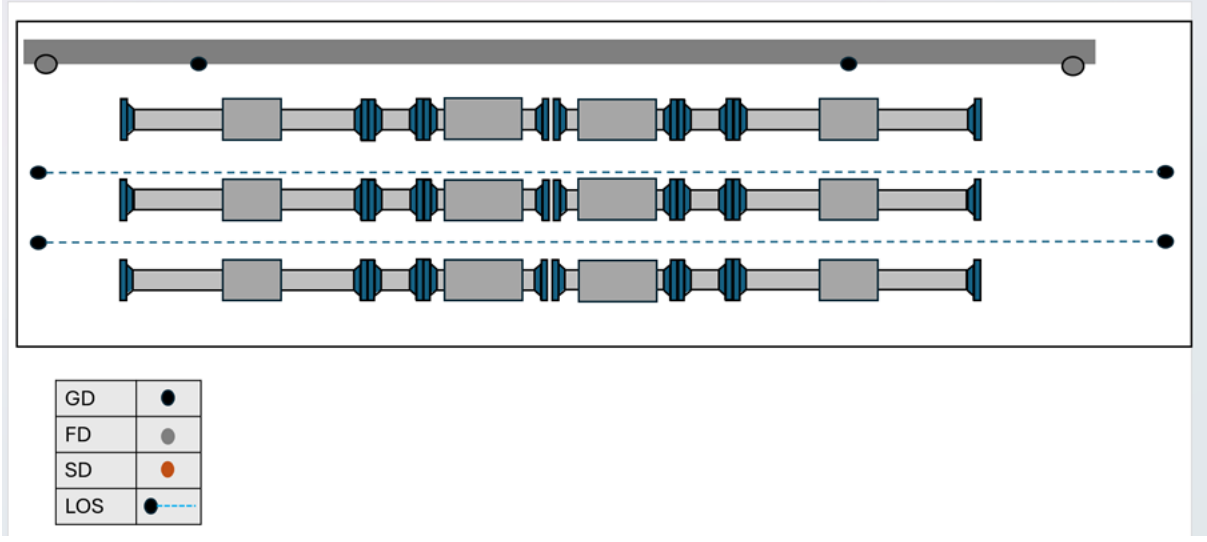
This location is the process area. There are multiple gas and fire detectors located here as this is one of the most likely spots for gas leaks and potential fire outbreaks. There are also line of sights here as they are one of the most reliable gas detectors.

27 FIELD AUXILLARY ROOM



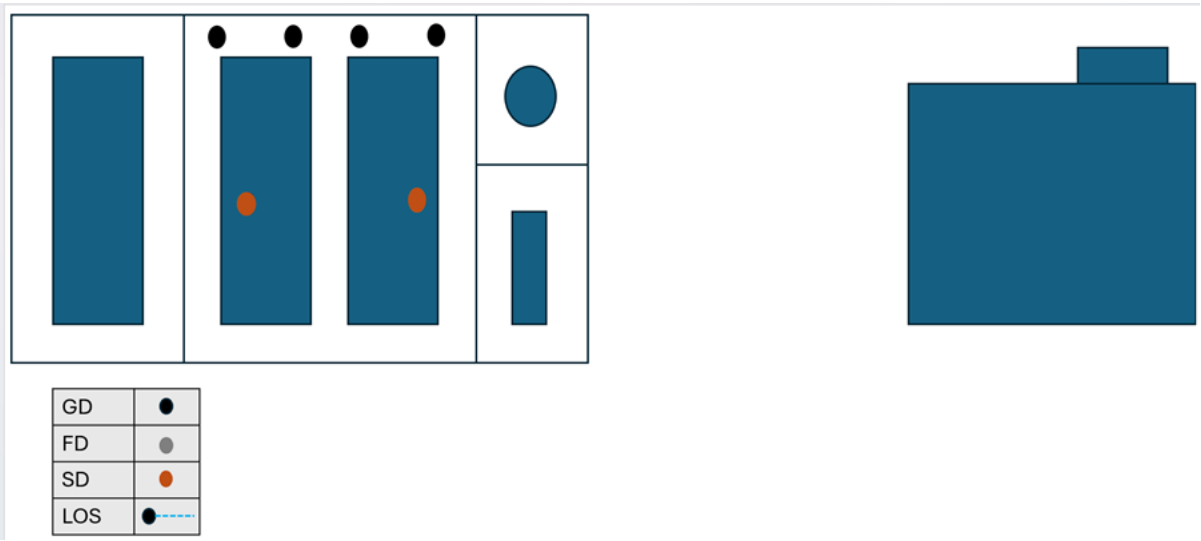
The field auxillary room does not contain any fire and gas detectors as it is an inside building and there is very little to no risks of gas leaks occurring in this building. However mainly inside this building there will be smoke detectors for extra safety in case a fire does manage to break out. These are not through labelled on the mapping system as it is located inside a building.

