5. TECHNICAL ASPECTS

5.1. Link Between Measures Taken and the MAHs Described

Mechanical / EC&I / Process Safety / Human Factors

The STOLTHAVEN Dagenham COMAH Safety Report is used as a day to day dynamic reference document, hence, the descriptive information required for this section of the Safety Report is provided in two ways:

- A comprehensive guide to the operation of the STOLTHAVEN Dagenham site is included in Section 2 of this Safety Report.

- Detail photographs, diagrams, and drawings as required to illustrate the text are resident in this section, this section also includes a significant number of appendices designed to provide demonstration to the reader that those procedures / standards referenced are actively used.

A systematic process has selected representative Major Accident Scenarios at the site. The Major Accident risk analysis process for the preparation of this safety report is conducted in two distinct steps.

1) HAZID study of the plants and processes (see Section 3.3.1 and Appendix 3.3); and
2) Linkage to the development of the Representative Set and Predictive Aspects Assessment (see Section 3.3.2 and Appendix 3.4).

As part of the 2019 COMAH Review, the HAZIDs for the site were completely re-assessed using a high-level guideword approach.

Hazard Identification and Risk Assessment Process

Stolthaven operates a number of methods for identifying potential hazards and their associated risks whether the consequences are off-site or on-site, or may affect health, safety or the environment or in some cases all three. These include:

- HAZIDs / HAZOPs / Major Accident Identification Studies
- Layer of Protection Analysis Review
- COMAH Risk Assessments;
- Occupied Buildings Assessments;
- Environmental Risk Assessments.

A detailed description of the COMAH assessment methodology for identifying and evaluating major accident hazards arising from the Site’s activities is given in Appendix 3.4 in this report.

The following Representative Set of scenarios has been chosen (Appendix 3.4 and provide the focal point for the discussions set out in Section 5 (Technical Aspects) of the COMAH Safety Report. Some parts of the Section 5 report will refer to the measures in place to prevent, control or mitigate a specific scenario or representation of scenarios, while others (for example, ignition controls / Hazardous Area Classification) would be relevant to most scenarios.

Table 5.1.1: Predictive Aspects Representative Set of Scenarios

Ref.	Scenario Description	Type of Release		Potential Events
Area 1				
1	Loss of Containment of a Flammable Material from a Bulk Storage Vessel in Area 1	1.1	Catastrophic Vessel Failure	Fireball, Pool Fire, Flash Fire, VCE, Vessel Internal Explosion.
		1.2	Major (500mm) Hole Failure	
		1.3	Minor (150mm) Hole Failure	
		1.4	Vessel Internal Explosion	
		1.5	Vessel Overfill	
2	Loss of Containment of a Flammable Material from a Road Tanker during Loading/Offloading Activities in Area 1	2.1	Guillotine (3 inch) Hose Failure	Spray Fire, Pool Fire, Flash Fire, VCE, BLEVE.
		2.2	15mm Hole Failure	
		2.3	5mm Hole Failure	
		2.4	Road Tanker BLEVE	
Area 2				
3	Loss of Containment of a Flammable Material from a Bulk Storage Vessel in Area 2	3.1	Catastrophic Vessel Failure	Fireball, Pool Fire, Flash Fire, VCE, Vessel Internal Explosion, OFCE.
		3.2	Major (500mm) Hole Failure	
		3.3	Minor (150mm) Hole Failure	
		3.4	Vessel Internal Explosion	
		3.5	Vessel Overfill – Typical Weather	
		3.6	Vessel Overfill – Calm Weather	
4	Loss of Containment of a Toxic Material from a Storage Vessel in Area 2	4.1	Catastrophic Vessel Failure	Toxic Cloud. *Flammable effects are considered under Scenario 3.*
		4.2	Large (5-minute) Hole Failure	
		4.3	Small (30-minute) Hole Failure	
		4.4	Vessel Overfill	
5	Loss of Containment of a Flammable Material from a Road Tanker during Loading/Offloading Activities in Area 2	5.1	Guillotine (3 inch) Hose Failure	Spray Fire, Pool Fire, Flash Fire, VCE, BLEVE.
		5.2	15mm Hole Failure	
		5.3	5mm Hole Failure	
		5.4	Road Tanker BLEVE	
6	Loss of Containment of a Toxic Material from a Road Tanker during Loading/Offloading Activities in Area 2	6.1	Guillotine Failure	Toxic Cloud. *Flammable effects are considered under Scenario 5.*
		6.2	15mm Hole Failure	
		6.3	5mm Hole Failure	
Area 6				
7	Loss of Containment of a Flammable Material from a Bulk Storage Vessel in Area 6	7.1	Catastrophic Vessel Failure	Fireball, Spray Fire, Pool Fire, Flash Fire, VCE, Vessel Internal Explosion, OFCE.
		7.2	Major (500mm) Hole Failure	
		7.3	Minor (150mm) Hole Failure	
		7.4	Vessel Internal Explosion	
		7.5	Vessel Overfill	

Ref.	Scenario Description	Type of Release		Potential Events
8	Loss of Containment of a Flammable Material from a Road Tanker during Loading/Offloading Activities in Area 6	8.1	Guillotine Failure	Spray Fire, Pool Fire, Flash Fire, VCE, BLEVE.
		8.2	15mm Hole Failure	
		8.3	5mm Hole Failure	
		8.4	Road Tanker BLEVE	
Site-Wide Scenarios				
9	Loss of Containment of a Flammable Material from Pipework during Ship-to-Shore Transfers	9.1	Guillotine Failure	Spray Fire, Pool Fire, Flash Fire, VCE.
		9.2	1/3 Pipework Diameter	
		9.3	25mm Hole Failure	
		9.4	4mm Hole Failure	
10	Loss of Containment of a Flammable Material from Pipework during Tank-to-Tank Transfers	10.1	Guillotine Failure;	Spray Fire, Pool Fire, Flash Fire, VCE, OFCE.
		10.2	25mm Hole Failure;	
		10.3	10.4 3mm Hole Failure	
11	Loss of Containment of High Flash Point from a Bulk Storage Vessel or Transfer Pipework	11.1	Pool Fire	Pool Fire; Spray Fire.
		11.2	Spray Fire	

During the HAZID's consideration was made to multiple types of causes of events, and a systematic line by line approach used to separate out scenarios and their measures into inherent, preventative, control and mitigation. The risk assessment findings from Section 3 are an integral part of understanding if the range of measures, described within Section 5, which prevent control or mitigate potential Major Accident Hazard Scenarios are sufficient; or whether more can be done to reduce risks further.

The contents of this Section, therefore, describe the methods of preventing hazard(s) escalating into a major accident and, in the event of failure, limiting the consequences of a major accident. The understanding of the risk, consideration of further risk reduction measures and details of the range of measures already in place, therefore, spans across Section 3 and Section 5 of the COMAH Safety Report, and any associated Appendices. To assist with demonstration of linkage, the tables in Appendix 3.8 link the measures in place with the Representative Set of Scenarios at a high level. Further discussion within this section presents these measures in more detail.

5.2. Prevention of Foreseeable Failures

5.2.1. Design

Mechanical / Process Safety / Human Factors

The site has taken and continues to look for measures to prevent Major Accidents or limit their consequences to a level that is considered to be as low as reasonably practicable (ALARP). To this end continuous improvement has been made over a number of years as problems have been recognised and opportunities arisen. This section of the report details what the historic design standards have been on site, along with where such improvements have been made from a design perspective.

Any further improvements identified when preparing the COMAH Report are included in the site's COMAH Improvement Plan (see Section 8 of this report)

5.2.1.1. Appropriate Design Standards

Mechanical / EC&I / Process Safety

The site has many years' experience in offloading, storing and transferring bulk chemicals, but not the detailed design knowledge of the said facilities – legacy facility. However, Stolthaven continues to undertake internal studies and assessments to further improve our knowledge and understanding of all assets including where possible the development of equipment related documents, asset hierarchy, registers etc.

Stolthaven recognises the need to maintain a library of quality documents related to its assets as such P&IDs and detailed designs such as where possible drawing, schedules and datasheets have been developed and maintained for the new Area 6, Area 1 and for future site upgrades / improvements.

The site has strengthened its expertise and resources (by the employment of key multi discipline personnel including providing access to other Stolthaven employees distributed in terminals across the globe) to control major projects from the conceptual design stage through to the detailed design and choice of equipment, including plant layout and design. It is believed that by combining the inherent operating knowledge of the site's personnel with the bought in skills of external contractors future developments will be designed and constructed to the highest standards based on internationally recognised codes.

Storage tanks: Ensuring equipment is designed to recognized standards, such as BS5500, BS2654 etc., such that it is able to withstand the maximum foreseeable operating conditions combined with operating the equipment within safe limits, greatly reduces the potential for any loss of containment. Tanks are built from either mild steel or 316 stainless steel.

The tanks in Area 6 are designed and constructed to recognised standard – BS2654. The tanks in Area 1 (Tank Pit 1 and 2) and Area 4 (Tank Pit 3) were designed and constructed in 2013 - to EN14015:2004. The tanks were designed to 100 mbar(g) positive pressure and -5 mbar(g) vacuum pressure.

In most cases their maximum design pressure is +56 mbar(g) and maximum vacuum pressure is –5 mbar(g). There are no pressure vessels holding COMAH dangerous substances on site.

A significant change to site is the installation of the new Area 1, the most recent example of a newly designed installation at the Stolthaven site. As would be expected, the newer installation is designed to current standards and an example of how Stolthaven use appropriated design standards when updating plant areas. The new tanks have been built to Standard EN 14015 *Specification for the design & manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded steel tanks for the storage of liquids at ambient temperature and above.*

The Stolthaven Engineering Standard for New Installations also requires all tanks to be:

- Compatible with the chemical and physical properties of the liquid to be stored;
- Protected to avoid excessive over and under-pressurisation and operated within limits established to ensure that this is achieved;
- Designed and constructed to withstand impacts on their integrity from normal operations and foreseeable events;
- Designed, constructed and installed to prevent failure due to corrosion or chemical interaction. The corrosion allowance must reflect the anticipated attack from the products stored.

Tank design conditions include the following:

- Maximum design temperature not less than 93°C and minimum 0°C;
- Minimum design pressure 15mbar and minimum vacuum -5mbar;
- Material of construction (for carbon steel tanks) - ASTM 131 Gr B or equivalent;
- Maximum filling speeds are 1 m/s until the filling nozzle of the tank is submerged, and thereafter 3 m/s for low flash and 7 m/s for high flash products.

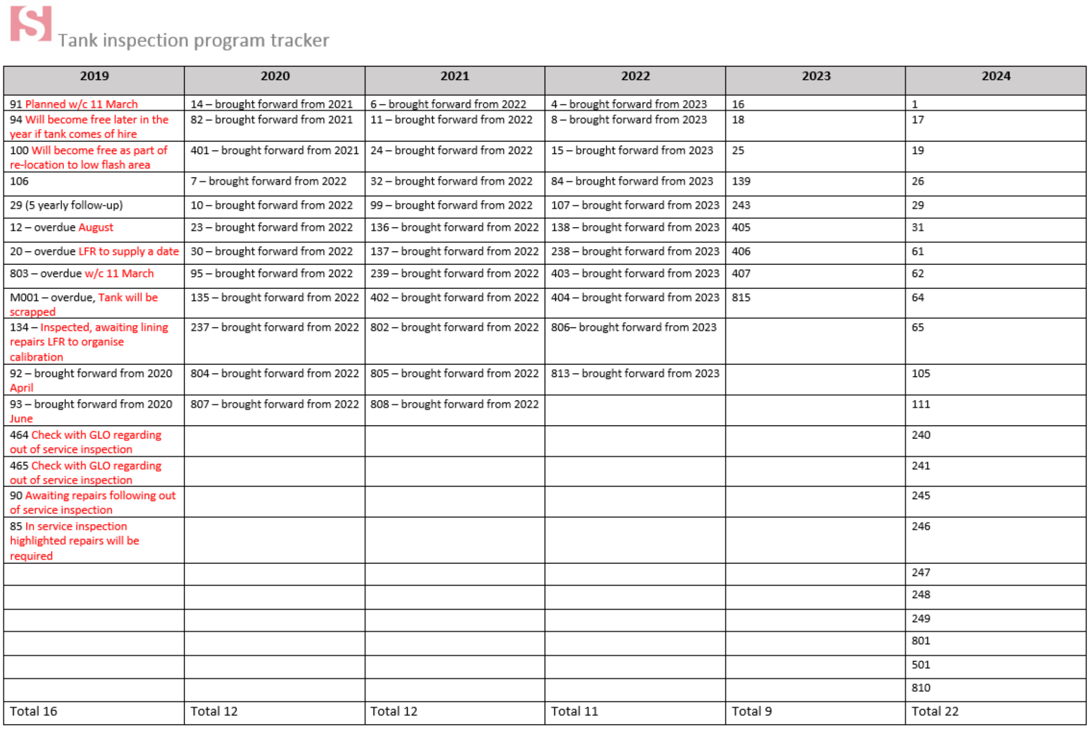
An example tank within this area is T0101 is to the latest version of BS EN 14015 *Specification for the design & manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above.* Design pressure range is -5 to +100mbarg, and design temperature range -20 to +100°C.

A typical storage tank P+ID is presented in Appendix 5.1 while Stolthavens current design philosophy is contained within Appendix 5.2. (includes mechanical and process control)

The older tanks are fabricated to Good Engineering Practice; to overcome this lack of design detail the site's previous owners undertook the design of some of the older tanks and vessels in-house and despite significant investigation the current management team have been unable to relate the legacy assets to the current British Standards. In 2008 the previous owners undertook a survey of **ALL** the storage tanks installed at Dagenham. During this survey every tank was subject to a detailed external inspection by a competent 3rd party (Royal Sun Alliance) and wherever possible internal inspections were also completed.

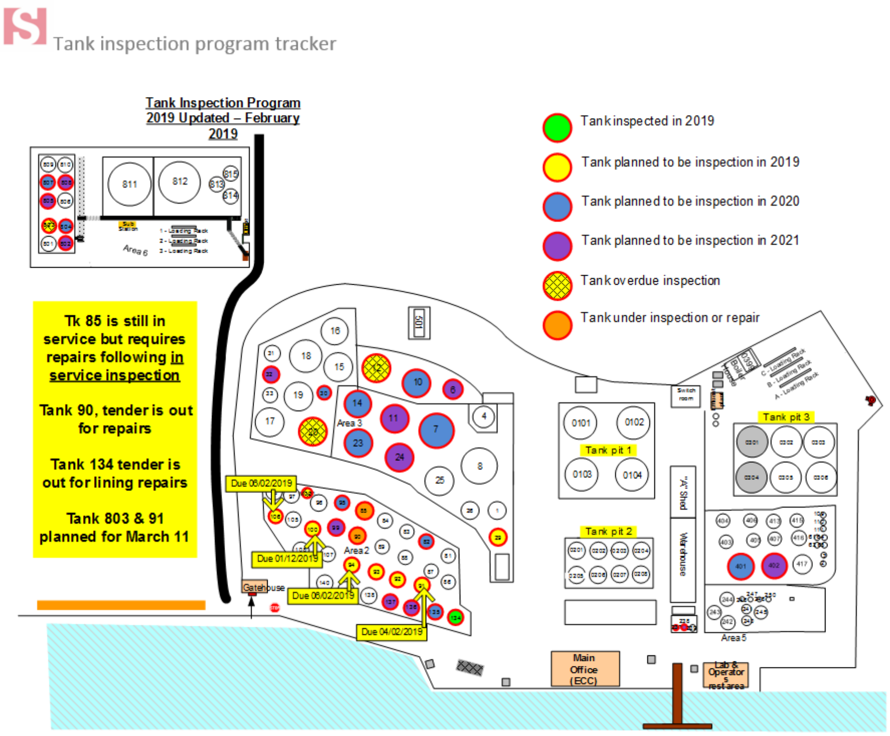
The findings of the tank survey work were then used to develop a detailed Tank Inspection baseline, which forms the foundation of the site's ongoing tank inspection programme (i.e. to EEMUA159) to assure their integrity, remaining useful life and comply with applicable regulations. Examples of both internal and external inspection records can be found in Appendix 5.3. Ongoing assurance of fit for purpose is covered by an inspection schedule presented in Figure 5.2.1.1 below

Figure 5.2.1.1 – 6 Yearly Plans for Tank Inspections.



Tank inspection program tracker

2019	2020	2021	2022	2023	2024
91 Planned w/c 11 March	14 – brought forward from 2021	6 – brought forward from 2022	4 – brought forward from 2023	16	1
94 Will become free later in the year if tank comes of hire	82 – brought forward from 2021	11 – brought forward from 2022	8 – brought forward from 2023	18	17
100 Will become free as part of re-location to low flash area	401 – brought forward from 2021	24 – brought forward from 2022	15 – brought forward from 2023	25	19
106	7 – brought forward from 2022	32 – brought forward from 2022	84 – brought forward from 2023	139	26
29 (5 yearly follow-up)	10 – brought forward from 2022	99 – brought forward from 2022	107 – brought forward from 2023	243	29
12 – overdue August	23 – brought forward from 2022	136 – brought forward from 2022	138 – brought forward from 2023	405	31
20 – overdue LFR to supply a date	30 – brought forward from 2022	137 – brought forward from 2022	238 – brought forward from 2023	406	61
803 – overdue w/c 11 March	95 – brought forward from 2022	239 – brought forward from 2022	403 – brought forward from 2023	407	62
M001 – overdue, Tank will be scrapped	135 – brought forward from 2022	402 – brought forward from 2022	404 – brought forward from 2023	815	64
134 – Inspected, awaiting lining repairs LFR to organise calibration	237 – brought forward from 2022	802 – brought forward from 2022	806– brought forward from 2023		65
92 – brought forward from 2020 April	804 – brought forward from 2022	805 – brought forward from 2022	813 – brought forward from 2023		105
93 – brought forward from 2020 June	807 – brought forward from 2022	808 – brought forward from 2022			111
464 Check with GLO regarding out of service inspection					240
465 Check with GLO regarding out of service inspection					241
90 Awaiting repairs following out of service inspection					245
85 In service inspection highlighted repairs will be required					246
					247
					248
					249
					801
					501
					810
Total 16	Total 12	Total 12	Total 11	Total 9	Total 22



Pipework: Fixed pipework is present on site to transfer materials from Jetties / Road Loading Areas into the storage tanks, and to perform tank to tank transfers. Pipework on site is generally to ASME B31.3 and a pipework specification is presented in Appendix 5.4.

Flexible hoses: The use of hoses is necessary when connecting to ships, road tankers and when undertaking tank to tank transfers. To significantly reduce the risk of release all the hoses used on the site (including the tanker connection hoses) are owned and maintained by Stolthaven and form part of the fixed installation. Hose bodies are designed to BS EN 13765:2010 (hose body specification).

All flexible hoses on site are registered and are inspected (by a specialist contractor company to industry good practice) on a 12-monthly basis as a minimum and inspected by the operator prior to each use. Practice has established that any damage to hoses is identified early and the hoses are immediately reported, the offending hose removed from use and quarantined, and replaced.

Seals: The Company has invested significantly in the replacement of pumps utilising single mechanical seals with newer double mechanical seal or magnetically coupled units, therefore significantly reducing the likelihood of any leak.

As part of the site's Plants Preventative Maintenance, all pumps with mechanical seals are checked for leaks daily by the operations team with any problems being reported on the Company's Express Maintenance System. Furthermore, all pumps are inspected every 3 months by members of the maintenance staff as part of the sites routine lubrication checks and are serviced annually (if required) during the annual shutdown.

Construction: All construction work is carried out in accordance with recognised standards. These standards are selected in consultation with the contractor undertaking the installation, the management contractor and Stolthaven. Due to the age of the site, standards have been applied that were relevant at the time the construction work was undertaken, but these may now have been superseded or withdrawn.

Where major modifications to plant or improvement projects to the site are to be undertaken, Stolthaven Dagenham employ a design contractor where required to specifically fill any observed skills gap within the Stolthaven Dagenham management team.

An example of this approach is the Front End Engineering Design (FEED) study undertaken by Albright Design Services prior to commencement of the Area 3 west bund upgrade works (in 2004). More recently the site has employed the services of P&I Design to carry out Layer of Protection Analysis (LOPA) for the newly constructed Area 1 project. The Site's respective owners installed the process units over a number of years to the Industry design standards pertaining at the time utilising their Engineering Departments, or nationally recognised Main Contractors, to design the plant and supervise its construction and commissioning. All new plant and equipment are designed, installed and maintained in accordance with the appropriate standard; an example of this approach occurred in the design and construction of Area 6 storage facilities completed in 2000 by Mowlem Engineering Ltd**.** Newly constructed Area 1 storage facilities completed in 2016 have been built to industry good practice, specification design codes such as BSEN14015, CIRIA 736 etc.

Appropriate standards are standards either by legislation or best practice. These will be British Standards, HSE guidance such as HSG 176 or industry approved codes of practice such as EEMUA 159. There is no difference therefore between appropriate standards and the highest standards.

Although Stolthaven Dagenham does not directly employ a Chemical Engineer, whenever necessary expertise and resources is brought in, in the from a specialist contractor who are able to undertake major projects from the initial conception by Stolthaven through to completion and handover to Stolthaven.

The adherence to the aforementioned standards can be demonstrated by reviewing example project files. The scope of the project was to design a Storage Tank area and this was contracted to a 3rd party main contractor. They produced the engineering and functional design specification for the project and subcontracted elements to expert organisations, e.g. Site Investigation Services, Civil Design. Typical project work documents can be found in Appendices 4.9 a – g.

Objectivity is demonstrated through compliance with British Standards and Approved Codes of Practice or their equivalent, such as ASME:

- The Storage Tanks are designed and constructed to relevant industry standards e.g. BS 2654 of a material suitable for the prescribed contents, either Carbon Steel or 316L SS.

- The structural support calculations were based on standard methods e.g. BS 8110 for the concrete, BSEN 449 for the steel, BSEN 6399 Part 1 for Dead and Imposed Loading for Buildings and BS CP3 Chapter 5 for wind loading.

The manufacturer of equipment confirms in their Certificate of Compliance that it is designed to the Standard; it is hydraulically tested in accordance with the Code and is independently verified by the Competent Person, as meeting the Standard. The Competent Person, as required by the Code, also stamps the vessel nameplate where necessary. The integrity of each system within the completed Storage Tank area is confirmed through:

- Proof testing with water, air/nitrogen, due to the nature of some products it is not always safe to introduce water into systems;
- Instruments are loop tested;
- Motor rotation is confirmed; and
- Electrical continuity of steelwork is proved.

To ensure the equipment remains fit for purpose all pressure systems are included in the Written Scheme of Work required for the PSSR 2000 Regulations and are consequently routinely inspected by the Competent Person. Site personnel or competent contractors inspect equipment not on the pressure systems register.

The design codes currently used are varied and examples of applicable codes are tabled in Table 5.2.1.1.1. The list is not exclusive but is used to demonstrate that equipment is designed and constructed to recognised national standards.