METERING



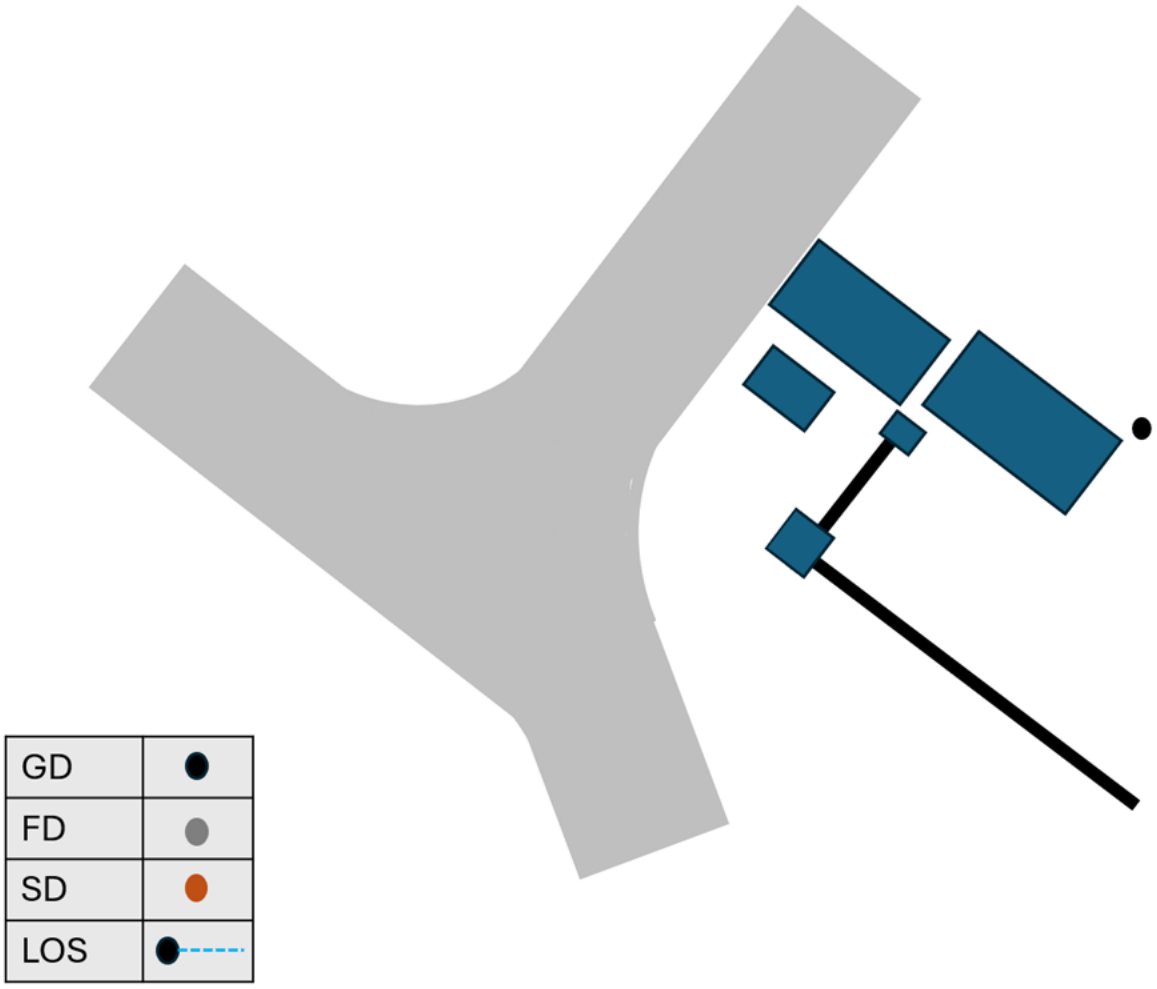
The metering system is also another dangerous place where potential gas leaks and fires can occur. This results in this area also being highly supported is gas and fire detectors to ensure if leaks take place they can be quickly dealt with.