Table 5.2.1.1.1: Design Codes

Equipment/Structure	**Standard/Code**
Building, Dead and Imposed loading	BS 6399
Bunds	CIRIA 736
Cables	To various BS EN Standards
Colour code	BS 1710
Concrete construction	BS 8110
Corrosion	NACE
Documentation	ISO 9001
Drainage systems	BS 8301
Erection	National Structural Steelwork Specification and Eurocodes
Instruments	DIN 50049, EN10204, DIN55350

Equipment/Structure	**Standard/Code**
Material forming and fabrication	ASTM, ASME.ANSI
Metallurgy	ASTM, BS
Motors	BS IEC 60079-19:1993
Motor enclosures	IP
Motor starter boards	BS EN 60947-4-1
NDT examination	ASME V
NDT interpretation	ASME VIII
Noise	BS EN ISO 11688
Piping	ANSI 31.3
Pumps	ANSI B73.1M or ISO 2858 or API 610
Storage tanks	BS2654, API 650
Structural steel	BSEN 10025
Switch gear	BS EN 60947-1
Transformers	BS 148
Welding	BS EN 287, 288, ASME IX
Wind loads on vessels, columns etc	BS Code of Practice CP3 Chapter 5
Valve actuators	ISO 5211
Flexible hoses	BS 3492 BX / BS 5842: 1998 (testing) BS EN ISO 8031:1997 (electrical continuity) BS EN 13765:2010 (hose body specification)
Area 1 Fire protection	NFPA 11, 13, 14, 15, 16, 20, 24, 25, 30 BS EN 13565 BS EN 12845 BS EN 9990:2006 IP19

Redundancy, Diversity, Separation and Segregation

Redundancy & Diversity

Redundancy was considered in the design of the facilities and is covered during the preliminary design review stage of plant design. This can be demonstrated by considering the following examples:

- As a storage terminal a key basis of safety is to maintain safe working levels within the storage tanks. Stolthaven use both redundancy and diversity when controlling level through the use of manual dips, automatic tank gauging and high-level switch based overfill protection on the relevant tanks.

- In the new Area 1 design double PVRV's were designed in for over-pressure protection; only a single relief valve is needed to relieve all credible pressure scenarios.

- Isolations between tank – tank or tank – jetty are a minimum of 2 x valve isolations to ensure that no single passing valve can lead to unwanted product flows.

- Firefighting provision installed into the new Area 1 design (foam and / or water) has manual mode of operation as well as automatic through heat detection / frangible bulb. A uninterruptible power supply is present on this also system.

- The site in 2018 upgraded its compressed air system (including 100% redundancy). This new system helps further improve the reliability of air supply to key plant and equipment.

- The site is equipped with a total of 2 steam boilers providing steam to the entire site. Each boiler is capable of providing sufficient steam individually and are therefore operated with one on line and the other in standby mode, in most cases.

- The site's is served by an underground electricity supply. The site is currently in discussions to purchase a separate substation (on a different circuit) to improve reliability of supply and import capacity. However, the nature of the site's operations is such that any loss of power or services to the site will not foreseeably increase the risk of a Major Accident. In such an event the plant is maintained in a safe condition until full power is restored. Appendix 5.5 provides a single line diagram for the incoming electrical supply. Appendix 5.6 provides a protection study for the main incomer while Appendix 5.7 provides a fault level assessment.

- The site has a back-up generator installed to provide power for the site's main firewater pumps in the event of a power cut. Fire water is supplied to the site & jetty by mean of extraction from the river Thames, via dedicated pumps and fixed pipework, with the inlet to the system fitted with filters. The system is tested every week. The newly installed firefighting system to provide cooling water and foam blanketing in Area 1 have (3 pumps for cooling water - a duty and two standby diesel pump) and (2 pumps for foam) respectively.

- Nitrogen is used on site to provide blanketing on certain of the bulk tanks. The nitrogen is supplied in the form of 'bottle banks' and at any point in time up to 6 sets can be in use. The use of nitrogen is purely for product quality reasons and the loss of blanketing to a tank does not increase the likelihood of a major accident. Nevertheless, the site holds two spare bottle banks on site at all times and replacement bottle banks can be delivered to the site within 2 hrs if necessary

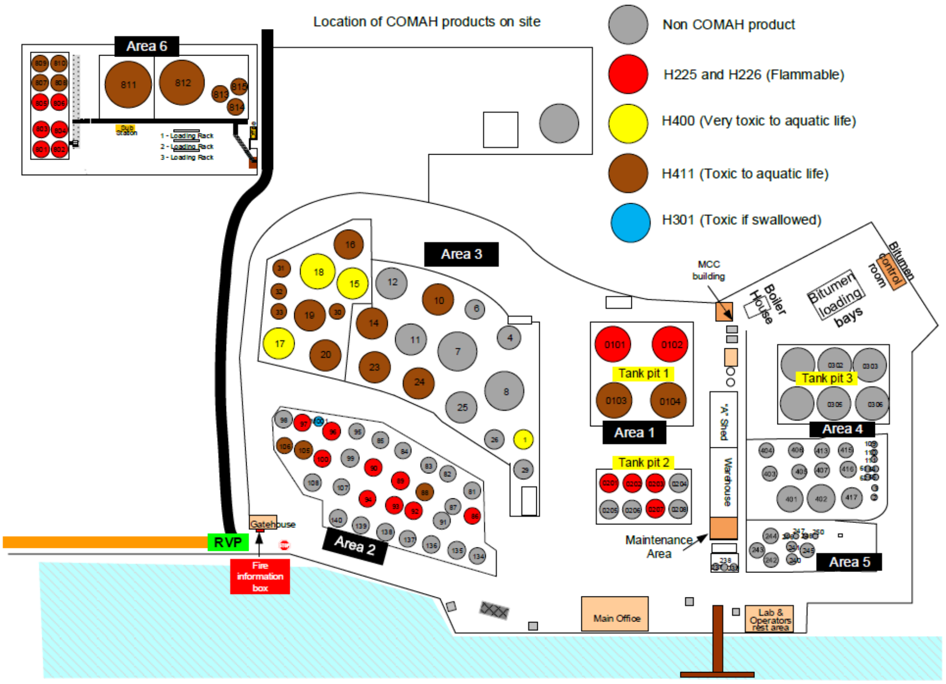
Separation and segregation

An attempt has been made to ensure adequate separation between storage areas within the most recently constructed areas. Due to the age of the installation records relating to the older parts of the site are sparse and in some cases the standards to which the installation was were designed are unknown. All future construction will be in accordance with HSG 176 – 'The storage of flammable liquids in tanks', and in association with guidance provided by Stolthaven Ltd, where possible.

Separation and segregation are two basic principles that have been applied to some areas of the facility.

The installation of dedicated flammable storage facilities are provided for bulk materials, segregated from non-flammable materials. This is shown diagrammatically in figure 5.2.1.2 below

Figure 5.2.1.2 – Site Segregation



- During the layout and design of Area 6 the flammable loading station and the flammable tank farm were located to be more remote. The flammable tanker loading station was designed and located in compliance with HSG 176 Guidance on Bulk Flammable Storage Tanks.

- The boiler plant, warehouses, offices and laboratories etc., are located in accordance with current guidance such that they are outside the hazardous areas. The site carried out an Occupied Building Risk Assessment (OBRA) related to the siting / locating of the new office building. The current OBRA is presented in Appendix 5.8.

- All air operated valves installed across the site have been design**ed** such that they fail safe on air / power failure. For example, all tank inlet and outlet valves fail close. The relevant surge calculations have been carried out to ensure the protection of associated pipework and flexible hoses following activation of the valves. During testing of ROSOV's closure time is recorded and relevant adjustments are made. The procedure for this testing is provided in Appendix 5.9 while a test record is presented in Appendix 5.10.

- The segregation of all flammable storage areas from potential fixed ignition sources. The site has strict policies on the use of electrical equipment and vehicles on site, smoking (and the carrying of smoking materials) and control of hot works.

- The site has conducted a number of hazardous area classification studies. (Copies of which can be found in Appendix 5.11 - 5.13), the conclusion of which is that the site's separation distances comply with recognised standards such as HSG 176, HSG 51, IP 15. For example, the flammable bund is greater than 8m from the nearest site boundary

Single Event with Multiple Effects

The site continuously stores and distributes hazardous and flammable liquids. Consequently, the filling, transfer, offloading and loading from storage vessels of these materials are regular events. There is no regular, scheduled period where the facility is shut down and all the chemicals are removed from site.

Table 5.2.1.1.2: Consequences of failures

Failure	**Consequence**
Electricity	Loss of power causes the transfer activities to stop at the storage facilities. The pumps will trip and actuated valves will move to their fail positions, however the ship's transfer pumps will continue operating, but communication between the shore-side and ship personnel will ensure that these pumps are switched off if an incident occurs. Some ships that dock at the transfer jetty provide a remote emergency stop button on the jetty for the use by shore side personnel in the event of an incident; to stop the ships transfer pumps. Emergency lighting is provided to enable escape.
Nitrogen	Consequences of failure – no hazard. As nitrogen used on site is supplied local to its use from dedicated bottle banks any loss of nitrogen will most likely be limited to a single tank. Regardless nitrogen is only used for product quality and the loss of the inert atmosphere would not result in any significant increase in risk.
Compressed air	During HAZOPs, the fail position of valves is assessed and, based on safe practice, are assigned fail-safe open, fail-safe closed or fail-safe in position.
Steam	Consequences of failure – no hazard.

Failure	**Consequence**
Firewater	The loss of fire water has been assessed as part of the sites Firewater Risk Assessment as a result the fire brigade has indicated that should firefighting water not be available from the site's own fire hydrants an alternate off site source could be used – such as the river Thames.
Potable water	Consequences of failure – no hazard
Telephone system	The loss of the site's telephone system in normal operation poses no hazard as due to the large area the site covers normal operations relied upon and make use of 2-way radios. Additional radios are stored within the site Emergency Control Centre (ECC) and are permanently on charge.
Gas	Consequences of failure – no hazard The hot oil heaters used to maintain the temperature of the Bitumen plant will cool. The site can run the said plant on gas oil with minimal pipework modification.

Earthquakes

Earthquakes are not considered credible as the area is not a seismic zone and they were not, taken into account in plant design. However, as the Plant is designed to recognised standards it should not suffer significant damage from an earthquake of a magnitude of 6 on the modified Mercali Scale which evidence suggests is the upper limit of UK earthquakes.

Flooding

There is a risk of flooding to the site. The site is downstream of the Thames barrier and is hence not protected by it. Flooding in the river would interrupt ship-offloading operations causing a commercial problem but is unlikely to result in a release from a storage tank as they are fixed down and are heavy. The sea wall is raised alongside the site.

In the unlikely event that the site did flood then some pollution would result when residues from drains and sumps were flushed out and small containers were washed away. Some equipment may suffer water damage, but this would not lead to a major emergency.

Extreme rainfall can cause the outfall to Chequers lane to become restricted, since the lane is prone to flooding. High water levels backing up may cause some drums to float and move from their storage locations.

The site undertaken a flood risk assessment in May 2013. This was carried out by a special Environmental Consultants (Enzygo Environmental Consultants). This site has used the information from the risk assessment to develop a Flood Risk Management Plan. A copy of the flood risk assessment and flood management plan is contained within Appendices 6.1 and 6.7.

Subsidence

There has been no evidence of any subsidence and the risk of contribution to a Major Accident is extremely low.

Extreme Atmospheric Temperatures

Extremes of ambient temperature do not have any implications for the materials stored on site. Most water pipes and systems exposed to external temperatures are lagged. Materials are stored under conditions which are suitable and appropriate to their requirements, as identified under the hazard and risk assessment procedure that is carried out when new materials are brought onto the site. Furthermore, tanks are either lagged or painted white to reduce ambient temperature effects.

Strong Winds

Meteorology shows that the prevailing wind direction is from the South West and there is no immediate off-site activity in this direction likely to pose a potential hazard. Extreme winds could in theory damage the installation. Design standards cater for all reasonable expectations from this eventuality. Any such events would not lead to a major emergency.

Lightning Protection

No lightning protection is afforded to the older storage tanks.

No lightning protection systems has been installed on the new Area 1 tanks; their roofs have a minimum thickness of 5mm

Ref.	Action
5.2.1.1.c	Undertake a detailed survey of the site’s existing lightning protection and earthing systems and undertake any improvements identified as necessary. Action in progress at time of COMAH Safety report revision. RA are being carried out on Area 2, 3 and main electrical equipment building.

5.2.1.2. Selection of Measures Taken to Prevent Major Accidents

The Selection of measures taken to prevent a Major Accident is a culmination of all the measures referenced throughout the Section 5 report, and linkage to the Major Accident Scenarios is provided via the FRRM Workshop, see Section 3. The text below focusses on changes to the site since the last COMAH Safety Report submission with respect to some of the measures installed.

Mechanical

The site in 2018 upgraded its compressed air system (including 100% redundancy). This new system helps further improve the reliability of air supply to key plant and equipment.

EC&I

The site has an ongoing upgrade programme to improve overfill protection on RTW loading bays (so far a total of 10 loading bay have been upgraded). Also, Area 1 loading bays (commissioned in 2016) include RTW overfill protection.

The site has installed automatic tank gauging (ATG) on all tanks containing COMAH products. These ATG have further enhanced the site ability to remotely monitoring tank filling operations.

Process Safety

The design standards used across the site vary. Since Stolthaven purchased the business there has been few major changes to the site. The last development completed was in 2016 when Area 1 was demolished and rebuilt to meet current engineering standards. Also, the secondary containment for both Area 2 and Area 3 have been upgraded (impervious floor, new bund wall, and drainage), and the site air compression system upgraded.

Over recent years the site's focus has been on preventative safety measures. This can be demonstrated by the coating internally of tanks 15 and 18 in preparation for the storage of amine product due to the aggressive corrosive nature of the product. Also, the installation of automatic tank gauging on all tanks in Area 2 and Area 3.

Stolthaven uses a hierarchical approach to risk and engineering management, i.e., first consider inherent safety, then prevention / control, then finally mitigation. A review of flexible hoses usage on site was undertaken in 2016 with a view to identify opportunities to eliminate the use of flexible hoses including insisting the use of rigid pipework in new engineering designs and modification of existing system, where possible.

Inherent Safety

The site receives stores and distributes hazardous, flammable and toxic liquids. These activities have not changed over many years therefore there have been a limited number of opportunities to increase the inherent safety of the installation. However, whenever possible improvements have been made, examples of which are;

- The replacement of carbon steel pipe work with stainless steel pipe work for the amine product to prevent corrosion.
- The inspection of all tanks to EEMUA 159 and actions required resulting from this inspection including the repair of defects and the date of the next inspection.
- The repainting of the tanks to prevent external corrosion.

- The removal of flexible hoses and replacing them with hard piping, where possible.
- The movement of low flash products into tanks with more robust engineering controls and firefighting capabilities.
- The site maintains an annual tank painting programme. In 2017, tanks 811 and 812 (in Area 6) were completely coated to mitigate possible corrosion. Paint repairs have also been carried out on various tanks on site – Area 4 and Area 3 specifically.

The site has completed a programme of Secondary Containment improvement in Area 6, Area 1, Area 2, and Area 3., The focus was to ensure the said bunds are 100% impervious.

The site management team understands that consideration of inherent safety principles begins at project conception phase and continues through later design phases. Therefore, Stolthaven capital projects procedure set out to ensure:

- New plant and equipment and all modifications are designed and installed in accordance with current approved engineering standards and regulations.
- Direct plant and equipment replacement, or repair is carried out in line with current approved engineering standards and regulations.
- All proposals for change to process plant and equipment engineering specifications receive proper consideration and approval through the Management of Change process.

During the construction of the new Area 1, the following are examples of how inherent safety principles have been applied.

- New tanks in Area 1 designed to Standard EN14015 Specification for the design & manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded steel tanks for the storage of liquids at ambient temperature and above;
- These tanks have a corrosion allowance of 1mm (shell) or 2mm (floor);
- Minimum separation distance of 10m for 5,000m3 tanks, in accordance with HSG176;
- No corrosive products stored.

The following features are key in the prevention approach to inherent safe design and are applied at Stolthaven Dagenham facility:

Accessibility, examples include:

- Safe access for collection of samples, testing and maintenance.
- Provision of access platforms, ladders, lifting devices.
- Easy access for isolation and depressurisation of equipment.

- Easy access and escape during emergencies.
- Easy access for emergency vehicles and crews.

Attenuation, examples include:

- Reduce pressure / temperature to the minimum possible to maintain fluidity

Integrity, examples include:

- Ensure equipment and piping has adequate corrosion allowance.
- Ensure pipelines are properly sized to minimise the effects of corrosion and erosion.
- Use heat resisted cables on critical safety systems in hazardous areas.
- Adoption of Mechanical Integrity and Asset Criticality Programmes.

Minimisation/Reduction, examples include:

- Minimise the number of flanged connections.
- Minimisation of number of flexible hoses used in processes following site reviews.
- Minimise the number of electrical devices (e.g. junction boxes, heaters, etc.).
- Install pumps close to their suction sources.

Orientation, examples being:

- Vent systems are located down-wind of process/storage areas of flammable / toxic materials.

Reliability, examples being:

- Minimise the use of unproven technology.
- Use equipment of known satisfactory performance.
- Design for minimum maintenance.
- Design to ensure that a failure of a process section has minimum effect on other equipment.

Segregation, examples being:

- Segregate flammable liquid pipe-work from ignition sources.
- Minimise routing emergency and control system cables through hazardous areas.

- Locate isolation valves outside the hazardous area (wherever possible).

Simplicity, examples being:

- Consolidate materials to a minimum.
- Keep design as simple as possible.
- Optimise plant design and eliminate superfluous equipment.
- Keep pipe runs short and simple.

Standardisation, examples being:

- Use proven systems and components wherever feasible.
- Standardise design as much as is practical to simplify maintenance.

In practice, some of the inherently safe principles do conflict with traditional operating and maintenance practices. For example, those principles that direct the design towards full welded construction to minimise leak sources. This may conflict with equipment isolation requirements. The use therefore of an integrated team throughout the phases of a project, with members drawn from the Engineering, Health and Safety and the Operations Groups, ensures that conflict is minimised.

Prevention Measures

Those methods that are intended to prevent the initiation of a sequence of events, which could lead to a major accident, examples include:

To prevent fire and/or explosion on board ship:

Ships are designed for handling flammable liquids and are fitted with fire/explosion proof equipment. The offloading jetty is manned at all times during the transfer operation and communication is made both verbally and visually. There is a ship/shore checklist completed before any offloading operations take place in order to identify any risks that might be present in the activities to be undertaken. Also, CCTV cameras have now been installed on the jetty head to further improve operational monitoring and security.

To prevent puncture of storage vessels and vehicle collisions:

All movements of the transport ships are in accordance with the relevant Merchant Shipping legislation and are controlled by suitably qualified and experienced ships' personnel. The offloading jetty is manned during loading/offloading and a collision would be detected in a timely manner, as such the loading operation would be stopped before the collision occurred.

A speed limit of 10mph is specified to manage the movement of road tankers around site. Bunded walls protect the tanks containing low flash materials. A one-way traffic system has been adopted on site, where possible to minimise collision and improve efficiency.

All FLT drivers are trained and examined to prove their competency in the use of these vehicles.

To prevent fire and/or explosion within the site:

- All pipelines are continuously bonded and all tanks are connected to earth;
- Road tankers are earthed during loading/offloading, site have progressed the retrospective installation of permissive earthing systems e.g. scully systems. These are currently present in Areas, 1, 2 and 6;
- Procedures and training are in place to prevent static discharge when dipping and sampling;
- All electrical equipment is to industry explosion proof standards and loading areas meet IP zoning standards;
- Normal conditions are over rich atmosphere in tank; and
- Nitrogen inerting facilities are provided for the site's storage schemes.

Control Measures

Those measures that are intended to limit a hazardous event from escalating into a major accident, examples include:

- Operational activities are supervised and are controlled by written procedures;
- Radar level gauges on all tanks (containing COMAH Products) with high level alarms to prevent overfilling.
- Installation of level gauges and instrumentation including pump shut off switches;
- Jetty water drench scheme to control outbreak of fire;
- Manifolds located within bunded areas to contain spills and leaks;
- Contractors work under a permit system and must supply risk assessments and method statements. Work that occurs within a flammable area requires that the atmosphere is tested for the presence of flammable vapours and oxygen content;
- Road tanker driver/operator is in attendance when loading and offloading operations in progress; and
- Ullage of tanks checked before transfer operations are begun.
- New NFPA (National Fire Protection Association) approved firefighting system with tank drenchers and foam pourers install on Area 1 tanks.

- CCTV cameras have now been installed across the site to further improve operational monitoring and security.

Mitigation Measures

Those measures that are intended to limit a hazardous event from escalating into a major accident, examples include:

- Bunding of storage tanks containing hazardous materials;
- The site has a firewater system;
- The site has an emergency response procedure;
- HVP pump inlet installed on adjacent jetty for use by London Fire Brigade;
- Operators are trained to fight small fires.
- Training and induction of personnel working on the site, raising the awareness of the hazards present and the actions to be taken in the event of an incident.

For the new area 1, the following additional mitigation measures have been implemented

- Redundant PVRVs (two fitted on each tank in Area 1).
- New dedicated fire water system.
- Cooling water can be supplied to tanks to protect against fire impact from adjacent tanks.
- Escape routes - complete walkway around the top of each tank, allowing escape in both directions; interconnecting platforms, stairways over bund wall; also, caged escape ladders over the bund wall.
- Sufficient space between tank bunds to allow ready access for fire appliances.

5.2.1.3. Layout of Units

Mechanical / Process Safety / Human Factors

The site is well laid out with the roadways designed with HGV movements fully considered in terms of roadway width, construction, corner radii and parking lay-bys. Adequate lighting is provided to enable safe 24-hour working. “Armco” barriers protect safety critical installations.

All Occupied Buildings are remote from the main operational storage areas of the site. The discussion in this section should be read in conjunction with the site layout plan, see Appendix 5.14.

No process equipment is located such that it is adjacent to through roads or vulnerable to vehicle impact. Storage tanks are in bunds and set back off roadways. The loading bays where they are not in bunds (for example tanks 81 to 97) they are protected by barriers.

The effect of specific aspects of the plant layout on Major Accidents is as follows:

Ventilation

As stated in HSG 176 The Storage of Flammable Liquids in Tanks, good ventilation ensures that any flammable vapours given off from a spill, leak or release will be rapidly dispersed. This is achieved by locating the storage tanks, transfer facilities; vent pipes etc. in the open air, in a well-ventilated position, as exemplified by the site’s overall layout, details of which given in Appendix 5.14.

Where smaller quantities are handled within the site’s warehouse areas, such as IBCs, these containers are always fully sealed, and the buildings used are design such that are not enclosed and have a good degree of natural ventilation.

Congestion

There is no congestion of structures or plant equipment within the production building or external tank farms that can foreseeably aggravate the pressure effects resulting from the release of a flammable substance.