27 ANALYSER HOUSE, GENERATOR & COMPRESSORS



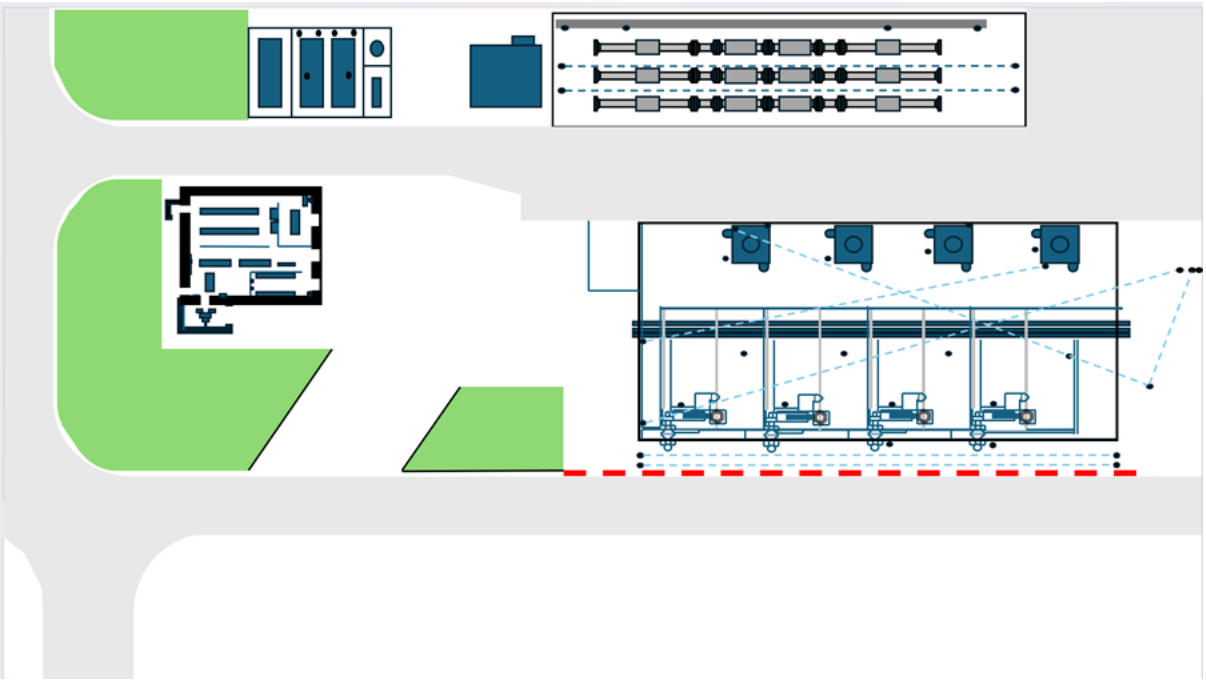
The analyser house also does not contain any fire or gas detectors on it as it is a building with little to no risks of gas leaks but may also contain some smoke detectors like the auxillary room. Moving onto the compressor and generator units, these areas will contain some detectors such as gas detectors as there is a risk of leaks happening.

GAS/PIG RECIEVER



The pig receiver area contains one gas detector as this device is only used once in every five years. The detector will detect for gas when in use as cleaning out under water pipes are dangerous and potential leaks of gas could occur.