Separation of Flammable Inventories and Ignition Sources

Hazardous Area Classification (HAC) studies have been undertaken at the terminal, the aim of which is to identify potential sources of ignition in all areas where there may potentially be a flammable atmosphere under normal or abnormal operations.

As a result of these Hazardous Area Classification studies the terminal areas have been classified as Zone 1, and Zone 2. The site is currently working towards compliance with DSEAR, with the next task identified being the assessment of mechanical equipment installed with the site’s designated hazardous areas.

Means of Escape and Adequate Shelter

There are clear means of escape from the Main Office, the Mess Room, Warehouses, and Workshop and from all hazardous areas of the storage facilities.

The site has two vehicular entrances one onto Thunderer Road and a number of alternative access gates located around the perimeter of the site therefore, in any wind direction there is adequate means of egress from the site.

A fire risk assessment has been undertaken in accordance with Regulatory Reform (Fire Safety) Order 2005. In the event of fire, the terminal personnel evacuate to the site Assembly Point located adjacent to the gatehouse, detailed information regarding the site emergency evacuation procedures may be found in Section 7 of this report.

The site has an Occupied Building Risk Assessment (OBRA) which was last performed in 2015. The location and design of new Occupied Buildings at the Dagenham will take into account this study. A copy of the OBRA can be found in Appendix 5.8.

The site currently does not have any buildings designated as 'toxic refuges' as they have not been considered necessary.

Access for Emergency Services

Access to the site for emergency vehicles is via Hindmans Way through the Main Gate on Thunderer Road. This has proved acceptable to the Emergency Services and they have expressed no concerns during their many visits.

Alternative access is provided by a number of gates located around the perimeter of the site boundary, and also by the adjacent river. Although the preferred alternative is via the Chequers Lane gate which is controlled by Stolthaven and can be opened electronically.

Plant Layout

All storage tanks are in bunds and set back off roadways; however, as identified in several HAZID scenarios vehicles do have need to approach some pumps and tanks that are adjacent to roads. As a consequence, an assessment has been carried out this has resulted in the installation of additional protective measures. These include the provision of crash barriers to the loading pumps and associated pipe work of Area 2.

All tanks in areas 1, 2, 3, and 6 have level measurement installed (ATG system) with high and high-high level alarms. Gauge accuracy is checked on a regular basis (monthly and prior to each ship) through manual dipping. Access stairways and platforms are provided for all storage tanks which require manual dips to be undertaken. Mobile and fixed access platforms are employed when necessary and all relevant terminal personnel are trained in their use.

Transfer pumps around the site are located in areas that are relatively easy to access, and they can be drained to sumps if required. Pumps are currently located both outside and inside of bunded areas. During the normal operation of the plant should an incident be reported following which a need to improve access is identified, then the necessary changes would be implemented using the sites Managing Change procedure, more detail of which can be found in section 5.2.5 of this report. The design process for all new installations on the site includes the involvement of both the site's Maintenance Manager and representatives from both the sites safety, operations and maintenance teams.

Separation from Site Boundary

The off-site impacts of the potential major accidents have been assessed in Section 3, the risks of which are all considered to be ALARP. The site is located on an area of 29 acres of land, bounded to the south by the river Thames, and a United Molasses Tank Farm to the north; Chequers lane and a roadstone depot to the East; and Hindmans Way to the West. There are no other chemical storage facilities abutting the site boundaries, or within the consultation zone of the site. All storage areas are sufficiently remote from the site boundary; the site roadways are located between the main storage areas and the boundary, to have a low likelihood of impact from off-site initiators.

New Developments

The Stolthaven Terminals Engineering Standard for New Installations (shown at Appendix 5.2) requires the arrangement of tanks to be planned in accordance with good operating and engineering practice, and with the aim of eliminating fire and explosion hazards to the greatest possible extent. It is important to realize that safety requirements dictate the disposition of storage tanks relative to adjacent equipment and to each other. For this reason tank design, tankage arrangements, tank distances and the provision of protection belts are governed by special requirements.

Spacing requirements:

Generally, the minimum spacing distances for tanks and ancillary equipment must comply with all local regulations. In the absence of these regulations it will be necessary to adhere to the philosophy and guidelines shown below. These spacings are intended to minimize the:

- fire hazard to equipment and buildings
- exposure of adjacent tanks
- risk of domino effects

Between tanks: Safety distances between above-ground tanks are in most countries stipulated by the local authority in their regulations. We comply as a minimum with these local regulations. Globally, these regulations have been modified during the years due to investigations and research performed after some recent major accidents but generally vary between 0.4 and 0.6 x diameter for fixed roof tanks and 0.3 x diameter for floating roof tanks, if low flash products (class I and II) are stored.

These minimum distances are linked with the cooling protection requirements of the local regulation. In most countries, the IP19 is used as a basis for the design of these cooling requirements. The above-mentioned distance rules may be smaller if similar cooling protection levels can be guaranteed. Between tanks and retention wall, the most common used calculation is half the height (H/2) of the tank to the inside of the foot of the retention wall. This is used because a leak in the shell will create a parabolic curve when it falls towards the ground. The maximum distance it could cross is H/2 of the leak height. Between tanks and loading stations for class I and II products we require a minimum of 15m. Between tanks and pump rooms we normally use 15m, if no additional pump protection is used.

Between tanks and non-hazardous areas like offices, warehouses, workshops and other buildings and between tanks and boundaries, we require a minimum of 15m. Distance to public roads and housing, we require a minimum of 30 m.

The new tanks were installed in compliance with HSG 176 G*uidance on the storage of flammable liquids in tanks.* This includes a 10m minimum separation distance for tanks of 5000m^3 capacity.

All new and relocated plant are laid out so as to facilitate access for maintenance. Tank spacings are intended to minimise the fire hazard to equipment and buildings, exposure of adjacent tanks and the risk of domino effects.

Easy access for the Emergency Services has not been hindered by the new development. All escape routes will be included in the Internal Emergency Plan. A series of interconnecting platforms and stairways will be installed to assist escape in the event of an emergency; a complete walkway will be provided around the top of each tank, allowing escape in both directions, and caged ladders will be installed to facilitate egress over bund walls. Sufficient space will be provided between the bunds to allow access for fire appliances.

Human Factors

The lighting on site is constantly under review including the conducting operational surveys to determine whether additional lighting is required to facilitate ease of maintenance of key items in the field.

Labelling / marking assessment are carried out periodically to ascertain requirement including refreshing deformed / faded signs etc. This is also assessed as part of the site human reliability assessment and safety critical task analysis. P+ID's are controlled and kept under review to ensure that site personnel have access to correct information.

Stolthaven engineering process assures that human factor consideration is given as early as possible in the design of plant and equipment, layout. The new Area 1 provides examples of this with accessibility to the tank roof provided by way of gantries to allow for maintenance and inspections of key items such as vents and gauging systems. Pumps are designed such that they are located outside of the main bund which provides benefits to both accessibility for maintenance along with locating potential ignition sources away from areas where releases of flammable materials could occur.

5.2.1.4. Reliability, Availability and Survivability of Utilities

Mechanical / EC&I / Process Safety / Human Factors

The reliability, availability and survivability of the utilities in relation to their effect on minimising the consequences of major accident hazards is given in section 5.1 of this report.

This section therefore gives a brief description of the impacts and likelihood of any failure and how adequate safety and reliability is obtained.

A record is kept of all maintenance performed on the various items of plant across the site after breakdown. At present no statistics are routinely generated from these records regarding reliability or frequency of breakdown.

A work request process was implemented with a view to record all maintenance activities. Upon analysis / risk ranking of the relevant data, a set of KPI's have been developed to measure key areas of site maintenance activities including statutory preventative and reactive maintenance. This KPIs are shared with the site management team periodically

Electricity

The site does not house any substations, and the electricity is brought onto the facility through incoming cables at 415 volts, via switch rooms. In the event of a total power failure the processes will stop and fail-safe as they have been designed to do. Power failure is considered at the initial design safety review.

The site electrical system is not protected from spikes and dips. Over current protection is facilitated individual to each user by the installation of appropriately rated fuses. The main site transfer is equipped with an internal earth fault protection device. The site does not have a history of frequent power interruption or spikes.

Within the site’s hazardous areas all electrical drives are supplied directly from their respective Motor Control Centre (MCC) using steel wire armoured cable having an inner PVC sheaf and copper cores.

Cable installation is carried out in accordance with current codes of practice, in particular, providing adequate segregation and identification between power carrying cables, instrument signal cables and Intrinsically Safe systems

An unannounced reinstatement of power will not cause any problems as no drives will restart automatically, with pumps and other equipment having to be manually restarted, locally, after a trip so that the operator can confirm it is safe to restart.

A protection study for the main incomer is provided in Appendix 5.6 while a fault level assessment is provided in Appendix 5.7.

There is a provision (physical connection) to supply power via a portable generator into site power network using locally sourced emergency generators from specialist suppliers. There is an emergency generator back up in case of mains electric failure which is primarily used to provide power to the site’s fire water pumps. The generator is located in No. 1 South Switch room near foot of the jetty. Start-up procedures are clearly labelled adjacent to the generator.

All new items in Area 1 have been installed to fail safe in the event of power or instrument air failure. Where there is potential for liquid lock-in and thermal ingress resulting in line failure, a pressure transmitter and vent valve have been installed, to enable depressurisation back through the relevant storage tank.

Instrumentation is also supplied with an Uninterrupted Power Supply (UPS) in the new Area 1 design.

With respect to legacy plant areas, there is UPS protection in Area 6 and on the new firefighting system. The site does not have UPS on any control systems however there are operational / emergency procedures in place to ensure that manual process valves are closed in the event of emergency. Level can also be monitored through tank dipping while ROSOV valves (where installed) will fail closed.

The fire alarm panel and repeaters have UPS back up however the sounders are mains fed, as such would be unavailable in a power loss scenario. It is noteworthy manual hand operated alarms are installed in key locations.

All occupied buildings are equipped with emergency lighting and illuminous signs to direct emergency evacuation. Also parts of the site have emergency lights with battery backup. Torches are available for use. Emergency lighting locations can be found in Appendix 5.15.

The electrical supply in the site is Low Voltage (LV) 415V, 50Hz , 4 wire, neutral point solidly earthed. The LV earth system comprises of ground electrodes connected to the site main incomer distribution board via a main earth bar. LV site distribution via switchboards located in the Electrical Equipment Building are connected to the main earth bar via sub main earth bars.

For hazardous areas TNS system earthing is applied.

Equipment Earthing-
The method of connection against faults is effected by means of the cable sheath and/or armouring of the distribution network which is bonded to the earth bars of the LV switchboards. Cable glands are provided with earth bonding to ensure earth continuity.

Enclosures located in hazardous areas and not in metallic contact with plant steelwork are bonded to the structure or plant earth system. Enclosures are connected to the supply cable armouring by certified cable glands.

Structures and Process Plant
Assessments are undertaken in accordance with BS EN 62305 for every structure to determine the requirement for lightning protection.

Steel tanks are earthed at a minimum of 2 nr. points to locally positioned earth electrodes.

Steelwork and machinery is electrically bonded to earth tape which is installed on the periphery of containment areas and connected to earth electrodes.

Pipelines are electrically bonded to tanks to which they connect and are made electrically continuous throughout their length and earthed at each end.

Road tanker earthing is provided by flexible cable earthed at one end and connected to a clamp at the tanker chassis.

Earth Electrodes -
The value of each system earth electrode resistance will not exceed 10 ohms.

The value of combined resistance of the conductors and associated earth electrodes installed for tank or structure earth will not exceed 10 ohms.

Intrinsically Safe (I.S.) Earth
Separate earth bars are provided for I.S. systems. The resistance to earth for the I.S. bars will not exceed 1.0 ohm.

Earth continuity bonding provided where flammable liquids are handled. The integrity of the system is visually checked as part of the site Mechanical Integrity Programme. Along with pipework, tanks and other structures with the other electrical systems being covered by a combination of the sites fixed wiring and hazardous area inspections.

Control System

The site operates a limited control system designed to provide the operations team with information on tank levels, in the event of power failure:

- All drives will stop
- All actuated valves & modulating control valves will go to their fail state
- All tank high level alarms would become active

On power reinstatement:

- All drives will remain de-energised
- All actuated valves will remain in their fail state
- All modulating control valves will remain in their fail state

Steam

Dry saturated steam is normally supplied at 100psi by any one of two boilers situated in Area 3. The steam is used for heating products via heating coils in tanks. The boilers operate on gas Oil. Loss of steam will cause some processes to fail and eventually cause products to become more viscous and becomes difficult to pump.

One boiler is capable of providing sufficient steam for the Works. To enable supplies to quickly return to normal if the on-line boiler trips a second boiler is operated in the stand-by mode. The stand-by boiler is operated just below service conditions and can be quickly brought on line by the Operator. Operators are alerted to boiler failure by an audible local alarm the current position of only needing one of two boilers ensures security of supplies under all foreseeable conditions.

Loss of steam would not have a significant initial impact on the process but if it were a long down time systems would cool.

Compressed Air

The site is supplied with compressed air at a maximum of 9 barg from two main air compressors. The air is used for instrumentation, driving tools, blowing through lines and general maintenance. In the event of a breakdown or low air pressure, the operator is alerted (locally) by a compressor failure alarm or the system’s low-pressure alarm. Also, the unit is fitted with a self-managing controller which will ensure that the most efficient compressor is automatically selected to run considering site air demand.

The consequence of failure is minimised by having 100% redundancy and a combination of five air receivers situated around the site.

The loss of instrument air to air actuated and control valves are considered in Safety Reviews during the design stage of a project to see if they should fail-safe open closed or stay-put in the same position. For example, all tank discharge valves close on loss of air, whereas the tank inlet valves fail close. However, relevant precautions have been taken to ensure the closing time considered to avoid surges and deadheading the ship discharge pumps.

Nitrogen

Nitrogen is used on site for purging and inerting process equipment as necessary. Specific requirements from certain customers require nitrogen blanketing of their stored materials and this is achieved by the use of dedicated bottle nitrogen banks brought onto site.

At least two spare nitrogen bottle banks are kept at the terminal at all times. Manual intervention is required to bring them online. Relevant site operational personnel are trained on the correct installation of the Nitrogen bottle.

Natural Gas

Natural gas is used to supply boilers that heat the Bitumen tanks. Hot oil is pumped through internal tank coils to heat the Bitumen to the desired temperature. The gas main is located above ground in Area 4 (non-COMAH) along the site boundary, an emergency shut down process is in place to close the gas supply in the event of emergency or by instruction from the gas supplier. The Laboratory using bottled gas for some testing operations.

Cooling Water

As no process chemistry or reactors take place on the site, the site does not have any cooling water systems

Towns Water

Towns water is used mainly in the site offices for domestic purposes. Towns water enters the site and is feed directly to a break water tank, equipped with a ‘Type A’ air gap. Town water is also fed to a fire hydrant located in Area 4

Fire Fighting Water

Firewater is taken directly from the adjacent River Thames and fed directly to the main jetty fire pumps, (2 x 4000 litres per minute electric pumps on No.5 (Thunderer) jetty), these pumps feed numerous strategically located hydrants around the site through a combination of 8” and 6” mains.

The fixed tank cooling drenchers are installed on the tanks within 2 are also fed direct from the pumped main. Details of the site fire main can be found in Appendix 5.16.

A new firefighting system has been installed in Area 1, a dedicated 3000cbm fresh water tank feeds the tank drenchers in tank pits 1 & 2 and the automatic fire suppression on the pump slabs and loading gantry. There are also several hydrants located around Area 1 which are part of the same system. The system is maintained to a pressure of 14 bar by two electric jockey pumps located in a pump house remote from any process areas, three diesel pumps provide power to pump water. In addition, foam pourers have been installed on all tanks in Tank pits 1 & 2. **5m³** of foam is stored in a dedicated tank power is provided by two diesel pumps. Extra foam is stored in the terminals warehouse.

Activation of the system can be from the Control Room, Pump House or from two distribution valve houses.

The system is tested weekly and a service contract is in place.

The sites fire water pumps located on the jetty are provided with a back-up emergency generator which is designed to supply power to the 2 main jetty fire water pumps in event of mains failure.

Communication Systems

The site has a hand-held intrinsically safe portable radio system for normal routine operations on the jetty and storage facilities. The radio system does not have a battery back-up power supply, as the existing supplies are considered sufficiently reliable. Furthermore, the radio system does not need a constant electrical supply to operate.

Notification of an emergency to the Emergency Services is via the 999 Emergency system. The site has an internet based phone system, and a fax line, which may be lost in the event of an emergency; however, a backup system comprising of a dedicated mobile phone is held in the Security Gatehouse for use by the Site Main Controller and/or the Site Incident Controller. This phone is only used in emergency situations.

Contractors would be expected to use the existing Works facilities unless they were to set up an “establishment” on the Works. In these circumstances they may be given permission to use mobile phones within their offices or, as part of the contract they may be required to provide their own telephone system.

Alarms

The site has a single alarm for use in emergencies, namely the fire alarm.

The fire alarm is used in the case of fire, explosion or any emergency requiring assistance from the Emergency Services. The fire alarm consists of a number of manual (red) call points which are located in all the occupied areas. Activation of any of these call points will set off the site fire alarm

The fire alarm is a continuous siren; on hearing it, everyone is instructed to stop work, make safe and make their way to the designated assembly point for roll call and further instruction. The site Incident Controller will initiate the call-in of the Emergency Services via a 999 call and verify the status of the Emergency and initiate the Emergency Response Plan.

The site's neighbours have all been supplied with a leaflet detailing what actions to take in the event of the declaration of an off-site emergency.

The alarm systems as supported by their own internal UPS systems and are maintained by competent 3rd party contractors.

5.2.1.5. Prevention and Containment of Releases

Mechanical

<u>Prevention</u>

Plant and equipment has been designed to recognised engineering standards appropriate to the maximum foreseeable operating conditions and the product to be contained.

Although the design standards of some of the older storage tanks on the site is not known, all the tanks have been subject to a formal external inspection which took place in 2008. The examination was undertaken by a competent 3rd party company (RSA) and the inspection methods were in line with the guidance published in EEMUA 159. Following the completion of the external inspections the site has developed a comprehensive tank / pipeline inspection schedule which is structure**d** to ensure all the tanks undergo an internal inspection prior to 2018

All new tanks and those installed in recent years (such as the development of Area 6 in 1999 and Area 1 in 2016) have been constructed to BS2654:1989 and BS EN 14015 respectively. Where the plant is designed with maximum and minimum pressures and temperatures the process is controlled such that these limits are not exceeded, for example, product pipelines 7 bar, 100'C.

For those systems containing storage energy the plant and equipment is inspected and maintained in accordance with the Written Scheme of Examination, prepared by the Competent Person to ensure its continued fitness for purpose, as required by the PSSR Regulations 2000

The Competent Person, as defined under PSSR, is an employee of British Engineering, Stolthaven's insurer. The Written Scheme of Examination is prepared by the British Engineering and the Competent Person then issues a report to Stolthaven Dagenham. This is reviewed by the site Maintenance Manager to validate and undertake relevant actions identified within the report.

In addition to the inspections by British Engineering several of the items covered by formal Written Schemes are also subject to maintenance contracts, for example;

- Boilers – serviced and maintained by Flare.
- Air compressors – serviced and maintained by CPC.

Stolthaven seeks to undertake site inspection based on a combination of and adherence to recognised best practice. Therefore, where a known standard, such as a British Standard or industry standard, such as EEMUA 159 exists, this will be the basis for the inspection and maintenance program.

With regard to pipeline integrity Stolthaven adheres to API570, but also recognises that joints present a potential weakness, and failure of such joints / flanges could contribute to a major accident such as the events considered in Scenario 3. To improve the integrity of such systems Stolthaven therefore endeavours to:

- Reduced the quantity of joints where possible;
- Flanges are minimised in the pipe racks and there are no joints where possible over un-surfaced ground, to prevent land contamination;
- Following maintenance all joints are leak checked before systems are back into service;
- Drip trays are provided to flush back the captured liquors produced during transfer pipe dis-connections;
- No excessive pump pressures are developed due to the design limiting factors incorporated into the equipment;
- In the event of an overpressure in the transfer lines on the jetty, the relief valve on board the ship lifts and relieves to the ship's storage tanks.

Table 5.2.1.5.1: Prevention and Containment Measures

Plant Item	**Measures in Place**
Pump seals	Designed to meet specification for the chemicals to be used. Those pumps which are fitted with a cartridge double seal arrangement operate with 30% solution of glycerol / water as lubricant and are maintained at 4 bar(g). (0.5 bar above maximum pump discharge pressure). MagDrive pumps have been installed in the new Area 1
Raw material and product lines	Designed in accordance with ASME 31.3b and from a material suitable for the fluid handled. All pipeline is subjected to regular external inspection studies (annually)
Flexible hoses	Hoses are subjected to external inspection and hydrostatic pressure / earth continuity tests on a annual basis. Pre-user checks are carried out prior to use, a hose register is maintained by the maintenance department.
Non-flammable tank vents	All non-flammable finished product tanks are vented to atmosphere.

Plant Item	Measures in Place
Flammable tank vents	The certain of tanks containing flammable materials are operated under a nitrogen blanket set at 20 mbar(g). Those tanks which are not blanketed are fitted with flame arrestors. The tanks are further protected from under / over pressure by individual relief valves set at +60 to +56mbarg and -5 mbarg
Isolation arrangements	Most isolations are by manual intervention.
Detection of releases	Detection is by operator attendance / fixed gas detection / instrumentation static tank monitoring / CCTV coverage in operational areas
Containment Measures	All tank farm areas (containing hazardous materials) are bunded. All bunds are emptied manually, and procedures are in place regarding the disposal of any liquids found in the bunded areas

Rotating Equipment

All rotating equipment are specified to meet Stolthaven Engineering Standards including being designed to exceed the operating conditions. Also, they are subject to regular inspection, maintenance, and testing by the on-site maintenance team. Magsafe functionality / protection to mitigate dry running are installed on all new tanks in Area 1.

Couplings

The barge loading system and fuel loading bays incorporate dry-break type coupling. This is subject to regular maintenance, inspection and testing.

Venting Systems

There are a number of different venting arrangements on the bulk storage tanks at Stolthaven Dagenham. Tanks are vented directly to atmosphere through arrangements which include Swan neck vents, double Swan neck arrangements or PVRV’s.

Isolation Arrangements

As a general site philosophy individual pipelines used for transferring materials have more than one means of isolation, by use of shut off valves provided at tank side, pipe manifold, exchange manifold, jetty shore side and jetty ship side. This minimises the overall hold up quantities contained within different sections of the pipe, but also allows alternative means of isolation in the event of an emergency or valve failure.

The site has undertaken a high-level review looking at whether the introduction of Remotely Operated Shut-off Valves (ROSOVs) would reduce the consequences of the currently identified scenarios further (see Appendix 5.17). All new tanks in Area 1 have been installed with ROSOVs and the issue of retrospectively fitting ROSOV’s to existing tanks is considered further in the ALARP workshop. This replaces the old Section 5 action, reference 5.2.1.5a.

NRV's are provided installed around pumps (except for pipe infrastructure requiring bi-direction movement / flow of products – in which case the design would have taken this into account to assure the safety. The SCADA (Area 1) system monitors product movement on site and any unintended flow is likely to be picked up by the Control Room Supervisor

Other Containment Systems – Secondary Containment

Because of the frequent transfer of chemicals, containment is achieved by a combination of factors including sound operating practices, trained and competent operators and knowledge of the plant equipment capabilities. Operating instructions have been developed over many years of experience in the use of the equipment, and the site has an ongoing programme of operator training to ensure competent operators support the design.

However, should there be an accidental release from the equipment:

- All tanks containing hazardous materials are installed within bunds; and
- Area 6 tanks are built on concrete and graded so that spilt product is directed to the drainage system that has been designed to contain spills and direct them to an effluent pit where the liquor can be sampled and treated. This is then pumped, by manually operating the switch to the site's effluent holding tanks prior to release to the site's drainage scheme.

Due to recent upgrade work to the site containment systems, all tanks which contain COMAH substances are present within bunds capable of retaining a minimum of 110% of the largest tank contents and have impervious floor designs. Any significant release will be contained within the bunded area, and the spill will be dealt with in a controlled manner.

The bunds around tanks holding COMAH products have been assessed and relevant recommendations (to meet best practice) have been implemented. Area 2 and Area 3 bunds (including associated drainage) have been upgraded to ensure its floor and walls are impervious.

The bunds are subject to ongoing inspection by site personnel. All identified defects are recorded, reported and corrective actions implemented.

Stolthaven do however, recognised that in the event of a catastrophic failure of a large bulk tank it is likely that there will be a degree of bund overtopping. In such cases material that escapes the Secondary Containment structures, will be contained by the site's Tertiary Containment and surface drains / effluent holding tanks. It is further acknowledged that if the drains do not contain the spill and depending on the tank location material may spread to neighbouring properties or to the river Thames.

Tertiary Containment

Stolthaven also acknowledges that in order for the site's Tertiary Containment and drainage systems to be effective in such scenarios the systems need to be in a good state of repair and in the case of the drainage system free for obstructions. From the original plant design, only Area 4 and small sections of Area 3 retain old drainage systems and the remainder of site drainage is newly installed during projects such as the construction of the new Area 1 and upgrades to bunds.

The site has also completed remedial works to the main foul sewer and the drainage system is inspected on a 5-yearly programme (as part of the site Prevent Maintenance Programme). All resulting actions are closed out in a timely fashion. The site operations team undertake a daily visual inspection of the drainage system and any observed abnormalities / defects are reported to the Maintenance Team to repair. The CCTV inspection was last performed in 2015 and all resulting actions have been closed out.

In terms of releases from road vehicles the maximum assumed spillage would be the maximum capacity of a road tank wagon – 35m3. The frequency of such at release is difficult to determine given the very low probability of a collision with enough force to puncture the barrel of the road tank wagon as the site speed limit is 10 mph. However, if this event did occur, dilution scenarios can be extrapolated from Section 3 which indicates such an event is not likely to result in a MATTE.

For minor spills there is a surface water drainage system on site, which connects the road gullies to the interceptor pit and then the effluent treatment plant prior to discharge to the Chequers Lane outflow point. Therefore, any surface spills from road wagons or other containers located within the site are likely to be contained by the drainage system and can be dealt with in the effluent pit.

However, if a spillage occurs in the weighbridge area, it cannot be contained and will flow directly to the river. Furthermore, the main roadway into the site that runs through the site adjacent to the river wall has surface water drains which discharge directly to the river. An uncontrolled release from a road tanker in this area could enter the river if the spillage control measures (drain mats, sand bags, and spill pumps) were not acted upon immediately. Due to the risks present, spill kits have been located along the river wall containing clay mats, boom and absorbent granules

Tanks have been selected to serve as containment for firewater runoff and / or emergency containment in the event of an incident. The tanks are located in Area 4. Under normal circumstances the tanks will be kept empty (where possible) and available for the receipt of firewater or product from a commercial tank in the event of a major tank failure.

Containment around Road Tanker Loading Areas

Any spills from road wagons or other containers located within the site, will be retained by the site's Tertiary Containment.

The material will, in most cases, flow into surface effluent drainage system (a schematic of which can be found in Appendices 2.4 - 2.10 and be captured in one of the site's effluent holding tanks. Should the release be large enough to overwhelm the site's effluent drainage system and depending on the tank location the release may spread to neighbouring property or in an extreme scenario to the River.

The site's surface water drainage system is designed to collect any liquid which finds its way into any of the site's road gullies, sumps or interceptor pits. From these various location's material is transfers either manually as in the case of bund sumps or automatically on the case of Area 6 to one of the site's numerous effluent holding tanks (Tanks 443 to 447) before being processed via the site's effluent treatment plant prior to discharge to the Chequers Lane outflow point.

Drainage System

The on-site drainage system is designed to control the flow of contaminated firewater, and prevent this water damaging the environment. Locations of drainage, retention sumps and interceptors can be found on the site map in Appendix 2.4 to 2.10.

The purpose of the Trade effluent and waste water system is to collect, segregate and treat all of the surface and waste water that enters the drainage system. The term Trade Effluent covers every type of wastewater excluding the following, which is classed as sewerage:

- Waste water from the Office block
- Waste water from the mess room building
- Waste water from the security lodge
- Waste water from the domestic drains of the Laboratory
- Waste water from the No.4 site office building
- Waste water from the domestic drains of the workshop and workshop mess room
- Waste water from the locker room.

Sewerage can be disposed of, in unlimited quantities, into the foul sewer that runs across the terminal and connects to the foul sewer in Chequers lane. Trade effluent is controlled and the terminal has to operate within the confines of the Trade Effluent Consent.

The system is semi-automatic and as such the operational supervisors should be aware of how the drains work and what needs to be monitored, checked and/or cleaned. Additionally, there are procedures to be set up following full or partial shutdowns.

The wastewater from the site is held in a bulk storage tank, which is used as an aeration vessel. This is designated as Tanks 464 and 465, which is located in No.4 Area. The description of the aeration tank system is detailed in Section 2.11.4 of the COMAH Safety Report.

Surface water will be transferred from various collection sumps and pumped to the main oil separator before it is aerated. This separator is located in Area 4, following which the wastewater stream is pumped to Aeration Tanks 464 and 465.

Certain designated sumps are pumped direct to Tank 35 at the effluent treatment and cleaning bay. These are surface water areas that are known to precipitate sludge and surface foams. Tank 35 must be regularly inspected to prevent overfilling and to monitor the condition of its contents. Below are the requirements for monitoring the contents of Tanks 464, 465 and 35:

The wastewater aeration tank contents are tested regularly and additionally as required by circumstances. The wastewater quality is to be tested against the requirements of the Consent to the Discharge of Trade Effluent.

Should the tank contents be found to be outside the terms of the Stolthaven Dagenham Consent the contents will be treated as appropriate or if necessary removed from site in an approved manner in accordance with the relevant waste disposal regulations this will be achieved by Stolthaven Dagenham procedures.

Further consideration of containment is demonstrated in the packaging and transportation of dangerous substances. All containers and packaging comply with the appropriate UN Packaging Standard and are marked with the appropriate specification.

Detection

Due to the high reliance upon manual operation for the site’s activities, operational staff are constantly moving around the site, coupled with the fact that operators are walking lines regularly during transfer activities, a release would be detected by visual observation or by smell. It is recognised by Stolthaven that such reliance on manual operation is undesirable and in demonstrating the commitment to continually improve, a shift towards engineered safeguards at the preventative end of the hierarchy of risk control has been made. Tank gauging has been installed on all tanks containing COMAH products including Hi and Hi Hi alarms and Layer of Protection Analysis has been performed to establish what additional measures will be required dependent upon the risks of specific products stored.

The alarm system has also been upgraded (to be more user friendly) and relevant operations personnel have been trained on the use of the system. Also, relevant cause and effect documentation are available for reference. Stolthaven maintain a service agreement with Agidens (the SCADA System Integrator). This service includes a 24/7 helpdesk that operations personnel can contact to clarify alarms.

Due to the size and nature of the bunds the site has reviewed the benefit that the installation of automatic gas monitoring and concluded that it offers little benefit of the current systems and procedures in place.

During transfers pipelines are inspected at least once per hour, therefore any spillage would be detected quickly by the operations teams. A minor release from a storage tank (say due to corrosion) would be more difficult and take longer to detect if the release was small. A physical stock reconciliation takes place at least once per month when the tank is physically dipped and inspected. The site's ongoing programme of installing accurate automated tank level gauging will go a significant way to allowing such leaks to be detected early, see action 5.2.1.5.e

EC&I

There are no relevant criteria.

Human Factors

There are no relevant criteria.

5.2.1.6. Design to Maintain Containment

Mechanical

Corrosion

Stolthaven acknowledge that corrosion is a general threat to bulk storage plant and structures, and the company makes a conscious effort to avoid, eliminate or mitigate problems at all stages of design. The plant itself stores material that is not significantly erosive but can be corrosive.

The site has been handling and storing bulk liquid chemicals for over 60 years. Knowledge and experience were utilised during the initial design of the storage tanks, piping and associated equipment, taking into consideration the most likely duty it will be used on.

Currently, before any chemical is transferred and stored, a review is conducted to study the compatibility between the product to be stored and the materials of construction of the storage and handling equipment. This review is conducted by the site management team and recorded on form FD24, "Storage and Handling Assessment".

Existing Tanks (Legacy Plant)

For existing tanks Stolthaven has instigated a storage tank inspection programme with assistance from an independent 3rd party specialist contractor, working under the guidance of RSA. This inspection is carried out to the industry standard, EEMUA 159. The subsequent report provides information on the plate thickness and whether the tank is fit for purpose, when the next inspection is required based on corrosion rates as well as recommended repairs (if any) to the tank. All recommended repairs are carried out as soon as practical, (a copy of a recent tank inspection report can be found in Appendix 5.3)

In addition to the formal annual external inspection Stolthaven staff visually inspect tanks during day-to-day operational tasks and if any issues / concern is identified these are immediately communicated the site management team. Should it prove necessary Stolthaven has its own ultrasonic plate thickness tester for immediate feedback.

New Tanks (Area 1)

For the new tanks:

- A minimum corrosion allowance of 1mm (shell) and 2mm (floor) has been made for the new tanks in Area 1, and no corrosive products are to be stored within them. Should this situation change, the relevant tanks would be lined as appropriate.
- ROSOVs are installed and in an alarm condition, the valves will close. Loss of air or power will result in an alarm sounding and the valves shutting;
- 2 PVRVs are being installed on each tank to protect against over pressurisation and vacuum;
- Fire water systems, and in-line foam supply have been installed in line with HSG176 and Energy Institute publication IP19 *Fire Precautions at Petroleum Refineries & Bulk Storage Installations;*
- Areas 2 & 3 bunding has been upgraded to industry good practice, impervious bund flooring and walls have been installed.

Where corrosion is considered a possibility, equipment has a corrosion allowance built into the design. Materials of construction are generally carbon steel, API 5L Gr.B being a typical piping specification, and Stainless Steel. The Stainless Steel, although primarily used to prevent corrosion, does provide some erosion protection as well.

All plant equipment is routinely inspected either by the Competent Person in the case systems governed by PSSR or by contract inspection companies for equipment that is not. These inspections are intended to highlight problems, where this is the case the asset in question is subjected to further, more detailed inspection and if necessary, removed for operation until such time as the necessary repairs have been completed.

In addition to the bulk storage tanks all structural steel is also routinely inspected for corrosion and detailed inspection reports produced, including detailed improvement plans.

For the site’s mild steel tanks and steelwork, a programme of is in place designed to routine painting prevents external corrosion.

The site has implemented a tank and pipework inspection programme (including in-service inspections). The latter is monitored and reported as part of the site process safety performance indicator. Also, the site has undertaken several pipework inspections (including CUI) and the resultant corrective action closed out in a timely manner.

Site pipework is subject to a 5-yearly inspection programme. For example, Area 2 and the Jetty pipework were inspected in 2014 as such are due re-inspection in 2019. The sites pipework inspection strategy is detailed in Appendix 5.19.

Erosion

There are no areas on the site where erosion is expected or has been found to be a concern.

External Loading

When designing new installations all relevant factors are considered. This can be demonstrated by considering the new Area 6 Storage tank farm and in general;

External wind loading was considered, that the design, with wind loading calculations being undertaken in accordance with BS6399 Part 2. These have proven to be satisfactory by the fact no structures / tanks have sustained any damage from gales since construction;

Before any construction takes place in a new area of the site, bore holes are sunk to check the load bearing quality of the land, (see Appendix 5.20 for details of the Area 6 boreholes).

Where necessary piles that meet the requirements of the relevant British Standards would be sunk to consolidated ground, an example of this is the piling that was undertaken prior to the construction of Area 6 and Area 1.

As part of any major construction dead and imposed loads are calculated in accordance with BS6399 Parts 1 & 3) by a competent and reputable 3rd party contractor. These calculations will take into account the expected loading of the vessels, equipment and their contents.

As the area is not seismically active no account is normally taken for ground movement. It is, however, accepted that storage facilities when constructed to recognised British Standards, should not suffer significant damage should an earthquake with a magnitude of 6 on the modified Mercali Scale occur. Therefore, any design incorporates the necessary safety factors.

New tanks are constructed to BS2654:1989. Existing tanks are inspected to and repaired as per the recommendations of EEMUA 159. This report may also make recommendations regarding load factors such as a restriction to use only a certain percentage of the tank capacity for a given density or a maximum permissible weight.

Structural steel is design to BS5950, or BS449 where applicable: Steelwork to these standards is satisfactory for ambient temperature of minus 15 to plus 30**ºC,** which is satisfactory for this area. Under fire conditions it is estimated the structural steelwork would fail after about 30 minutes. However, the fire brigade and the Works emergency response should have cooling on the steelwork and vessels well within this time. The fire brigade response time is < 10 minutes.

As part of the design process, the calculation of the snow and wind loadings for pipe rack structures was carried in accordance with the requirements of BS6399: Part 3:1988 and Part 2 :1997 respectively and applicable Eurocodes. Appendix 5.21 is an extract of the structural calculations.

The structural calculation for the tanks is based on the requirements of EN14015:2004. This is approved by a third-party inspector (Bureau Veritas). All tanks are fitted with a wind girder to provide structural reinforcement as per the calculations. Appendix 5.22 is copy of the stamped and approved calculation document. to BS5950 Structural use of Steelwork in building.

Impact

Aircraft

Aircraft could impact any part of the site due to its proximity to the London City Airport, causing releases and immediate ignition of large inventories of dangerous substances. There is a high escalation probability. No prevention measures are possible. Fast response of emergency services would limit the escalation potential. An impact from an aircraft, Scenario 2, though unlikely, would be catastrophic and the likelihood is considered within Section 2 and 3 of this COMAH Report. The site has not considered aircraft impact in the design of plant and equipment.

Shipping

There is the possibility of a vessel impact on either the jetty or a ship while on station. The river traffic is controlled by the Port of London Authority and is outside of the influence of Stolthaven. Nevertheless, site’s personnel are trained by the local fire brigade to tackle small fires, and the site’s jetty has a firewater drench system that is regularly inspected by the Port of London Authority and the Local Fire Authority with inspection reports issued.

Road Traffic

Road traffic is seen as the prime risk of impact upon the units. The storage tanks are all protected by bunds There is a blanket speed limit on site of 10 mph, as the roads are relatively short this is generally adhered to; hence any impact should be low speed. However, the hazard assessment identified some pumps and tanks as being particularly vulnerable to an out of control tanker and suggested they be provided with some form of protection. As a consequence, an assessment has been carried out and as a result additional protective measures have been implemented across the site including the provision of crash barriers to the loading pumps and associated pipe work of Area 2.

A major concern is during maintenance and construction when cranes are travelling on roads, manoeuvring in close proximity to operating plant and are used to lift loads over equipment. The Permit to Work Procedure controls the use of cranes on the Works. Only competent operators are permitted to operate cranes on the site and the equipment itself is inspected and tested by a Competent Person. Certificate of test and inspection are requested when hired plant is brought onto the facilities.

The HAZID study identified ship collision with the jetty as a possible impact risk. Although there is no control over shipping in the river by the site, the ships are controlled by the relevant merchant shipping legislation and Port of London Authority regulations. Any ship on a collision course with the jetty would be detected as the jetty is manned during loading/offloading operations. Therefore, the transfer operation could be stopped and the personnel on the jetty removed from the area.

Pressure Deviation

Equipment is designed for both the maximum and minimum anticipated conditions. However, in anticipation of the possibility of failure of any control systems albeit manual or automatic or human error the bulk storage tanks are protected by relief systems, valves and bursting discs.

The site’s bulk storages tanks generally operate at or close to atmospheric pressure. As the storage tanks are not designed for excessive pressure or vacuum each is fitted with proprietary pressure and vacuum relief valves (PVRV). These devices are set such that they provide adequate relief to avoid any over or under pressure being generated.

The bulk tank pressure / vacuum relief devices are inspected tested and repaired on a routine basis (see Appendix 5.23 for an example of a recent PVRV inspection record).

Liquid locking in the piping is avoided by the correct design of the piping system; this can be demonstrated by the continued operation of the schemes. The requirement to prepare rigging instructions prior to material transfer gives the site operations teams chance to review the piping arrangements before any material movement takes place, and therefore the opportunity to highlight any possible problems.

Pressure deviation could occur through thermal expansion caused by external fires. Automatic fire detection is installed as part of the new firefighting system in Area 1 pump slab and loading gantry, otherwise detection would be visual by the Operator. Insulation would provide some protection in the incipient stages of the fire and once it is detected vessels will be cooled with firewater and the fire extinguished using either on-site resources and/or the local fire brigade.

Temperature Deviation

All storage tanks, piping and other process equipment are designed for the internal process temperatures that are not extreme. For any new installations extremes of temperature would be considered during the risk study stage of a project. The factors considered would include ambient conditions, external fire, freezing and higher temperatures.

Under fire conditions, it is estimated the structural steelwork would fail after about 30 minutes, although there are no supporting calculations for this. Regardless the fire brigade and the on-Site fire system should have cooling on the steelwork and vessels well within this time.

Ref.	Action
5.2.1.6. b	Undertake calculations to determine how long the site's structural steel work is likely to survive in a fire scenario and act on the finding appropriately.

Insulation, steam or electric tracing protects process and utility lines that could freeze.

For new area designs, consideration has been made to the installation of fire protection systems. The sizing of these systems is based upon NFPA and API standards, and an example calculation is provided in Appendix 5.24, while Appendix 5.24a provides a compliance report.

Vibration

Hazard studies have recognised vibration as a potential cause of a loss of containment from rotating equipment such as product transfer pumps. This risk is mitigated by vibration checks on pumps and motors, and example of which is presented in Appendix 5.25.

Wrong Equipment

The Maintenance Department replace equipment on a like-for-like basis, so the main risk is in the original specification of equipment.

Any new equipment, i.e. not like for like replacement, is subject to formal Management of Change. This process is detailed further in Section 5.2.5 of this report and would include on-site personnel conversant with the nature of the process and the change being requested to participate in a formal documented review. Should a 3rd party contractor is involved in the modification project their engineer(s) would also be involved.

New equipment is inspected during construction / fabrication to ensure correct materials of construction and the use of the correct standard, for example a new vessel or a company engineer or a third party would inspect motor control centre at the vendor's premises. The Competent Person inspects pressure equipment, and hazardous area electrical installations.

Since the last COMAH Safety Report, site have reviewed the Management of Change Procedures and updated the training requirements and conducted training for individuals.

Defective Equipment

All new equipment is subject to a formal inspection before first use. For existing equipment due to the nature of the site's operations, such as the frequent line inspections carried out by the operators and the site’s Preventive Maintenance Programme, most defects are discovered quickly, the item is then removed from service pending repair. Any defect identified is recorded on the site’s maintenance systems using the FD28-01 form, further details of this system can be found in Section 5.2.4 of this COMAH Safety Report.

Defects in instruments installed in the new Area 1 and Bitumen alarm in the SCADA system in the control room other instruments tend to be noticed by the operators, but defective alarm settings are only discovered on planned inspections. Defects and repairs to pressure equipment are referred to the Competent Person for approval before repairs are made and/or the equipment returned to service.

The site maintains relevant maintenance related KPIs both at the departmental and site management level. The KPIs includes both leading and lagging indicators that are set to provide early warning and provide assurance that the system implemented to mitigate MAH are fit for purpose.

Human Error

Human error can be the only initiating event or can occur in combination with equipment and / or system failures. It is also recognised that initiating events can often be traced back to a management system failure (training, procedures etc.), which are also human failures, in supervisors and managers.

As a consequence, during the completion of the site’s Risk Assessment it was determined that human factors played an active part in a considerable number of scenarios. In particular activities related to storage tank filling and tanker loading remain heavily dependent upon manual control and intervention, as is evidenced by the number listed. For review scenarios in which human actions are considered a key control were:

Table 5.2.1.6.1: Key Human Factors Controls for Various Scenarios

Description	**Key Control**
Failing to connect piping, flexible, pump correctly	Competent operator
Vehicle colliding with a tank.	Competent driver
Forklift truck damages drums	Competent driver/operator
Crane/forklift truck damaging piping.	Competent driver/operator
Overfilling a storage tank.	Competent operator
Failing to set valves correctly during a product transfer, opening a wrong valve.	Competent driver/operator
Leaving a drain valve open on a vessel.	Competent operator
Ship pumping against closed valve	Competent operator

The frequency assessment in Section 3 estimates the contribution of each human action to the overall MAH frequency. Where the resulting risk is not in the broadly acceptable region, additional measures or improvements were identified to reduce the risk.

Training is carried out in many aspects of work. This is particularly important in hazardous situations such as: Working at Heights, and Electrical Safety. Other aspects of training are covered in Section 4 Management Systems.

The effects that human failure has on accidents and incidents are identified and assessed under the accident reporting and investigation procedures. These procedures are described in Section 4 Management Systems. The investigations initiated by these procedures consider management causes and human factors and recommend improvements to prevent further occurrences. The recommendations are reviewed and agreed by management who assign responsibility for completing the approved actions.

It is recognised that human error can lead to failure of containment. Many safeguards are implemented to reduce the opportunity for human error. Examples of these are:

- High Level Alarms;
- Checklists covering safety critical activities;
- Written Manufacturing Methods and Work Instructions;
- Training;
- Permit to Work procedures;
- Life Critical Procedures.

To reduce the effects of human error on the operations rudimentary instruments monitor the conditions and procedures control the activities of the operators. To prevent overfilling of storage tanks the maximum safe operating levels have been set and operators have to monitor level, using either level instruments or by manual dipping. Stolthaven are committed to the installation of accurate tank level gauging and associated level alarms and interlocks. Level gauges with Hi and Hi Hi alarms have been fitted to all tanks containing COMAH products, that is all tanks in Areas 1, 2, 3 & 6.