OVERALL SITE VIEW



This image shows the overall BBL site showing how the plant is located and where all specific areas are located. It also shows exits and entrances to the site allowing people to know where to exist in case of a gas leak.

11. COVERAGE

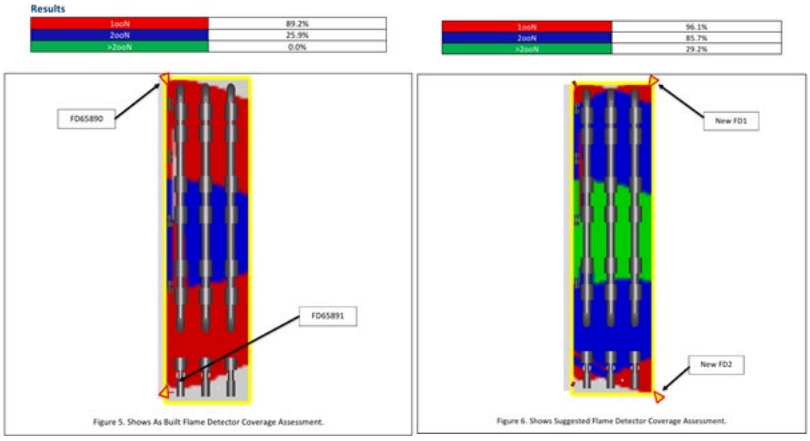
Coverage targets

There is a specific target of coverage detectors should cover over a certain area of site.

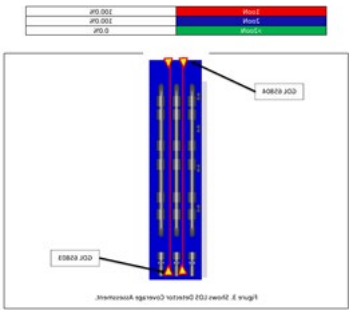
Number of detectors	Coverage percentage
1ooN	90%
2ooN	85%
>2ooN	N/A

If these percentage can't be met, more detectors in either fire or gas needs to be installed depending on which detector coverage is low. The percentages are high as if there is an incorrect amount of detector coverage it can result in a large threat to employee's lives. The >2ooN does not have a specific percentage needed to be met as it is not required specifically but is a good to use to prove there is a large coverage of detectors in a hazardous area.

27 METERING AREA

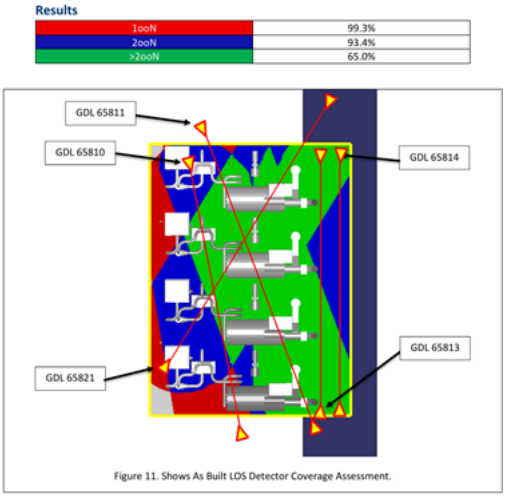


The first image shows that the percentage requirements for flame detectors are not met in the metering area. This poses a risk to anyone working near or on the metering area. The second image shows where the new detectors would be located and showing how adding two new flame detectors will complete the coverage targets required.



This image shows the coverage for gas detectors on the metering area. The two line of sight detectors meet the current targets for the percentage coverage. The gas detectors will not have to be altered.

27 BURNER/PROCESS AREA



This image shows the gas coverage for the burner/process area on the BBL site. The gas detector coverage is fully met in this location, meaning no altercations will need to be made in this area.

This image shows the burners flame detector location and the coverage of them. There are four burners located in this image resembling the BBL burners at Bacton. The first three platforms have full required coverage of 1ooN and 2ooN. However, the fourth platform containing the fourth burner only has full percentage coverage of 1ooN and does not have any coverage for 2ooN. Another flame detector would have to be installed in platform four to allow the full coverage to be met. This is shown in the image below where this new flame detector would be located.