Structural Steel

Special factors to be considered are the risks of subsidence and high winds that may have an adverse effect on Unit structures and buildings.

Before erecting the new civil structures, ground stability is considered to minimise the risk of settlement and foundation problems. Due to the location of the site before any work is started in new areas, boreholes are sunk to confirm ground conditions.

Foundations are purpose-built on the basis of assessed loads with due consideration to ground stability factors, the type of structure proposed and the consequences of possible settlement.

Specialist civil engineering contractors are used to calculate and design foundation requirements.

Any design takes into account loading of the vessels and equipment during testing and operation and predicted wind loadings. Structural steel on site is designed to BS5950, or BS449 where applicable, and considers the following parameters:

- Dead and imposed loads (BS6399 Part 1 and Part 3)
- Wind loading (BS6399 Part 2) or BS Code of Practice CP3: Chapter V: Part 2: 1972. Using this Standard means that structures are designed for a basic wind speed of 45 metres/second that will be exceeded statistically only once every 50 years. The basic speed is then multiplied by appropriate safety factors to determine the design wind speed.
- Design of shear studs for composite action (BS 5950 Part 4)

Pipework

Piping is generally designed and constructed in accordance with ANSI B31.3. The materials used for pipe work are selected for the duty for which they will be used and this is detailed in engineering standards.

Aggressive materials are contained in, stainless steel as appropriate depending on the application. ASA 150 RF flanges are fitted as standard across the site and the number of joints is kept to a minimum dependent on ease of installation and requirements for service.

There are no system requirements on the site that would require the use of a higher-pressure rating than ASA 150 and the piping used is typically be Schedule 10.

Stolthaven maintains relevant engineering standards related to the design and construction of tanks and pipework in line with the requirements of EN14015:2004 and ASME B31.3 / ASME B16.5 respectively. See Appendix 5.4 for a sample pipe specification for the new installation (Area 1).

For the new Area 1 installation, transfer lines between the jetty and storage tanks will have been run at 7barg and have been tested to 30barg. Hoses have been designed to 16barg.

Vessels

Pressure vessels are designed in accordance with PD5500 Cat 2 Specification for unfired fusion welded pressure vessels or ASME 8, and atmospheric vessels in accordance with either API 650 or BS2654 Specification for manufacture of vertical steel welded non-refrigerated storage tanks with butt-welded shells for the petroleum industry. When necessary a corrosion allowance is prescribed within these standards. However, when the service is anticipated to be corrosive the corrosion factors are designed out by using suitable materials; this can be demonstrated by the use of the Epoxy Novolac Lining system on tank T15

Process equipment is designed to operate under all foreseeable conditions and potential deviations anticipated during its operation. This applies to all vessels and piping, tanks and associated structures. Documented details of the design Standards used for each item of equipment are to be found in the Engineering / Maintenance Records.

Storage tanks filled to less than the safe ullage (150mm below maximum permissible dip on calibration chart of tank) and pipe work containing product is operating at less than 7 bar pressure.

For the new Area 1 storage tanks;

The new tanks in Area 1 have been built to Standard EN 14015 *Specification for the design & manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded steel tanks for the storage of liquids at ambient temperature and above.*

The Stolthaven Engineering Standard for New Installations also requires all tanks to be:

- Compatible with the chemical and physical properties of the liquid to be stored;
- Protected to avoid excessive over and under-pressurisation and operated within limits established to ensure that this is achieved;
- Designed and constructed to withstand impacts on their integrity from normal operations and foreseeable events;
- Designed, constructed and installed to prevent failure due to corrosion or chemical interaction. The corrosion allowance must reflect the anticipated attack from the products stored.

Tank design conditions include the following:

- Maximum design temperature not less than 93°C and minimum 0°C;
- Minimum design pressure 15mbar and minimum vacuum -5mbar;
- Material of construction (for carbon steel tanks) - ASTM 131 Gr B or equivalent;
- Maximum filling speeds are 1 m/s until the filling nozzle of the tank is submerged, and thereafter 3 m/s for low flash and 7 m/s for high flash products.

The tanks in Area 1 are atmospheric pressure and temperature tanks, and are fitted with two Pressure Vacuum Relief Valves (PVRVs) with 100% redundancy in relief sizing, and an Emergency Relief Valve (ERV).

Looking forward, vessel procurement would be on the basis of incorporating inherent safety at the design stage.

Relief Systems

All storage and pressure containing equipment which have pressure relief devices fitted and these relief valves are inspected on an annual basis (see Appendix 5.23 for a copy of a recent relief inspection report). In addition, certain tanks are fitted with fire engulfment relief, although this is limited to the tanks installed within Areas 1, 2 and 6. Tank relief systems have been inspected, tested and the result recorded. They are subject to a 12-monthly maintenance regime and most recently was carried out by a 3-party approved specialist contractor in July 2018. The results are considered during the assessment of relief cases and major accident scenarios.

Pressure relief valves are installed where appropriate to control loss of containment due to over pressurisation. In other situations the pressure that can be supplied to the equipment is designed to be lower than the vessel design rating. The design codes and standards used are API 520, 2000 for selection, and installation of pressure relieving devices in refineries or their equivalent. Calculations are available for inspection.

For the new area 1 installation all tanks are atmospheric pressure and temperature tanks, and are fitted with two Pressure Vacuum Relief Valves (PVRVs) with 100% redundancy in relief sizing, and an Emergency Relief Valve (ERV).

Electrical and Instrumentation

All new equipment which is installed within a hazardous area complies with the ATEX directive. Existing equipment has been retro-inspected, tested and approved accordingly. Where retro-testing and approval is not viable, replacement equipment to the ATEX standard is sought.

The process areas have been designated hazardous areas following an area classification study using guidance from:

- IP Model Code of Safe Practice, Part 15 – Area Classification Code for Petroleum Installations
- BS EN 60079 Electrical apparatus for use in explosive gas atmospheres Part 10:2003 classification of hazardous areas.
- Scientific Institute Research Association (SIRA) to consider those substances not considered by IP15

As a result in general they have been classified Zone 2 IIC T4. A copy of the sites most recent hazardous area classification study can be found in Appendix 5.11 – 5.13.

The electrical and instrument installation complies with:

- BS5958 (various parts) Code of practice for control of undesirable static electricity

- BS6739 Code of Practice for instrumentation in process control systems: Installation, design and practice

- BS7671 Requirements for Electrical installations. IEE wiring regulations, 18th edition,

- BS EN 60079 Electrical apparatus for explosive gas atmospheres (various sections)

- CP1013 Earthing.

All the new tanks in Area 1 are fitted with independent high level and high high level switches, interlocked to close delivery valves. If the switch set-point is reached, an audible alarm sounds in the control room. If a tank is in static mode (i.e., no filling or emptying operation is being carried out), a software generated status flag will sound an alarm in the control room if the tank level changes beyond a certain amount.

The requirements of BSEN 61508 have been taken into account in designing Safety Instrumented Systems for the new tanks. Following the completion of LOPA studies, it has been decided that level switches on tanks and pressure transmitters on piping will be to SIL2.

Lightning Protection

No lightning protection is afforded to the older storage tanks.

No lightning protection systems has been installed on the new Area 1 tanks; their roofs have a minimum thickness of 5mm.

Earthing

The plant is provided with an earth protection system that meets the recommendations and requirements of Earthing Code of Practice BS7430:1991, Static Protection BS5958:1991 and Equipotential Bonding, 16th Edition IEE Wiring Regulations.

All the new tanks in Area 1 Area 2, Area 3, and Area 6, and all new pipework containing flammable liquids, are earthed.

Bunds

Bunds are designed by consultant civil engineers to take into account loading on the walls if the largest vessel failed catastrophically, the bund walls across the site are constructed from a variety of materials but in general the older bunds are brick built with the new bunds being reinforced concrete. Areas 2 & 3 now have newly constructed bunds.

Where any bund requires modification the change is subject to the sites Managing Change Procedure (see Section 5.2.5) however, in general the following standards are used:

- CIRIA Report No. 164 "Design of containment systems for the prevention of water pollution from industrial incidents" – 1997 is used for guidance.

- BS8007:1987 for water retaining structures

- Plain bar reinforcement to BS4449, Grade 250. Fabric reinforcement to BS4483

Older bunds where design intent is not recorded are upgraded or replaced when appropriate; this includes strengthening walls with reinforced concrete and lining them to resist erosion.

The tanks in Area 1 are being located in two separate bunds, TF1 and TF2 (north and south bund). Each will have a capacity of at least 110% of the largest tank in the bund.

Philosophy to Determine Design Margins over Operating Conditions

It is the general industry philosophy to work 10% below the maximum design condition of the equipment but no specific standard is used to determine the factor. Relief Valve Set Points are generally the same as the equipment Design Pressure, or as required by the relevant code.

5.2.1.7. Design of Structures

Mechanical

Adequacy of design

The MAPP and the associated management systems in place ensure that high standards are pursued in all facets of the installation design, construction and operation. This is supported through ensuring the fitness for purpose of the equipment through the procedures outlined in the Site Engineering and Maintenance Procedures and through inspections conducted by the Site’s Competent Person.

That the installation is designed and constructed to the appropriate standards is demonstrated by considering the example of the design / construction of Area 1.

Objectivity is demonstrated through compliance with current British Standards and Approved Codes of Practice or their equivalent, such as ASME B31.3 for pipe work, BS 5500 Category 2 for the pressure vessels and EN14015 for atmospheric tanks. The choice of materials is reviewed internally, and tests are undertaken whenever necessary to ensure the materials of construction are suitable for the prescribed contents. For example, 316L SS was selected for the new bulk storage tanks installed in area 6 and the lining material for Tank 134 (see Appendix 5.26).

The design of the structural steel work is based on;

- BS 449 part 2, BS CP3 Part 1 for Dead and Imposed Loading for Buildings;
- BS CP3 part 2 for wind loading;
- BS 4 or BS 4848 for Structural steelwork.

All equipment is supplied (where appropriate) with the appropriate Certificate of Compliance, including details of any hydraulic pressure testing where dictated by the design code. All such tests are independently verified by Competent Persons, again as required. If necessary, the Competent Person will stamped the vessel nameplate.

To ensure the equipment remains fit for purpose all pressure systems are included in the sites respective Written Scheme of Examination as required under PSSR and are consequently routinely inspected by the Competent Person.

Design codes

The design codes currently used are can be found in Section 5.2.1 of this report. The list is not exclusive but is used to demonstrate that equipment is designed and constructed to recognised national standards.

Electrical, Control & Instrumentation

There are no relevant criteria.

Process Safety

There are no relevant criteria.

Human Factors

There are no relevant criteria.

5.2.1.8. Design for Operational Extremes

High standards are pursued in all facets of the installation design, construction and operation. Ensuring equipment remains fit for purpose is through good maintenance and inspection practices and the use of competent maintenance technicians and contractors. These internal efforts are supported by the Competent Persons appointed to inspect specific equipment.

The Company do not carry out their own plant design capability, but use the services of engineering design organisations to complete the work. Design organisations are vetted in accordance with Company procedures and they must demonstrate their design competence and their compliance to industry design codes.

This can be demonstrated by the appointment of Albright Design to support the site engineering team during the design and build of the Area 1 facility.

All other potential operational extremes involve process deviations described elsewhere, such as high and low pressure or high level.

EC&I

There are no relevant criteria.

Human Factors

There are no relevant criteria.

5.2.1.9. Materials of Construction

Mechanical

The site handles products that have a fire risk, and if released to atmosphere some may produce toxic concentrations or prove a risk to the environment. There are specific and easily identifiable risks in the storage of bulk liquid chemicals, and the site has over 60 years handling experience. The materials of construction are well understood for the raw materials. But before any materials are to be stored, the site undertakes a review of the material's properties and its compatibility with the site piping and storage equipment. Recommendations are then made to limit the risks involved in handling the material and actions undertaken to address the issues.

Where appropriate, some storage tanks are lined to prevent corrosion of the tank material. This lining requirement is determined in consultation with product manufacturers and suppliers of tank lining materials, as part of the management of change process. In general piping and storage tank materials of construction is API 5L Gr. B but Stainless Steel 316L is used where corrosion and erosion is anticipated.

Selecting materials

The Company employ experienced staff who are responsible to assist in the specification of materials of construction for plant equipment. To assist them in ensuring compatibility with the chemicals contained various data sources are used.

Reference sources such as corrosion charts, manufacturers' information, suppliers' product stewardship manuals, engineering textbooks and Internet web sites are used. For chemicals or mixtures where no information is available laboratory and plant token testing can be undertaken using test specimens (including welds and heat affect zones). Such tests are conducted for a range of concentrations and temperatures.

The previous issue of the COMAH Safety Report issued an action (Ref 5.2.1.9a) which required the development of a compatibility matrix for fluid to materials of construction. The compatibility of materials is assessed as part of the site engineering process, including during relevant MOC assessment. On reflection, it was decided that a case by case assessment is more valuable (and reduces room for error) compared to a matrix. Also, this is an infrequent event therefore a site-specific matrix will not be developed.

Corrosion

It is recognised that corrosion could weaken vessels and containers reducing their ability to contain generated conditions. Potential corrosion problems are analysed at the design stage through HAZOP to ensure that suitable materials are specified.

Where corrosion is considered a possibility, equipment has a corrosion allowance built into the design. Materials of construction are stainless steel 316L, mild steel, and epoxy lined mild steel.

Selection of appropriate materials of construction for equipment and instrumentation are founded on information obtained from: British Standards, equipment validation studies, HAZOP review notes, and industry learned bodies. They take into account the possible chemical interactions, corrosion mechanisms and erosion resistances.

Manufacturers' recommendations are also considered for the specification of sensors in contact with process fluids and services. The requirement for increased corrosion resistance of instruments is understood on the site. Where possible, non-intrusive or non-contact instruments, e.g. ultrasonic are specified. Hence, for a Stainless-Steel pipe, a pressure indicator diaphragm may be PTFE coated, Tantalum, Hastelloy or similar material offering a higher level of corrosion resistance. This choice is dependent upon the criticality of the instrument and its particular duty.

Changes to materials of construction are carried out under the Modification system, which is described in Section 5.2.5.

The materials used for piping are selected for the duty for which they will be used based on published chemical resistance charts, ASME B31.3 and site operational experience. Aggressive materials are contained in Stainless Steel or lined Mild Steel pipe depending on the application. ASA 150 RF flanges are fitted as standard and the number of joints is kept to a minimum dependant on ease of installation and requirements for service.

Where joints are required NCAF full-face with, gaskets are used. These gaskets are resistant to all materials used in processes. However, corrosion studies are carried out via the Design of Chemical Processes and HAZOPs to ensure that no unsuitable material is used.

Erosion: Correct line sizing ensures that flow rates and velocities are not high enough in any of the plant areas to cause significant piping erosion problems.

Continued Fitness for Purpose

All plant equipment routinely inspected either by the Competent Person, in the case of equipment covered by the sites written scheme, or by approved competent staff or contract inspection companies for equipment that is not.

Such inspections do sometimes highlight problems, which require further investigation. (Examples of In-Service and Out-of-Service Vessel inspection reports are included in Appendix 5.18).

The site undertakes painting of low temperature carbon steel piping and structural steel work to prevent external corrosion. This is of particular importance due the site proximity to the River Thames.

Matching Processes to Equipment

The current management of change procedure ensures that the impact of any changes to existing procedures or the introduction of new business, are adequately assessed. The management team carry out a ‘Storage and Handling Assessment’ through completion of form ‘FD24’. A copy of this form is included at Appendix 5.27

New Chemicals / Processes

Before any new processes are introduced the HAZOP considers the likelihood of corrosion.

If Corrosion was considered a potential threat an assessment would be done in the laboratory, e.g. to ensure acidic chlorides do not come into contact with stainless steel equipment, or high pH material enters unsuitably lined tanks.

When the technical expertise is not available within the Company guidance from published chemical resistance, charts is used in combination with advice on metal and elastomer selection from external experts.

The general philosophy is to design the plant to try to avoid corrosion of plant items; this approach is in-line with the site’s inherent safety philosophy. Where this cannot be achieved is the equipment at risk would be regularly inspected and be changed out on a risk-based approach.

General

Lifting beams and equipment are also tested to stringent standards, typically 1.5 times their design weight

5.2.1.10. Excursions beyond Design Conditions

Mechanical

There are no relevant criteria.

Process Safety

Assessment

Normal and maximum operating parameters have been established for all site based on the process requirements and the engineering design of the equipment. The safe working parameters for each product are investigated and confirmed at the assessment stage through a variety of Hazard Studies. The assessments involve chemical compatibility tests etc. and a

HAZOP of the process to ensure the existing controls are adequate for the new process or, where they are not, to identify additional measures.

These studies and reviews identify the possible causes and consequences of potential excursions beyond operating limits and help identify appropriate control systems to control the variables within the prescribed limits.

Prevention

There are a number of reasons for processes exceeding design conditions these are understood and considered in the Plant Operating Procedures and Emergency Procedures. Causes of such conditions could include, contamination by a previous product, failure of a relief device, excessive transfer rates, or overfilling a storage tank; that they are considered can be demonstrated by the following.

The HAZID tables contain all the potential major accidents identified for the site, some of which can arise through excursions beyond the safe operating limits of the equipment. The risk reduction measures in place to prevent, control, detect and mitigate against such events are summarised in the HAZID tables and the scoring system highlights those events that do not have adequate controls, for such events additional risk reduction measures have been identified and actions taken.

Any events that were chosen for the representative set are also highlighted and further analysis of these events can be found in Section 3.

Contamination

Materials are stored in dedicated bulk storage tanks or in smaller containers. Transfers lines are hard piped (as far as possible) (a process is in place to remove flexible houses from piping routes) from the jetty to the tank farm areas, at the end of the transfer these lines are (in most cases) left empty. With multiple products stored on site, contamination leading to a Major Accident Hazard through (for example) adverse chemical reaction is always a possibility which requires controls from the site. During the decision to obtain new businesses, such considerations are made. The site has complied a compatibility matrix of its current substances and this can be viewed within Appendix 5.28.

During the compilation of the COMAH Safety Report, Stolthaven engaged with the Health and Safety Executive over potential contaminations issues with one of the sites non-COMAH substances (UAN32). An initial review of this was contained within Appendix 5.28 and further comments are provided within Appendix 3.11 of the COMAH Safety Report.

Over Pressuring

Ultimate protection is provided by passive safety systems such as relief valves and pressure and vacuum valves, which might also incorporate flame arrestors.

All relief systems are designed to relevant API Standards (API 520, 521, 526). Those systems that might be susceptible to trapped pressure, such as the piping from the tanks, are either left empty or fitted with thermal relief valves, for example the transfer lines from the jetty to the various tank farms.

All such passive devices are included on either the site's written scheme or SAP based maintenance schedule for annual inspection and testing.

Overfilling

To prevent overfilling of storage tanks the maximum safe operating levels have been set and operators have to monitor level, using either level instruments or by manual dipping. Stolthaven are committed to the installation of accurate tank level gauging and associated level alarms and interlocks. Section 2 of the COMAH Safety Report provides tables which highlight the overfill protection present on every tank; Section 5.2.1.11 details the Safety and Reliability considerations for over-fill protection systems.

Warehousing

Within the site's warehouse areas there is no process equipment. As a consequence, the only safe operating limits that might be exceeded are the overloading of mechanical handling equipment and the overloading of racks.

Mechanical Handling Equipment

All mechanical handling equipment is marked with its safe working load.

Assurance that appropriate standards are being achieved is provided by the Competent Person who inspects annually, or 6 monthly in the case of lift trucks used for lifting people in a cage system.

Human Factors

There are no relevant criteria.

5.2.1.11. Safety and Reliability of Control Systems

Mechanical

There are no relevant criteria.

EC&I

The facility's operations are controlled either by the use of automatic shut off systems or manually operated valves. Area 1 and some tanks in Area 3 & 6 have instrumented systems installed in line with the guidance HSG 176 The Storage of Flammable Liquids. All tanks in Area 1, 2, 3 & 6 have level indication with Hi and Hi Hi alarms. Other parts of the site rely on manually 'dipping' storage tanks to reduce the probability of overfilling, this process is carried out for every transfer of bulk liquid and check dips are carried out hourly. The tables in 2.11.1 of the COMAH Safety Report clarifies the current overfill protection status of all tanks.

Control

Motors → All motors drives are controlled from local Start / Stop button, located within 2m of the drive in question or from the motor control centre (MCC) building as part of a controlled measured delivery. Emergency stops are local to motors.

Variable Speed Drives → All variable drives are control by individual inverter drives with local Start / Stop or from the motor control centre (MCC) building as part of a controlled measured delivery. Emergency stops are local to motors.

Actuated Valves → Actuated valves are either controlled using local toggle switches are in the case of Area 3 by predetermined batching sequences or as part of a delivery process controlled by the SCADA.

Control Valves → Control valves are controlled by local stand-alone 3 term controller or as part of a delivery process controlled by the SCADA.

The following devices are indirectly monitored for failure:

Actuated On/Off Valves → Actuated valves installed within Area 1 and Area 3 are fitted with position limit switches, which constantly monitor the position of the valves. Should a valve change position unexpectedly the device would go into 'Fault' and stop any active batching sequence.

Operating Duty

The operating duty for automated valves is considered during the HAZOP of any new design, when a new process is being considered, or when maintenance or operating experience identifies a problem. This review will consider the type and how performance may be affected by process and external environment. Historical site experience is also taken into account such that previous problems are not repeated.

Due to the site proximity to the River Thames the effect of atmospheric conditions on the type and materials of construction for valves is part of the selection process. For example, uncoated Aluminium would not be used if corrosion was anticipated.

Filters are installed in the air line to air actuated instruments to prevent desiccant carry over affecting operation.

Environmental Considerations

The site has conducted a number of hazardous area classification studies, (A copy of which can be found in Appendix 5.11-5.13). The hazardous areas study was bases on the following standards:

- IP Model Code of Safe Practice, Part 15 – Area Classification Code for Petroleum Installations
- BS EN 60079 Electrical apparatus for use in explosive gas atmospheres Part 10:2003 classification of hazardous areas.
- Scientific Institute Research Association (SIRA) to consider those substances not considered by IP15

As a result, in general, control and instrumentation within hazardous areas have been classified Zone 2 IIC T4.

As part of the Hazardous Area study a series of electrical area classification drawings have been produced. The site has undertaken a review of all electrical equipment to ensure they conform to the Zone requirements.

Back-up Measures

The consequences of power and air failure are considered in detail in Section 5.2.1.4. In summary in the event of power failure:

- All drives will stop
- All actuated valves & modulating control valves will go to their fail state
- All tank high level alarms would become active

On power reinstatement:

- All drives will remain de-energised
- All actuated valves will remain in their fail state
- All modulating control valves will remain in their fail state

To ensure valves fail to their prescribed position this is achieved by the use of spring return actuators.

The fail-safe condition of each valve is determined during HAZOP studies and tested during commissioning. For example, the outlet valves on all the bulk storage tanks and reactors fail closed thus preventing the movement of materials around the site. In ALL cases the loss of compressed air poses no safety concerns and would only result in operational difficulties.

An unannounced reinstatement of power will not cause any problems as no drives will restart automatically, with pumps and other equipment having to be manually restarted, locally, after a trip so that the operator can confirm it is safe to restart.

Safety Integrity – New Builds

Layer of Protection Analysis (LOPA) Studies have been carried out by a third party for the new storage tanks in Area 1. These studies were used to determine the SIL requirements for Safety Instrumented Functions (SIFs). The analysis proceeded on the worst-case assumption that site might in the future store Gasoline. (note - there are no current plans to do so). The LOPA work indicated that a SIL 2 over-fill protection system would place the risk well into the Broadly Acceptable region on a per scenario basis. Therefore, the overfill protection systems on Area 1 new build, were designed and installed to this integrity level. Appendix 5.29 presents the Area 1 LOPA study.

Safety Integrity – Existing Tank Systems

For existing plant, a retrospective LOPA study was carried out by 3rd parties to establish the integrity requirements for over-fill protection across the site. The scope of the work was extremely large and aimed at understanding the risks for all tanks, and all harm outcomes (low flash point, high flashpoint and environmental harmful) to enable Stolthaven to create a rule set on a product by product basis with respect to overfill protection requirements. The LOPA study is presented in Appendix 5.30 and the output of this work is currently being reviewed by Stolthaven to enable risk-based decisions to be made in relation to the degree in which retrospective addition of such protective features will be applied.

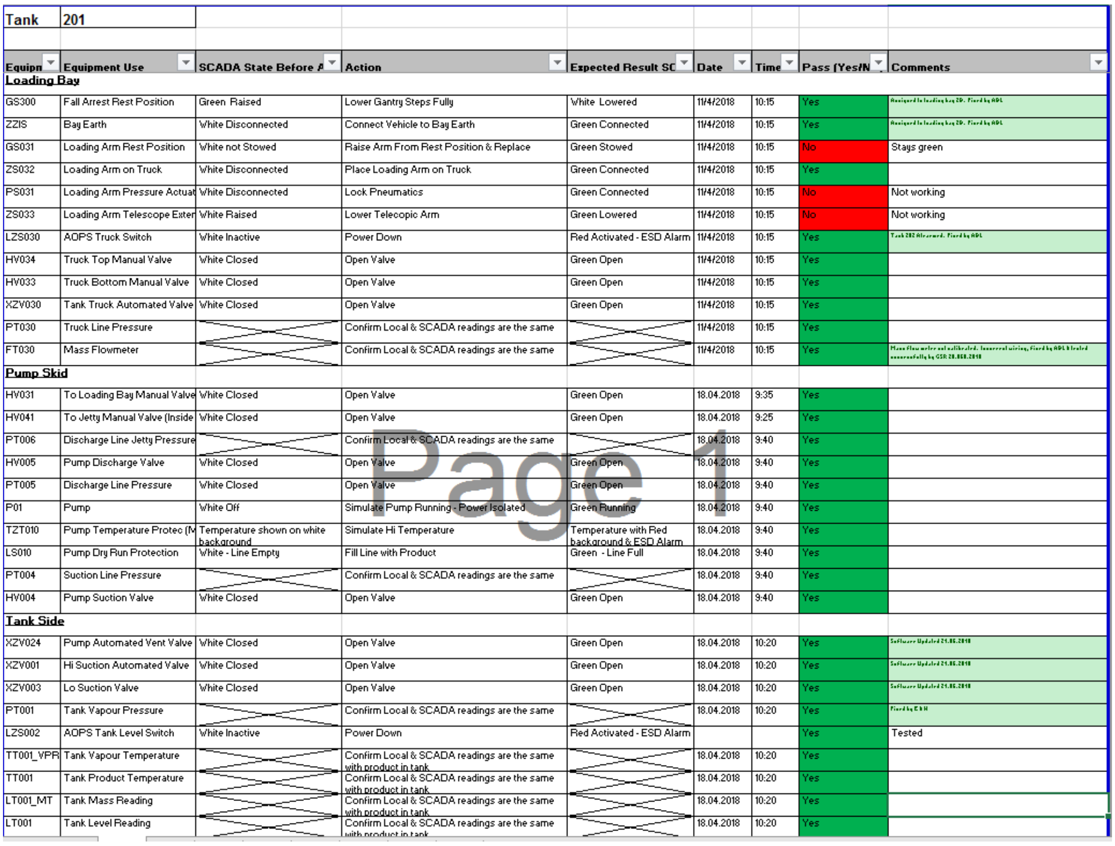
Inspection

Stolthaven recognises that the Probability of Failure upon Demand (PFD) of its overfill trip protection is related to the proof testing quality and frequency. As such, all safety systems and equipment are inspected and maintained. The inspection and maintenance are normally planned to be completed during Tank downtime periods. Competent site technicians perform inspection and maintenance (in addition electrical systems are inspected by an external Competent Person). When a new system is installed as a project, then the control loops are fully tested in the pre-commissioning phase to ensure the interlocks work properly.

Site actuated valves are inspected as part of the site preventative maintenance programme. The trip testing of ROSOV’s is recorded, and example procedure and record sheet for this activity is presented in Appendices 5.31 and 5.10. The ATG is also inspected and tested, a service report is presented in Appendix 5.32.

Other testing records for instrumentation and control are presented in the figure below.

Figure 5.2.1.11 – SCADA Status Testing



Tank 201

Equipn	Equipment Use	SCADA State Before A	Action	Expected Result SC	Date	Time	Pass (Yes/N	Comments
Loading Bay								
GS300	Fall Arrest Rest Position	Green Raised	Lower Gantry Steps Fully	White Lowered	11/4/2018	10:15	Yes	Assigned to loading bay 2B. Fixed by ADL
ZZIS	Bay Earth	White Disconnected	Connect Vehicle to Bay Earth	Green Connected	11/4/2018	10:15	Yes	Assigned to loading bay 2B. Fixed by ADL
GS031	Loading Arm Rest Position	White not Stowed	Raise Arm From Rest Position & Replace	Green Stowed	11/4/2018	10:15	No	Stays green
ZS032	Loading Arm on Truck	White Disconnected	Place Loading Arm on Truck	Green Connected	11/4/2018	10:15	Yes	
PS031	Loading Arm Pressure Actuat	White Disconnected	Lock Pneumatics	Green Connected	11/4/2018	10:15	No	Not working
ZS033	Loading Arm Telescope Exter	White Raised	Lower Telecopic Arm	Green Lowered	11/4/2018	10:15	No	Not working
LZS030	AOPS Truck Switch	White Inactive	Power Down	Red Activated - ESD Alarm	11/4/2018	10:15	Yes	Tank 202 Alarmed. Fixed by ADL
HV034	Truck Top Manual Valve	White Closed	Open Valve	Green Open	11/4/2018	10:15	Yes	
HV033	Truck Bottom Manual Valve	White Closed	Open Valve	Green Open	11/4/2018	10:15	Yes	
XZV030	Tank Truck Automated Valve	White Closed	Open Valve	Green Open	11/4/2018	10:15	Yes	
PT030	Truck Line Pressure		Confirm Local & SCADA readings are the same		11/4/2018	10:15	Yes	
FT030	Mass Flowmeter		Confirm Local & SCADA readings are the same		11/4/2018	10:15	Yes	Mass flow meter not calibrated. Incorrect wiring, fixed by ADL & tested successfully by GSR 28.05.2018
Pump Skid								
HV031	To Loading Bay Manual Valve	White Closed	Open Valve	Green Open	18.04.2018	9:35	Yes	
HV041	To Jetty Manual Valve (Inside	White Closed	Open Valve	Green Open	18.04.2018	9:25	Yes	
PT006	Discharge Line Jetty Pressure		Confirm Local & SCADA readings are the same		18.04.2018	9:40	Yes	
HV005	Pump Discharge Valve	White Closed	Open Valve	Green Open	18.04.2018	9:40	Yes	
PT005	Discharge Line Pressure	White Closed	Open Valve	Green Open	18.04.2018	9:40	Yes	
P01	Pump	White Off	Simulate Pump Running - Power Isolated	Green Running	18.04.2018	9:40	Yes	
TZT010	Pump Temperature Protec (M	Temperature shown on white background	Simulate Hi Temperature	Temperature with Red background & ESD Alarm	18.04.2018	9:40	Yes	
LS010	Pump Dry Run Protection	White - Line Empty	Fill Line with Product	Green - Line Full	18.04.2018	9:40	Yes	
PT004	Suction Line Pressure		Confirm Local & SCADA readings are the same		18.04.2018	9:40	Yes	
HV004	Pump Suction Valve	White Closed	Open Valve	Green Open	18.04.2018	9:40	Yes	
Tank Side								
XZV024	Pump Automated Vent Valve	White Closed	Open Valve	Green Open	18.04.2018	10:20	Yes	Software Updated 21.05.2018
XZV001	Hi Suction Automated Valve	White Closed	Open Valve	Green Open	18.04.2018	10:20	Yes	Software Updated 21.05.2018
XZV003	Lo Suction Valve	White Closed	Open Valve	Green Open	18.04.2018	10:20	Yes	Software Updated 21.05.2018
PT001	Tank Vapour Pressure		Confirm Local & SCADA readings are the same		18.04.2018	10:20	Yes	Fixed by E&H
LZS002	AOPS Tank Level Switch	White Inactive	Power Down	Red Activated - ESD Alarm			Yes	Tested
TT001_VPR	Tank Vapour Temperature		Confirm Local & SCADA readings are the same with product in tank		18.04.2018	10:20	Yes	
TT001	Tank Product Temperature		Confirm Local & SCADA readings are the same with product in tank		18.04.2018	10:20	Yes	
LT001_MT	Tank Mass Reading		Confirm Local & SCADA readings are the same with product in tank		18.04.2018	10:20	Yes	
LT001	Tank Level Reading		Confirm Local & SCADA readings are the same with product in tank		18.04.2018	10:20	Yes	

5.2.1.12. Human Factors

Mechanical

There are no relevant criteria.

EC&I

There are no relevant criteria.

Process Safety

There are no relevant criteria.

Human Factors

The Company recognises in its MAPP that human factors play a significant role in the prevention and mitigation of major accidents. The fallibility of people means that even those trained and competent to carry out their role could still make errors, and therefore the need to minimise reliance upon them in preventing Major Accidents. To this end, Human Factors is recognised and reviewed as part of the Stolthaven Management of Change (MOC) process and limited credit is taken for human intervention when viewed as a risk reduction measure.

A hierarchical approach is adopted at design and subsequent review stages for any project or modification in order to remove, where possible, or at least minimise reliance upon personnel in the prevention, control and mitigation of such events. Automated systems are utilised where possible and their requisite integrity maintained via prescriptive inspection, maintenance and testing schedules.

Where human involvement is required, numerous measures are taken to minimise variability and maximise an individual’s opportunity for success;

Current standards & guidance, such as EEMUA 191, EEMUA 184, EEMUA 201 & ISO 11064 are applied in order to address recognised Performance Influencing Factors and minimise the risk of human error. Accessibility for operating & maintenance tasks is assessed for each change during the MOC process, with due consideration given to layout, noise, temperature, lighting, fatigue, etc. Tools such as 3D modelling and simulation are applied, where appropriate, at the design stage of major projects to aid this process. Multi-discipline teams, including front-line operations and maintenance personnel, are actively involved in design discussions and reviews and risk assessment processes in order to ratify assumptions and provide a thorough assessment and effective, safe solution.

Where change is introduced, consideration is given to the need for operating and maintenance procedures and schedules and for the provision, or update, of training. Requirements are determined from applicable guidance, existing policies and procedures.

Equipment, pipework, cables, etc., are allocated unique identification numbers and are clearly labelled on site to aid operations and maintenance personnel and reduce the likelihood of human error.

Where it is deemed that reliance upon human intervention fails to provide sufficient risk reduction and / or it is practicable and justifiable to do so, interlock systems are utilised to protect against conditions with Major Accident potential.

All tasks are reviewed to identify those, whether operational or maintenance related, critical to the safe operation of our facilities. In turn, the identified tasks are subject to *Critical Task Analysis* where consideration is given to the robustness of procedures and control measures and how reliability may be improved. Modification to instructions and training requirements are made accordingly.

It is acknowledged that, for most Major Accident scenarios, the desired level of risk reduction cannot be attained through human intervention alone, and it is therefore common on-site for automated safety systems, such as overfill protection and the isolation of heat sources upon high temperature, to replace or supplement operator actions; the required level of integrity of such systems is determined through application of Layer of Protection Analysis (LOPA) and systems are designed, specified, installed, inspected, maintained and tested accordingly.

Situations where human error could occur and result in an accident are identified within the risk assessment process. Identification of these potential accident precursors enables equipment to be changed to remove the risk, the introduction of passive protection devices or the development of Safe Working Procedures in order to eliminate the hazard or mitigate it.

Procedures

Procedures and rules are in continuous development or improvement to implement the Company's continuously improving health and safety and environmental policies.

Procedures take into account the findings from hazard review studies and risk assessments of the process. The draft procedures are scrutinised by production, development and safety management to ensure that all risks are understood and that adequate safety control measures are in place. Operators are then trained against the approved procedures and the process is introduced to the facility. Continual appraisal of the control measures is carried out by plant management through auditing exercises. Where necessary, amendments to the manufacturing instructions are completed using the site's change control procedures to introduce improvements.

The importance of these procedures can be demonstrated by considering the controls that exist to prevent tanks and tankers being overfilled, hazards recognised in the HAZID, examples include.

- *Overpressure due Pumping against closed valve due to routing error.*
- *Line routed to wrong tank during fill operations.*

The operating procedures in place for all transfers are robust and are documentation driven, with independent crosschecks at most of the critical stages. However, the transfer operations are reliant on human intervention, either through tank dipping or monitoring of transfers. Records for tank dipping are presented in Appendix 5.33 while Appendix 5.34 provides the procedure for ship to shore transfers.

All generic tasks have been risk assessed and where necessary method statements have been produced and made available to the operators. Most on plant all maintenance work requires a Permit to Work prior to the commencement and implicit within the Permit to Work is a risk assessment. This is covered in greater detail within Section 5.2.4.

Training

All Process Operators receive initial training on the operation of the storage and transfer facility and associated equipment within their area of responsibility when they first start. Refresher training has only been provided when new processes are introduced.

When a new process is to be introduced the management assesses the complexity and risk and when required develops the Operating Instructions and then trains the personnel that will operate the process. On simple processes, such as pumping a product from one tank to another, this training might initially be verbal instruction from the Shift Supervisor. Operator competence is assessed and determined by the Shift Supervisor through monitoring performance. Since the issue of the last COMAH Safety Report, the training program has been reviewed and audits are conducted to ensure compliance with procedures.

Competence

Staff

All employees receive formal induction training, followed by relevant on the job training, in accordance with an analysis of training needs carried out at the time of commencement of employment. As appropriate, in-house and external training courses are provided such as permit to work, confined space, alarm management, incident command, etc. Health, Safety and Environmental training requirements are identified by the respective managers during the training needs analysis that takes place annually.

Additionally, for each position, there exists a competency profile within the job description; this includes, amongst other elements, the relevant qualifications, skills and experience necessary to carry out duties in the management of major accident hazards. Job descriptions are in the process of being further reviewed.

All managers and staff have the opportunity for an annual review of their training and development needs. The review focuses on improving or maintaining high levels of competence by agreeing a Personal Development Plan as part of the appraisal process which is revised on an ongoing basis and includes an assessment of whether current knowledge and application meet the needs and requirements of the role. The process of identifying the training needs for senior managers is the same as that for other employees.

Following the identification of a training need during the review, agreement is reached between both parties on how the training should be carried out and on its timing. Training can be internal or external.

Contractors

Contractors employed on a regular basis are inducted in the procedures and safe systems of work relevant to their activities. The level of training is based upon the type of work they will be doing and the location. Induction training is supplemented by additional training according to needs; e.g. those contractors that are authorised to receive Permits to Work receive extra training to explain their additional responsibilities.

Departmental Managers are responsible for ensuring that any contractors appointed to work in their areas of responsibility have the necessary competence. Contractors are vetted (FD106) before being allowed to work on-site, safety tours and audits are conducted.

Validation and evaluation of training

All training carried out is assessed and evaluated. This is put into practice via the Individual Training Record form which requires the person planning the training to define how it is to be carried out and evaluated (e.g., on a competency basis, or using practical or theoretical tests). The responsibility for ensuring that competency requirements are met rests with Departmental Managers. Since the last COMAH Safety Report, the training program has been reviewed and audits are conducted to ensure compliance with procedures.

Within the Training Procedure, there is a form used for evaluation of the effectiveness of Training Courses.

All employees are given environmental training which includes:

- A general introduction to the company Environmental Management Systems
- The significant environmental aspects and impacts
- The importance of adherence to procedures (to adhere to regulatory controls), including the consequences of deviation from procedures
- Reporting responsibilities.

Alarm and Shutdown Systems

All tanks in Areas 1, 2, 3 & 6 have level indication locally and displayed in the control room, manual dips are taken before and after bulk liquid movements and crossed checked with level gauges. Tank levels are monitored during transfer by taking hourly level readings and a flow calculation is recorded. Expected transfer completion times can be displayed and manual level alarms can be inserted to alarm at a set point.

Major accidents caused by overfilling are avoided by physically checking all tank contents from the level indicators, or regularly checking with dip taps, during the transfer operations; and checking the ullage of the receiving tank and the discharging vessel before transfer operations begin.

Examples of other site-based alarms are provided in Table 5.2.1.12.1

Table 5.2.1.12.1: Process audible / visual alarms

Alarm situation	Audible	Visual
Steam boiler – low water etc	Yes	Yes – boiler panel
Site Compressed Air - low pressure	Yes	No
Bulk storage tanks – high and low levels	Yes	Yes – Jetty & Gate House

Ergonomic Factors

The plant was originally designed and built for a very high degree of manual operation, but access to certain valves and equipment was poor, to either operate or maintain. Improvements to access have made over recent years, or where this has proved difficult temporary access provided, as needed.

During the design process of all new installations access & egress is actively considered and wherever possible the requirement for temporary access for either operational or maintenance tasks is eliminated the need for routine temporary access.

Improvements are ongoing and initiated as opportunities are recognised. As an example, newly installed walkways have been added to the bunding upgrade of Area 1, 2 & 3. Also, the additional level gauges that lessen the need to access tank tops for manual dipping.

The site is also committed to improvement related to road tanker loading which include metered discharges, in order to stop the need for operators to climb to the top of storage tanks and road tankers in order to check levels and quantities transferred. Several loading bays in Area 2 have been converted to bottom loading.

Safety and Reliability Concerning Human Actions

The general direction of process operation improvement is toward providing sufficient automatic safeguards without relinquishing human control. Improvements are being introduced as opportunities are recognised. Notwithstanding the improvements that are intended, due to the nature of the business there will always be activities that do rely on a high degree of human action and the intention is to make these as safe and reliable as possible, through procedures that are regularly reviewed. This is assured by:

- *Training that is validated*
- *Risk assessment*
- *Monitoring by supervisors*

The design and construction of storage Area 1 exemplifies ongoing site improvements, by incorporating SCADA control system for bulk product movements.

Shift operation is conducted by the Shift Supervisors, and Operators. Operators perform all tasks related to the transfer facility and are trained to be capable of carrying out all tasks associated with the safe operation of the terminal.

By definition they spend a lot of the shift out and about on the plant. In this way, through their knowledge and experience, they play an important part in identifying the potential for accidents or incidents. For example, they can detect the strange and unusual noises motors/pumps make before bearings fail or spot leaks before they become serious.

There is a formal reporting system in use at the terminal to record incidents and near miss events. All employees are responsible for noting potentially unsafe working practices and raising the awareness level before an incident occurs. Near miss reports are produced monthly and displayed on notice boards.

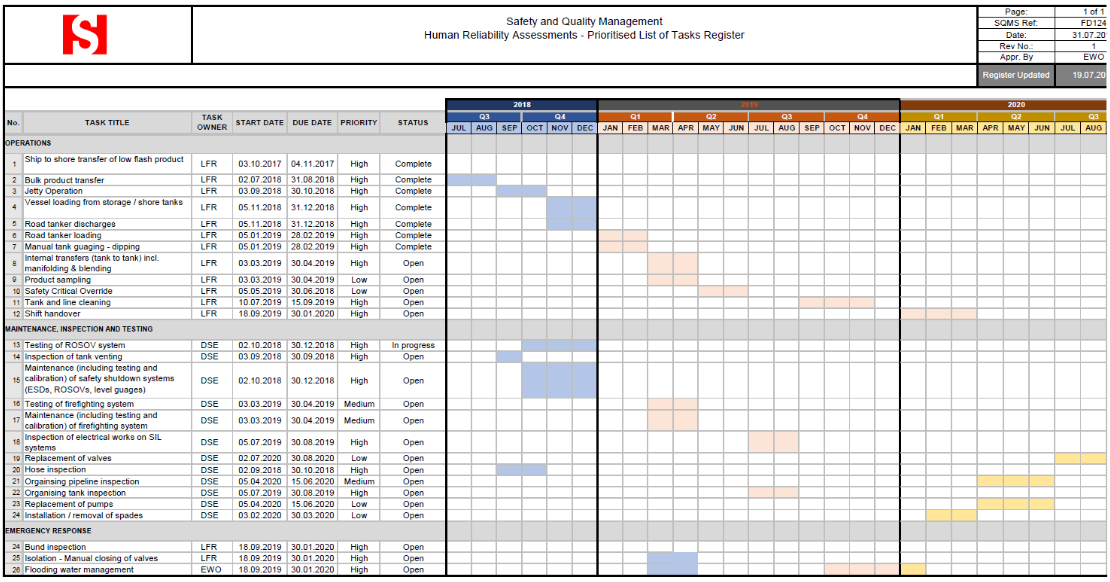
The reliability of humans with respect to their actions and / or inactions is considered within risk assessments. The most relevant examples of this are within the Layers of Protection Analysis presented in Appendices 5.29 and 5.30. Justifications of values are also presented within these Appendices, along with Section 3 of the COMAH Safety Report. Generally speaking, reliability claims (expressed as probabilities of failure per operation) of better than 0.01 are not used, this is in accordance with EEMUA191 and BS EN 61511 2017. Reliability claims of between 0.1 – 0.01 are robustly justified with references to the task, while in situations where operators are expected to respond to emergency situations, probability of failure is taken to be between 1 – 0.5. With specific reference to the LOPA analysis, real site data was used thus providing a strong justification of values used. Human reliability assessments (HRA) have been conducted of all major tasks with Safety Critical Task Analysis conducted as a further means of identifying potential human failures. An example HRA for a ship to shore transfer is provided in Appendix 5.35 while a Safety Critical Task Analysis (SCTA) for checking the ships contents against tank ullage is presented in Appendix 5.36.