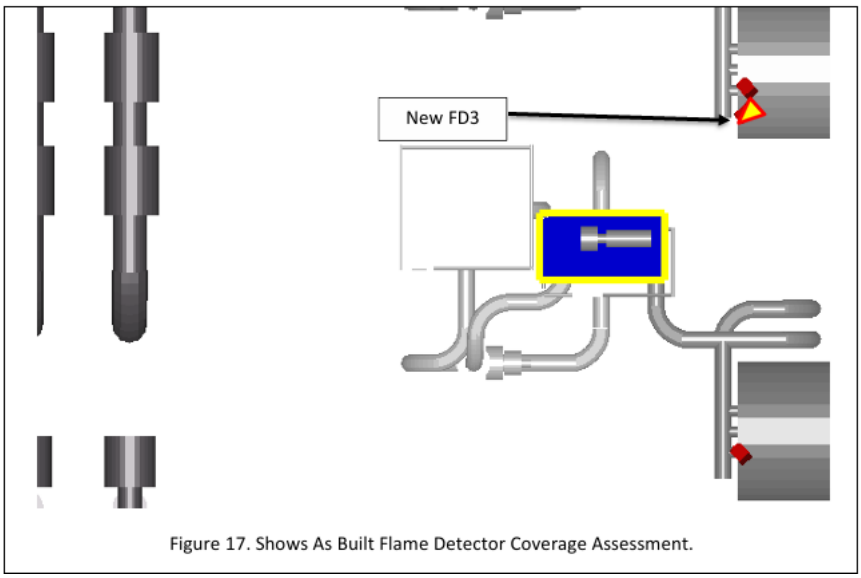


Figure 17. Shows As Built Flame Detector Coverage Assessment.

27 BBL INLET AREA

This image below shows there is only one acoustic device in this area, and it is communicated through site that this is a sufficient amount of detectors for this location and implied that no flame was needed for this area. This is located on the top right of the sight (Northeast).

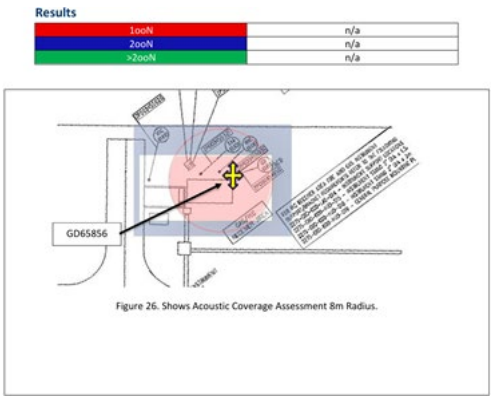


Figure 26. Shows Acoustic Coverage Assessment 8m Radius.

27 INSTRUMENT AIR/ DEISEL GENERATORS

In this area there was no existing mapping images. But the current gas detection devices are located in the most logical places being the reason behind the no mapping images. On the instrument air housing units, the gas detectors are located on the external air intakes. This is to monitor potential gas leaks on the main plant be taken through the air vents. Each housing has two detectors on them and does not need altering so no recommendations for this area.

However, for the diesel generator there are no gas detection devices located in this area. The question was asked if there was any needed in this location and no clear response was given as to why it would be needed in this area.

27 XZV VALVE --- AUXILLARY ROOM

Currently there is a single acoustic device located on the side of the auxillary building monitoring the valve. Some of the detection coverage is lost due to it being mounted on the side of the building not allowing full use of the 360-degree coverage. The detector has also been installed incorrectly, and the detectors display was also facing the building, meaning anyone who wanted to see the live reading or the status of the detector would not be able to. The current location could be improved upon by relocating it.

There is a singular flame detector device located in the XZV valve area and does not cover the 2ooN only the 1ooN. It was suggested on site that that no improvement would be required.