Since the site continues to be a largely manual operated facility and therefore the site management team remain committed to on-going Human Factors Risk Assessments. Several site personnel have been trained on the Human Factor and Human Reliability Assessment methodology. The site has developed and implemented dedicated procedures for carrying out HRA and Safety Critical task Analysis.

The site is operating to a prioritised two-year Human Reliability Assessment program as agreed with the Competent Authority). This program covers key aspects of our operations including maintenance and inspection, emergency response etc. The actions from the HRA and SCTA are entered the site Continuous Improvement Register from where they are tracked to closure.

The overall site HRA program is presented in Figure 5.2.1.12 below.

Figure 5.2.1.12 – Human Factors HRA Plan



Safety and Quality Management
Human Reliability Assessments - Prioritised List of Tasks Register

Page:	1 of 1
SQMS Ref:	FD124
Date:	31.07.20
Rev No.:	1
Appr. By	EWO
Register Updated	19.07.20

No.	TASK TITLE	TASK OWNER	START DATE	DUE DATE	PRIORITY	STATUS	2018						2019												2020							
							Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3	
							JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
OPERATIONS																																
1	Ship to shore transfer of low flash product	LFR	03.10.2017	04.11.2017	High	Complete																										
2	Bulk product transfer	LFR	02.07.2018	31.08.2018	High	Complete	▨	▨																								
3	Jetty Operation	LFR	03.09.2018	30.10.2018	High	Complete			▨	▨																						
4	Vessel loading from storage / shore tanks	LFR	05.11.2018	31.12.2018	High	Complete					▨	▨																				
5	Road tanker discharges	LFR	05.11.2018	31.12.2018	High	Complete					▨	▨																				
6	Road tanker loading	LFR	05.01.2019	28.02.2019	High	Complete							▨	▨																		
7	Manual tank guaging - dipping	LFR	05.01.2019	28.02.2019	High	Complete							▨	▨																		
8	Internal transfers (tank to tank) incl. manifolding & blending	LFR	03.03.2019	30.04.2019	High	Open									▨	▨																
9	Product sampling	LFR	03.03.2019	30.04.2019	Low	Open									▨	▨																
10	Safety Critical Override	LFR	05.05.2019	30.06.2018	Low	Open											▨	▨														
11	Tank and line cleaning	LFR	10.07.2019	15.09.2019	High	Open															▨	▨	▨									
12	Shift handover	LFR	18.09.2019	30.01.2020	High	Open																			▨	▨	▨					
MAINTENANCE, INSPECTION AND TESTING																																
13	Testing of ROSOV system	DSE	02.10.2018	30.12.2018	High	In progress				▨	▨	▨																				
14	Inspection of tank venting	DSE	03.09.2018	30.09.2018	High	Open			▨																							
15	Maintenance (including testing and calibration) of safety shutdown systems (ESDs, ROSOVs, level guages)	DSE	02.10.2018	30.12.2018	High	Open				▨	▨	▨																				
16	Testing of firefighting system	DSE	03.03.2019	30.04.2019	Medium	Open									▨	▨																
17	Maintenance (including testing and calibration) of firefighting system	DSE	03.03.2019	30.04.2019	Medium	Open									▨	▨																
18	Inspection of electrical works on SIL systems	DSE	05.07.2019	30.08.2019	High	Open													▨	▨												
19	Replacement of valves	DSE	02.07.2020	30.08.2020	Low	Open																									▨	▨
20	Hose inspection	DSE	02.09.2018	30.10.2018	High	Open			▨	▨																						
21	Orgainsing pipeline inspection	DSE	05.04.2020	15.06.2020	Medium	Open																						▨	▨	▨		
22	Organising tank inspection	DSE	05.07.2019	30.08.2019	High	Open													▨	▨												
23	Replacement of pumps	DSE	05.04.2020	15.06.2020	Low	Open																						▨	▨	▨		
24	Installation / removal of spades	DSE	03.02.2020	30.03.2020	Low	Open																				▨	▨					
EMERGENCY RESPONSE																																
24	Bund inspection	LFR	18.09.2019	30.01.2020	High	Open																										
25	Isolation - Manual closing of valves	LFR	18.09.2019	30.01.2020	High	Open									▨	▨																
26	Flooding water management	EWO	18.09.2019	30.01.2020	High	Open																▨	▨	▨	▨							

Fitness to Work

An individual's on-going fitness is determined by a combination of self-certification and supervisory observation. Occupational health surveillance has been conducted in 2015, a service is provided for ongoing access to occupational health by staff. Following illness / injury, the individuals' doctor is responsible for pronouncing employees fit to return to work. However, prior to returning to work Stolthaven will arrange for an Occupational Health assessment to determine whether due to the nature of the injury or illness the person might be inhibited from undertaking certain aspects of their role. This is particularly important for persons returning from a long period of absence. In such cases the employee could be phased back into work in a controlled manner and monitored.

Stolthaven has a strict substance abuse policy, and any incident related to a transgression of such guidance is covered by the company's disciplinary procedures.

There are 8 first aiders at the site, with a first aider always on site during operational activities. Emergency showers, eye wash facilities and Emergency First Aid Kits are located in all Departments. A well-equipped First Aid room is located in the Assistant Operations Manager's office.

Manning

The site has 24/7 supervision in place with 5 supervisors rotating a 12-hour shift pattern. 6 chargehands and 21 operators carry out site duties including covering shifts at a weekend on an overtime basis when required. The site maintenance team consisting of 3 mechanical fitters 2 electricians 2 supervisors and storeman generally work daytime with a call out process in place for emergency breakdowns or emergency conditions. Site security is maintained by the 24- hour presence of a security guard.

The offloading ship moored at the jetty is manned at all times by the ship's crew. The owning company and size of vessel determine the ship's compliment, as well as the relevant Merchant Shipping legislation.

Holidays and sickness are addressed through overtime working and call out. The manning levels are considered appropriate to deal with the tasks necessary to fulfil the day-to-day operational requirements and to respond to foreseeable emergencies. The manning has been derived after many years' experience of operating and takes into account the technology and automation changes that have taken place. The numbers enable operators to take reasonable break from their tasks without risk to the safety of the operation. A mess/rest room is provided remote of any process areas.

As part of their induction programme, new employees accompany experienced Operators who advise them of site safety and operational practices. Competence to act alone is assessed by the Operations Manager through personal observation, questioning and through consulting the trainer and a sign off process

The Health and Safety Policy document permits any employee to refuse to work or use equipment if he or she considers the work or equipment to be unsafe.

All employees are authorised to immediately stop any operation where they have reasonable grounds to suspect imminent danger.

New Area 1 Installation

For Area 1, reliability of human action is critical in selecting the correct tank to receive a product. When pumping into a tank, the SCADA mimic will show which tank has been selected; it will not be possible to pump a material into the wrong tank.

The layout of alarms on display screens has been considered at the design stage; the most critical alarm will always be placed at the top, with different colours being used, depending on their relative criticality.

Regarding workplace design considerations, Stolthaven are planning to build a new control room, to replace the current arrangement of individual control points. There will be no panel instrumentation, all plant items being computer controlled. However, loading data will be entered at local points, but will be visible from the control room.

Fatigue

Stolthaven are generally moving towards increased levels of automation. The following considerations have been applied to new plant:

- 24/7 supervision
- For shipping operations, depending on the complexity of the operation being undertaken, there will be one supervisor, one charge hand and a minimum of two operators present, until smooth running conditions have been reached for the transfer concerned;
- For operations involving a ship / barge, personnel from the ship will also be present throughout an operation. For transfers involving road vehicle, a site operator completes the relevant paperwork when the vehicle arrives, then accompanies the driver to the loading / offloading point.

The site continues to be a largely manual operated facility and therefore the site management team remain committed to on-going Human Factors Risk Assessments. Several site personnel have been trained on the Human Factor and Human Reliability Assessment methodology. The site has developed and implemented dedicated procedures for carrying out HRA and Safety Critical task Analysis.

The site is operating to a prioritised two-year Human Reliability Assessment program as agreed with the Competent Authority). This program covers key aspects of our operations including maintenance and inspection, emergency response etc. The actions from the HRA and SCTA are entered the site Continuous Improvement Register from where they are tracked to closure.

During the HAZID process certain scenarios identified involved 3rd parties. Examples are:

- Road tanker drives away during loading / off-loading.
- Tanker impact on bulk storage tank or pipe work
- Vehicle collision - two road tankers.

The Company does not have any control of the competence of these drivers, the responsibility for that rests with their employers. However, the Company has subscribed to the industry "Safe Loading Pass Scheme" which serves to assess driver competence (and vehicle integrity) to a pre-determined acceptable level. To reduce the likelihood of a collision, or to minimise the consequential damage, the Company have imposed a 10-mph speed limit and implemented a one-way traffic system across the site. Also, physical barriers have been erected around key asset to protect them from impact. The site has also improved its driver induction program including issuing induction and information booklets.

To prevent vandalism or sabotage, the site has a CCTV surveillance system. There is a total of 73 CCTV cameras (with plans to increase this number in the future) on site which are used to monitor security and oversee operational activities.

5.2.1.13. Location of Flammable Substances

Mechanical

A Mechanical Ignition Risk Assessment will be undertaken where necessary, as part of the site redevelopment activities. The most recent development to create the new Area 1 utilises ATEX rated magnetic drive pumps within the design.

A Hazardous Area classification document was created/updated as part of TP01/02/03 project. All equipment installed in an ATEX zone or system is ATEX rated and carry their ATEX certificates and is adequately earthed.

Ref	**Action**
5.2.1.13b	Mechanical Ignition Risk Assessment to be carried out.

EC&I / Process Safety

Classification of Areas

In 2017, an explosion protection document (EPD) (Appendix 5.37) was compiled for the whole site in accordance with article 8 of the ATEX 137 (118a) Directive - 1999/92/EC - Minimum Requirements for Improving The Safety And Health Protection Of Workers Potentially At Risk From Explosive Atmospheres. It is also intended to demonstrate compliance with DSEAR. The Dangerous Substances and Explosive Atmospheres Regulations. Statutory Instrument 2002 No. 2776. The EPD includes a hazardous area classification of the terminal based upon the guidance of EI 15 previously known as IP 15 is the Model code of safe practice Part 15 Area classification code for Installations handling flammable fluids 4th Edition June 2015 ISBN 978 0 85293 717 4 - published by the Energy Institute (Formerly the Institute of Petroleum).

The site conducted its most recent hazardous area classification (a copy of which can be found in Appendix 5.11-5.13) the purpose of the study was to identify potential sources of ignition in all areas where there may potentially be a flammable atmosphere under normal and abnormal operations. The classification study has been undertaken using guidance from:

- IP Model Code of Safe Practice, Part 15 – Area Classification Code for Petroleum Installations
- BS EN 679 Electrical apparatus for use in explosive gas atmospheres Part 10:2003 classification of hazardous areas.
- Scientific Institute Research Association (SIRA) to consider those substances not considered by IP15

Where appropriate electrical equipment necessary in such areas is appropriately rated, as such the electrical and instrument installation complies with:

- BS5958 (various parts) Code of practice for control of undesirable static electricity
- BS6739 Code of Practice for instrumentation in process control systems: Installation, design and practice
- BS7671 Requirements for Electrical installations. IEE wiring regulations, 16th edition,
- BS EN 60079 Electrical apparatus for explosive gas atmospheres (various sections)
- CP1013 Earthing.

All flammable storage areas are appropriately segregated from potential fixed ignition sources. The site has strict policies on the use of electrical equipment on the plant, smoking and the carrying of smoking materials.

A Hot Work permit system is in place for maintenance activities which require open flame or potential ignition sources.

Anti-static footwear is standard on site.

A substantial number of raw materials used on site are conductive by their nature and flexible hoses are maintained under a Hose Maintenance Schedule under which they are regularly inspected and checked for electrical continuity, pressure test and physical damage.

New Area 1 Installation

Hazardous Area Classification has been carried out for the site as it is. This is undergoing review as part of the site redevelopment and will be updated in accordance with the transfer of materials into different storage tanks. Revised area classification drawings have been performed and are presented in Appendix 5.11 – 5.13.

Identification of Flammable Atmospheres

The site does not have a fixed flammable gas detection system.

For any activities such as hot work or confined entry where a flammable gas is suspected or may be present portable detectors are used. These are controlled by the SHEQ Manager and undergo regular calibration and testing in line with the manufacture’s recommendations (a copy of a current calibration certificate is included in Appendix 5.38.

With respect to maintenance work it is assumed that a flammable atmosphere might exist and on this basis gas tests are done prior to the approval of hot work and the issue of a Permit to Work. This is issued prior to any activity that might generate heat.

Sources of Ignition

Across the site sources of ignition are effectively controlled in all hazardous areas by a combination of design measures, and systems of work, including:

- Use of electrical equipment and instrumentation classified for the zone in which they are located.
- Earthing of equipment, checks to confirm effectiveness and continuity. Area 1, Area 2, Area 3 earthing network have been recently upgraded as part of the secondary containment upgrade works.
- Elimination of surfaces above the auto-ignition temperatures of the flammable materials being handled / stored.
- Provision of lightning protection.
- Correct selection of vehicles / internal combustion engines that have to work in the zoned areas.
- Prohibition of smoking / use of matches / lighters in areas of risk.
- Controls over the use of normal vehicles.
- Controls over activities that create intermittent hazardous areas, e.g. vehicle loading / unloading
- Control of maintenance activities that may cause sparks/hot surfaces/naked flames through a Permit to Work System.

The following sections provide more detail on the above aspects.

Electrical Equipment

The site developed a framework for the design, maintenance / testing of EX equipment to meet the requirements of IEC 60079. The specific requirements are documented with Stolthaven procedure (DAG-ENG-EMS-009) and is presented in Appendix 5.41.

The site has employed 2 CompEx trained technicians to help coordinate and implement the new site ATEX inspection programme. So far, ATEX inspections have been completed for Area 6, Area 2, Area 3, and Jetty. The corrective / preventative actions identified during the inspections are tracked to closure.

All electrical equipment installed within the production areas is suitable for operation in the hazardous area zone in which it is installed.

All equipment is installed and maintained by Comp Ex trained and staff and contractors. An example certificate of competence is presented in Appendix 5.39 while Appendix 5.40 provides an example inspection record. Stolthaven's overall strategy to the management and inspection of electrical equipment which is present within a potentially hazardous area, is detailed in Appendix 5.41.

Fired Boilers and Furnaces and Workshops

These are they separated from the process and storage areas in accordance with good practice.

Hot Work

Life Critical Standards are in place to cover all aspects of maintenance work on site.

These are incorporated into the safe systems of work, including that applying to Permits to Work. The Permit to Work Procedure describes general permit arrangements on site and assigns associated duties. Permit Officers, i.e. work authorisers, are Managers and nominated Team Leaders. All Permit Officers and Permit Recipients receive training so that they are competent to use the system. In all cases, the Permit incorporates a Checklist to ensure the Life Critical Standards are being followed and adequate controls are in place. The job must be "walked and talked" by the Permit Officers and the Permit Recipients. For Hot Work, Line Breaking and Confined Space Entry, two Permit Officers are required so as to allow double-checking and signature for control measures. All persons working under a Permit are required to sign it.

Selection of Equipment

Fixed Equipment in a Hazardous Area

Equipment has been selected and installed on the basis of the zone requirements and is certified in accordance with ATEX Directive Regulations or to previous BASEFA and CENELEC certification where used equipment has been utilised. All equipment is rated EEx IIC T4.

Example of mechanical equipment present within a hazardous area is illustrated in Appendix 5.42 (Rotork Gearbox conformity declaration) and Appendix 5.43 (BV4 Smart conformity declaration)

Lightning

For the new area 1 No lightning protection has been installed - all the tanks will be earthed and have been designed with a minimum roof thickness of 5mm.

Earthing

Flexible Earths

Where it is necessary to use flexible earthing leads (such as tanker offloading point) a proprietary earth proving unit is installed. This unit is self-checking by design and will fail safe thereby halting / preventing the transfer of flammable materials to / from the tanker.

Additionally, there are a number of earth leads which can be used where necessary to provide temporary earths that are inspected prior to use with any defects immediately reported and the associated equipment is taken out of use.

Earth Systems

The site operates an earth protection system meeting the recommendations and requirements of the following guidance:

- ***Earthing Code of Practice BS7430:1991,***
- ***Static Protection BS5958:1991 and Equipotential Bonding,***
- ***18th Edition IEE Wiring Regulations.***

In hazardous areas the earthing arrangements in use comply with the recommendations made in BS5345. They are subject to routine inspection and examination under the hazardous area wiring examinations

Earthing on Piping

During the installation of new pipework for containing flammable materials earth continuity checks are undertaken. The site does not undertake routine re-testing of pipework systems as the nature of the pipework (being all metal, with metal face to face bolting) is such that there are no isolated sections where a charge could develop.

For the new area 1 bonding is used for all pipework containing flammables. This would dissipate any accumulated static charge. Liquid pumping speeds will not exceed 1m/s, and tanks will be filled by dip pipe rather than splash filling.

Radio Frequencies

There are no radio transmitters on or nearby the site that might affect control equipment, furthermore the use of hand held transmitters, such as short wave radio is not permitted within close proximity of vulnerable control equipment.

Only authorised radios are allowed into the process areas and are these intrinsically safe.

Ships berthed at the jetty turns their radar systems off once docked, which provides protection against radio transmission frequency ignition.

Mobile Telephone & Radios

The carrying and / or use of mobile telephones within the production areas is prohibited under the site rules.; The site uses Atex 2-way radios to carry out standard operations, these will also be available for use in the event of power failure and or a major accident. These radios are stored within the Emergency Control Room and are constantly on charge.

Inspection and Maintenance

Competent Electrical Technicians repair electrical equipment in hazardous areas under the direction of a Competent Person.

The condition of flameproof seals in motors is part of the inspection and test schedule performed by the Competent Person. External contractors who issue certificates of compliance complete the servicing of electric motors.

Maintaining Equipment Certification

The company maintains all installed equipment to its original standard. This is achieved either by in-house maintenance carried out by the Company’s own engineering and maintenance team or, in the case of specialist equipment that might require calibration, by a recognized service company or the manufacturer. The company’s maintenance system contains the original specification; therefore, if a calibration certificate was required originally it will be maintained throughout its working life.

This can be demonstrated by the by inclusion of the calibration certificate for a flammable gas detector in Appendix 5.38. The calibration of such devices is undertaken by the equipment supplier which the site has service contracts with. The contacts are such that they notify the site when their equipment is due for calibration. Any damage to these items is recorded on an incident form and they are removed from service and returned to the manufacture immediately for repair / recalibration.

In accordance with BS7671:2001 the site undertakes fixed wiring inspections. The Express Maintenance system issues inspections of electrical installations. The process of populating Express Maintenance with planned inspections is in progress.

5.2.2. Construction

5.2.2.1. Appropriate Standards of Construction

Mechanical

<u>Management of Construction</u>

The Company employs a Project Manager who is responsible for overseeing the design, construction and installation of new plant and machinery and can act as the CDM Principle Designer for work carried out under the Construction Design and Management Safety Regulations 2015 (CDM). The Company has access to global engineering experience any shortcomings of required skills can be outsourced. It is believed that by combining the inherent skills and knowledge of the site and companywide personnel with the contracted skills of external contractors, developments are designed and constructed to the highest standards based on internationally recognised codes.

All engineering contractors are selected by a process that involves the completion of a pre-tender document by the contractor followed by a review of the document by the nominated CDM Co-ordinator which normally comprises of the Project Manager, Designer and the EHSQ Manager. If considered appropriate an audit of the contractor will be undertaken prior to award of the contract.

The Project Manager is involved with the offsite design and construction by consulting engineers and ensures they are in compliance with recognised standards and meet the requirements of the Company. The Engineer oversees the installation ensuring it is in accordance with the design intent.

For smaller projects the Maintenance Manager and Supervisors, supplemented when necessary by engineers from other locations and external contractors, are used and the sites' personnel complete the risk assessments and, if considered necessary, the method statements. The risk assessments for these small projects are incorporated within the Permit to Work Procedure.

For the new Area 1 and the on-going site development project was **c**arried out fully in accordance with the provisions of the Construction (Design & Management) Regulations 2015, and documentation to meet these provisions has been drawn up. The project Scope and Requirements document includes the need to protect and work around ongoing site operations, and to remove five tanks located within the live operating plant and to transfer them to the demolition phase area for processing. The Scope and Requirements document includes decommissioning aspects of the project.

The Stolthaven management structure for the purposes of CDM compliance is presented in Figure 5.2.2.1.1 below, while the management structure in place for the ongoing projects is shown in figure 5.2.2.1.2.

Figure 5.2.2.1.1 – Stolthaven CDM Management Structure

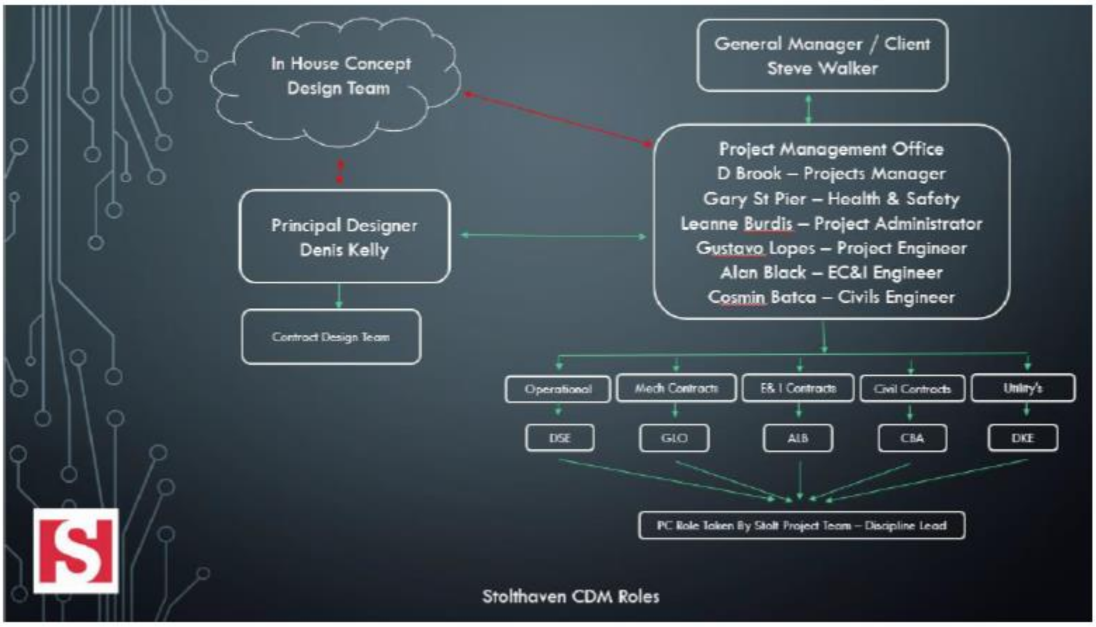
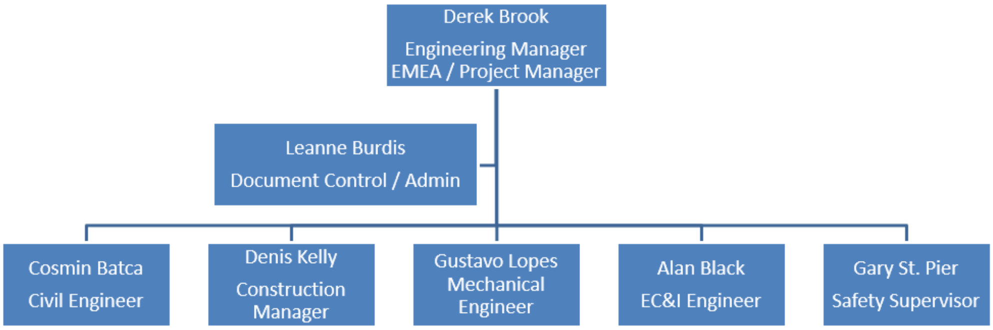


Figure 5.2.2.1.2 – Stolthaven Management Structure On-Going Projects

Project Team Structure and Organisation



<u>In-house Project Management</u>

Work Initiation

Engineering changes and capital projects are initiated through the Managing Change Procedure (See Section 5.2.5). Each new project is given a unique number and recorded on the project register. The work is prioritised by the Project Manager based on safety, health, environment, production or operational criteria.