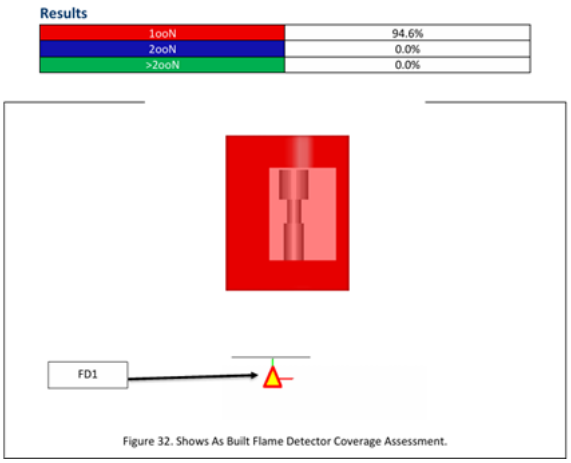


Figure 32. Shows As Built Flame Detector Coverage Assessment.

27 ANALYSER HOUSE

It was communicated that a single gas detector was to be installed within th4e analyser building however has not been mapped.

12. RECOMMENDATIONS & BENIFITS

There are multiple recommendations that should be made to the current BBL site with its existing gas and fire detector infrastructure. The main idea is to install new detector in previously shown locations above. This helps to increase the detector percentage coverage across specific areas of the BBL site at Bacton. New installations should only be added to locations that need them to meet detector coverage requirements to maximise efficiency and minimalize costs. By adding these new installations increases safety in these areas helping to protect employees in that district of Bacton along with the working equipment and infrastructure that is housed on the BBL site and surrounding structures in the Bacton Shell site. This would save money in the future if a leak does occur, it can be quickly detected and managed allowing to protect everyone on the site saving money from health care and damages to property.

13. HEALTH & SAFETY

27 REGULATIONS

- **BS EN 60079-29-----Detection of Flammable Gases and Oxygen**
  This standard specifies in requirements, test methods and acceptance criteria for flammable, oxygen and toxic gas detection equipment. This will include all vapour and gas detectors along with the alarms and signals it will process and give in detection of a gas or vapour hazard.

- **BS EN 45544-----Detection of toxic gases and vapours**
  A fourth part of a multi-series standard that gives guidance on selection, installation, use of maintenance of electrical apparatus used for direct detection and direct concentration measurement of toxic gasses and vapours in the workplace atmosphere. This regulation is applied to any devices that sound indications or alarms to warn the presence of toxic gas in the area or that initiates protective protocols.

- **BS 5839-----Fire detection and fire alarm systems**
  A fire safety standard that provides recommendations for the design, installations, commissioning and maintenance of fire detection and fire alarm system in non-domestic premises. It serves as a code of practice rather than a requirement to install fire detection systems in any specific building.

- **COSHH-----Control of Substances Hazardous to Health Regulation**
  This legislation relates to the control, monitoring and attend to substances that can be dangerous for others to come into contact with or that pose a danger to other objects if spilt. This is related to Bacton as there are multiple hazardous substances that could pose a potential threat and danger to the surroundings. This standard needs to be implemented to not only ensure the safety of any employees but also to protect existing infrastructure that if it comes into contact with such dangerous substances could potentially fracture or contain damage and lose the company money.

- **HASAWA-----Health and Safety at Work Regulation**

This standard implies the protection of employees inside the work site. This places any workers/employees above anything else ensuring the safety of others and that all employees are protected. To achieve this this legislation implements that the work site should be a safe place to work with minimal hazards that pose threat to employees on the site. If there are hazards that can't be implemented other legislations are put in place to decrease the risk as much as possible to prevent the hazard from have an increase chance of occurring.

14. CONCLUSION

To summarise this document, this report goes into strong depth about the different types of fires that may happen on a gas plant, different types of fire and gas detectors that can be used to monitor leaks and outbreaks. Furthermore, this document goes into detail about false alarm stimuli, Explosive limits, HVAC systems, existing infrastructure, gradings and voting's. The report also finalises with the locations of the BBL site, coverage of detectors, recommendations and benefits and the health and safety. This document is a descriptive report about all these subjects going into depths about why they happen at Bacton and how they are related to the Shell site.

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