Records and Drawings

A project file is established for each project to contain all information regarding the project. It will typically contain:

- Records of initial design meetings
- Project scope
- Design philosophy
- Engineering calculations
- Hazard Study records
- Risk assessments
- Installation records
- Test certificates
- Handover certificates
- Project report
- Equipment data sheets

Other documentation may be included in the project file as appropriate for the individual job.

New drawings are recorded in the Engineering Department drawing register. Drawings are generally retained in CAD format in order to facilitate updating for modifications. Modification control is exercised over all drawings in this system.

Where possible, drawings are obtained from equipment suppliers in a compatible CAD format again to facilitate updating for modifications. Otherwise drawings are obtained on paper and placed in the Engineering Department records.

Drawings awaiting updating are filed in Engineering Department records and updated at the earliest opportunity, depending on the priority.

Equipment Schedules & Design Details

The Maintenance Manager / Supervisor arranges for the new equipment to be allocated a unique asset number and recorded in the company Asset Register. An asset data sheet is also completed and placed in the Project File and engineering department files.

Project Management System

This is described in the Management of Capital Projects Procedure (see Appendix 5.44); this covers areas such as:

- Initiation of job request;
- Project authorisation;
- Scope of work;

- Project strategy;
- Modification Procedures;
- Design records;
- Quotations;
- Cost estimates;
- Risk assessments;
- Tender appraisals;
- Installation records;
- Test & handover certificates;
- Project report;
- Data sheets;
- Drawings.

Hazard & Risk Assessment

Hazard assessment is carried out during projects according to Risk Assessment Procedure. Hazards are assessed whenever:

- A significant change is proposed to a procedure or process;
- A new item of equipment is installed that results in a significant change to a procedure or process; or
- A new process is under consideration.
- Following an incident / accident

Furthermore, the requirement for a Hazard and Operability Study is assessed whenever:

- A modification is made to an existing process; or
- A minor modification is made to existing plant or equipment.

The Hazard and Operability Study uses a guideword approach and the outcomes of the study plus any actions are recorded on a standard sheet. Actions are assigned and recorded on standard HAZOP Action Forms.

The Hazard Study Process used by Stolthaven along with the associated risk assessment provides linkage between Hazard, Frequency, Consequences, Risk and Control Measures.

Risks would be identified during this process e.g. toxic, flammable and explosive and appropriate prevention, control and mitigation options considered.

Control of Design Standards & Legislative Compliance

For the installation of significant projects, the Company uses outside assistance from professional design contractors to undertake design, procurement and installation work for major projects.

The preferred contractor will generally have successfully undertaken a number of similar projects and a record of completing them within company and legislative requirements. It will be advantageous if there is a longstanding relationship between the parties; however, this is not a prerequisite and other companies meeting the required criteria for competence may be used.

The Company monitors the external contractor's performance closely, requiring the submission of reports at regular meetings on the projects progress. It is a condition of the project that all regulatory requirements are met and that industry best practice is maintained at all times. Compliance against appropriate standards is maintained by the contractor's quality system.

Quality Plan

Before a project commences with an external company, they would be required to provide a quality plan to enable Stolthaven to comply with the ISO 9001 standard. This will cover such items as:

- Scope of Works
- Responsibilities
- Identification and assessment of sub contract labour
- Identification and assessment of material and service suppliers
- Material specifications
- CDM regulation compliance
- Health, Safety and Environmental matters
- Procedures covering all aspects of the project including change control
- All the relevant information would be included in a Quality Plan document supplied by the contractor

Compliance with CDM Regulations

The Construction Design and Management Regulations 2015 are applied to all major Construction Projects. The construction of the new Area 1 project was undertaken under the Construction Design and Management Safety Regulations 2007

Appropriate Materials of Construction

Materials of construction are determined in the design stage based on the process conditions and fluid, gas or vapour characteristics. The materials are reviewed and approved by the Project Manager as part of the design verification process; existing site specifications are utilised or existing duties where appropriate. Where a new duty has been created or alternative materials are identified for an existing duty then new specifications are created as required. Any such change would be subject to the sites Managing Change Procedure (see Section 5.2.5). Where necessary reference sources such as corrosion charts, manufacturers' information, suppliers' product stewardship manuals, engineering textbooks and Internet web sites are used. For chemicals or mixtures where no information is available laboratory and plant coupon testing would be undertaken using test specimens (including welds and heat affect zones) where deemed necessary. Such tests are conducted for a range of concentrations and temperatures.

Construction Codes and Standards

For projects which fall under the CDM Regulations, the Principal Contractor is responsible for ensuring the equipment or modification is constructed in accordance with the agreed design intent and the appropriate codes and standards.

The design codes currently used are can be found in Section 5.2.1 of the COMAH Safety Report. The list is not exclusive but is used to demonstrate that equipment is designed and constructed to recognised national standards.

For smaller projects the Maintenance Manager / Supervisor is responsible for ensuring the equipment or modification is constructed in accordance with the agreed design intent and the appropriate codes and standards. This is achieved through the application of key engineering procedures that ensures adequate safety and reliability during construction including for example:

Compliance with Pressure Systems Regulations

The procedure for Compliance with the Pressure Systems Regulations ensures that the requirements of the regulations are met by nominating the Maintenance Manager / Supervisor as the responsible person. The competent person for pressure systems is provided by company approved insurers and determines the inspection schedule and method.

Inspection and Testing of Plant and Equipment

Arrangements for the Inspection and Testing of Plant and equipment is contained in the Maintenance Department procedures and Work Instructions and ensures that all plant and equipment is tested and inspected according to the appropriate design codes, standards and regulations. The responsibility for ensuring that all equipment is appropriately inspected tested and records maintained is with the Maintenance Department.

Pressure Testing of Pipework and Equipment

As part of the installation of new and reinstatement of pipe-work systems following modification, pressure testing of pipe-work and equipment is undertaken. This is normally achieved by undertaking either pneumatic or hydraulic pressure tests prior to the handover of plant to operations. Such testing would be in accordance with ASME B31.3 and GS4, the HSE guidance note *Safety in Pressure Testing*. An example pressure test for the Road Loading Pipework is presented within Appendix 5.45 and a pressure test for an individual spool is presented in Appendix 5.46.

Portable Appliance Electrical Equipment coming onto Site

The checking of Portable Appliance Electrical Equipment coming onto site ensures that all equipment is inspected and tested by a competent person prior to the equipment being taken into operational areas. The site's Maintenance Manager / Supervisor is responsible for ensuring the procedure is followed and that only competent electricians carry out the testing. The procedure only allows authorised equipment onto site: a permit to work is required before any contractor equipment can be used on site and the user must carry out a visual check of the equipment prior to use.

Static Earthing of Process Equipment and Pipework

Static Earthing of Process Equipment and pipework ensures that the responsible project engineer complies with BS5958 *Control of Undesirable Static Electricity.*

Instrument Calibration Procedure

Instruments on the Calibration List are calibrated on installation and at an appropriate frequency based upon the duty and style of instrument. It is the responsibility of the Maintenance Manager / Supervisor to ensure that instruments are calibrated in accordance with the requirements and records are kept of all calibrations.

Pre-commissioning Equipment

Under the Managing Change process, it is the responsibility of responsible engineer to ensure that equipment pre-commissioning is carried out to the manufacturer's recommendations. The responsible engineer ensures that the appropriate mechanical, instrument and electrical checks are undertaken and recorded on the pre-commissioning records.

Handover of Plant

Under the Managing Change procedure, the handover of plant to operations is completed in such a way to ensure that all the appropriate checks have been carried out and that the plant is safe for use. The project leader is responsible for the generation of a handover certificate and for the instrument handover certificate as applicable.

Controlling and Recording Changes to Design

On large projects the Managing Contractor, in consultation with a Stolthaven Company representative, is responsible for controlling all changes to the original design and for producing the as built drawings. The Competent Person approves deviations from the original design of pressure containing equipment.

All contractors supplying a service or materials are expected to provide documentation to prove that the materials or service provided are as per the specification. These might be data books in the case of a vessel, a certificate of conformance for an instrument or a test and inspection certificate for an electrical cable, etc.

5.2.2.2. Assessment and Verification of Standards

Mechanical

Engineering work on pipelines and the installation of new pipelines are completed to appropriate welding codes and are radiographically inspected. As part of the site's ongoing Mechanical Integrity Programme all pipelines are inspected regularly and also hydraulically tested, as required. The tests are witnessed by a competent 3rd party (see Appendix 5.45 and 5.46 for copies of recent pipework testing certificates). The pipework specifications and design codes used by site are illustrated in Appendix 5.4.

New storage tanks are hydrostatically tested. During commissioning the storage tank's capacity is calculated against liquids with a specific gravity of 1.0. Where chemicals of a different density are to be stored, the storage volume of the tank is adjusted. For those tanks which are currently not equipped with any level instrumentation, the manual dipping procedure and record logs are adjusted to accommodate the change in density.

A process for the identification of applicable legislation, codes and standards have been developed including a dedicated procedure. Also, the site has subscribed to a external legislative update service (and other relevant industry bodies) that ensure the site is abreast with relevant applicable changes.

Prior to any construction contract being issued, the contractor is vetted to ensure the quality of the work he has done in the past is satisfactory. Generally this is not an issue as the same contractors are regularly on the site and the Company is familiar with their practices and procedures. With respect to a new contractor, his previous work at a local plant would be evaluated through asking their personnel how the contractor had performed.

It is anticipated future significant projects would be "turnkey" – design and build by a Management Contractor. They provide the professional management of the project and ensure that the project is constructed to suitable design standards. They may sub-contract the civil and structural work but that does not absolve them from responsibility to ensure the construction is "fit for the purpose", as exemplified by storage Area 6 construction.

The site influences the choice of sub-contractor and encourages the use of local contractors who have worked at the site for piping, electrical and instrumentation installations.

Whenever contractors are used they are chosen because of their expertise related to the task in question. This can be demonstrated by considering the following:

1. Contractors are required to pre-qualify before being allowed to work at the site.
2. Pre-construction information is issued
3. Prior to working on site, contractors are informed during the site induction about:
    - Hazards to which they or their employees may be exposed;
    - Appropriate precautionary measures;
    - Site safety, health and environmental procedures, including emergency procedures.
4. Prior to beginning work on site, contractors agree to:
    - Abide by the site rules as informed during the induction;
    - Comply with legislation and internal health, safety and environmental requirements;
    - Use equipment that meets recognised industry safety standards;
    - Provide authorised site representatives access to their work area(s).

Standards of Workmanship

The Standard of workmanship is assessed by the site Maintenance Manager / Supervisor and Main Contractor (where appropriate).

Confirmation of Design Intent

The Maintenance Manager / Supervisor approves the initial design. When deviations are required or occur they are fed back to the Maintenance Manager / Supervisor / Project Team for approval or to agree a corrective action. This process, if appropriate, would involve the Competent Person.

For large projects the Main Contractor and the site Project Manager / are formally responsible to issue a confirmation that all work has been completed to the design intent before final handover, this involves checking:

- The materials of construction are verified by examining the certificate of conformance.
- Weld procedures and welders are approved to the Code, such as ASME IX, by a reputable testing facility such as Lloyds Registry and, as required.
- Where work is subject to NDT, the NDT is performed by a specialist company and the Technicians who perform the work are qualified to ASNT Level II, CSWIP or equivalent. The Competent Person is required to confirm that all pressure bearing equipment meets code requirement through visual inspection, approving NDT results and witnessing pressure tests
- The equipment is pressure tested; this is witnessed and approved by a Company representative and the Competent Person, where required.
- Leak testing is routinely undertaken whenever joints have been broken. In the case of construction, additional leak testing is done to prove the joints when spades and blinds are removed after testing.
- The electrical systems are inspected and certified in accordance with the all applicable current regulations
- All safety equipment including relief valves, isolations valves, etc., are supplied with manufacturer’s test certificates or fully tested on site prior to handover.
- Racking is constructed and repaired in accordance with the Storage Equipment Manufacturers Association (SEMA) Codes of Practice.

Throughout the construction phase, interim defect lists are prepared and actioned. Deviation from the design requirement is communicated in writing to the Project Manager, who then seeks approval from the project team.

Quality Assurance

For major new plants or major changes to the plants on site, a commissioning checklist would be written but as stated previously this information is not necessarily available. The Safety Plans from construction projects are held with the equipment Data Books and Engineering Drawings are held on site. However, the documentation for some of the older equipment is lacking due to poor storage practices and age; some equipment is over 50 years old.

Commissioning

Under the Managing Change Procedure (see Section 5.2.5), the Company appoints a Commissioning Leader as required. Their initial task will to undertake a pre-commissioning review.

Once installed all piping and connected equipment is washed out and pressure tested to prove the system. On large projects this would generally done by the installation company, assisted when practicable by site personnel, and they provide test results. On small projects and minor changes, the site will complete the piping washout, pressure testing and instrument commissioning. The results of tests are generally kept but records of start-up checks and washouts are not kept.

Instrument and electrical installations are tested once they have been installed to ensure electrical continuity. Instruments can also be calibrated at this time and signals injected to check out level alarm settings. A site operator will normally be involved with this process. The Competent Person verifies all pressure tests and other pre-commissioning checks at this time.

In terms of commissioning, a typical sequence of events would be:

- Members of the operators and maintenance teams walk the lines and check that the Process and Instrument Diagrams (P&IDs) have been adhered to.

- The Maintenance Manager / Supervisor undertakes an on-site review and prepares a detailed defect list of items that need remedial action; this will include items identified during the operators' line walk. This is then discussed with the Main Contractor and actions are agreed. Wherever possible, corrective actions are taken straight away; however, issues relating to the inherent design will be deferred and formally reviewed.

- The Maintenance Manager / Supervisor will then review all test documentation as part of the hand over process to ensure that all pre-start up work has been completed and that competent personnel have witnessed the tests.

- During this process the Maintenance Manager / Supervisor will draft a commissioning programme including start-up checklists for each process. This programme is then formally agreed with the Main Contractor and operations teams.

Concurrent with the above the Operations Manager will ensure that the necessary Plant Operating Procedures and Work Instructions are developed.

Once the plant was ready to start, the commissioning process would begin. The process will include:

- Washing out of lines to remove any construction debris / contaminants;

- Pressure testing of lines and equipment; instrument checking and electrical rotation checks;

- Water runs to ensure liquid can be pumped and systems work. Where water cannot be used, other assurance techniques are developed;
- Chemicals inventoried to the tanks;
- Based on the start-up experiences the Operating Procedures and Work Instructions are updated.
- Operator training.

Project Hand-Over

Project hand-over is agreed between the Project Manager and the Operations Manager. The following documents are included in the hand-over package:

- HAZOP Action Status;
- Construction Hazard Study Status;
- Pre-Commissioning Hazard Study Status;
- Miscellaneous Test Reports (e.g. pressure testing, loop test schedules, etc);
- Project Hand-over Certificate as appropriate.

Documentation and Storage

- The CDM Principle Designer is responsible for the collation all relevant information and it inclusion within the Health and Safety File. The file and as-built drawings are held in the Company's Archives.
- The commissioning checklist would be written but, as stated previously, this information is not necessarily available.

EC&I

When equipment is installed within hazardous areas, a verification check is performed to ensure that the equipment selection is suitable for the specific zone and product type. This is performed prior to commissioning and involves an engineering review of documents and in the field initial inspections to BS EN 60079-17 (detailed). This check is recorded and retained by the Maintenance department.

5.2.3. Operation

5.2.3.1. Established Safe Operating Procedures

Mechanical

An experienced and competent workforce operates the facilities.

The site has 24/7 supervision in place with 5 supervisors rotating a 12-hour shift pattern. 6 chargehands and 21 operators carry out site duties including covering shifts at a weekend on an overtime basis when required. The site maintenance team consisting of 3 mechanical fitters 2 electricians 2 supervisors and storeman generally work daytime with a call out process in place for emergency breakdowns or emergency conditions. The minimum workforce on a night shift is 1 supervisor, 1 chargehand and 4 operators.

The managers and shift supervisors have many years' experience in the day-to-day operation of bulk liquid chemical storage and transfer facilities.

Production operators are experienced and have demonstrated competence during on the job training. They are guided by Operating Instructions that address aspects of the plant operation and fully integrate safety, health and environmental issues into the process. There are weaknesses and some tasks do not have detailed procedures, they have been identified and will be improved, through the close-out of actions identified in the Human Factors Risk Assessment and this COMAH report, as well as ongoing improvements identified by operations staff. Human reliability assessments have been conducted of all major tasks with Safety Critical Task Analysis conducted as a further means of identifying potential human failures.

Training

All training is carried out based on the instructions that are written in departmental and site procedures and work instructions.

New Operational staff undergo a competency-based training programme over a period of several weeks as directed by the Operations Manager. Before being deemed fully competent to operate on the plant, an assessment is conducted to establish that the operator has the necessary skills and knowledge to operate safely.

Refresher training is carried out periodically when changes occur or when incidents or trends in behaviour indicate this is necessary.

The site has Lone Worker procedures to ensure work operations of a hazardous nature are not carried out without adequate controls in place. Intrinsically safe Radios are in place on site to maintain contact where this is appropriate.

In line with First Aid at Work Regulations, First Aid cover has been assessed as being required during all times when operational activities are being undertaken.

Workloads and scheduling are arranged to minimise any effect of fatigue. Trained staff are able to cover all required operational team duties. Work is generally varied to minimise the effects of boredom.

Development of Procedures

The tasks which require a procedure is determined by department heads following an assessment of the risk associated with the relevant task. The Manufacturing Methods and Work Instructions for the Tank Farm Area, Warehouse and Laboratory have been developed through experience and controlled trials. This includes:

- Initial Plant Design;
- Plant or Process Commissioning;
- Experience of other similar Processes;
- Plant Operation Experience;
- Investigation of Incidents;
- Relevant Chemistry;
- Plant Audits;
- HAZOPs;
- Risk Assessments; and
- What If Studies.

The procedures address start-up, normal and abnormal operations, shutdown and emergency shutdown issues. The Operations Manager is responsible for the management of a training programme for all the Shift Team Leaders and Operations Team Members.

They are developed in consultation with the operational personnel and procedures for all the operations normally undertaken on the plant are available. The procedures incorporate the operating parameters for the plant, including flows, temperatures, pressures, test methods etc. These are normally expressed as a range of values within which it is safe to operate.

Review and Amendment of Operating Procedures

The Instructions are evergreen and are routinely updated as knowledge and experience is gained to ensure a comprehensive set of instructions is always available. The improvements may be process improvement from identified best practice proposals made by Operators following operational experience; safety improvements following accidents / incidents; risk assessments, HAZOPs; or COSHH assessments. There is a process for drivers to suggest improvements to loading facilities. Critical safety data is included in the Operating Instructions.

Other safety data is available through referenced links in the Operating Instructions (for example risk assessments).

There are no formal review frequencies for Operating Instructions, as it is a continuous process; also, transfer procedures are developed each time a material is to be stored or transferred. This may, however, change as the site progress toward improvement. Operating Instructions are living documents and are reviewed constantly to ensure that the process is run as safely as possible. Operators are encouraged to review the Instructions to confirm the procedures are accurate and reflect the current mode of operation.

New or amended procedures are distributed according to the distribution lists and controls in the ISO 9001 Quality system that requires receipt signatures and the destruction of the previous revision. Procedures and Work Instructions have clear revision status numbers and are signed documents by approved personnel.

Any new or changed Procedure or Work Instruction ready for issue is assessed as to the degree of training that is required. If the change is significant a training programme will be developed, and an individual training record generated, if the change is minor it is acceptable that the document is signed for as read and understood by the recipients expected to use them.

Procedures and Work Instructions are living documents and as such are reviewed constantly to ensure that the process is carried out as safely as possible. A review of any Procedure or Work Instruction may be prompted by one or all of the following:

- Feedback from the training process;
- Process improvement from laboratory experiments;
- Proposals made by operators following operational experience;
- Safety improvements following accidents/incidents;
- Risk assessments or HAZOPs;
- COSHH assessments;
- Any change (as defined by the Managing Change Procedure);
- Customer requirements;
- Near miss reports

Efficacy of procedures and their compliance with Stolthaven and international standards are assessed by auditing. The audit process involves the examination of records and documentation together with physical inspection to obtain evidence. Additional internal audits may also be carried out by the company as required; these may be in the form of safety inspections.

For operational areas, the Operations Manager is the focal point for all audits. The Operations Manager will assess audit findings and arrange for work to be carried out to comply with any actions.

Proposed amendments are fed from all these sources to the Operations Manager or Departmental Manager, who considers the merits of each and progresses those that are felt to have a positive benefit. Any change identified which involves changes to the operating parameter envelope laid down in the procedures or to the plant equipment requires the use of the Managing Change Procedure.

Specific special written instructions are issued when appropriate, to deal with minor variations within the operating parameters described in the main procedures, and these are authorised and dated by the Operations Manager.

These specific instructions typically deal with issues relating to scheduling but can also be used to give instruction in which procedures are to be followed in, say, a start-up or shutdown situation, or whether a non-routine Method Statement is being used.

Temporary Constraints / Abnormal Operations

Protective devices and interlocks cannot be overridden by Operational staff and if this is necessary it must be done through a permit to work that can only be authorised and signed by the Operations Manager **and** the SHEQ Manager

All plant operations must be carried out according to the procedures contained in the Manufacturing Methods and Work Instructions. If a task or operation is identified which does not have a laid down procedure, it is automatically classed as a non-routine job, and requires formal assessment and written instruction and approval by the Operations Manager and the SHEQ Manager.

Electrical Maintenance Procedures

The site operates procedures to govern safe Isolation and energisation of electrical equipment (DAG-ENG-ELEC-005) and Electrical Authorisation (DAG-ENG-ELEC-002). These documents have been developed in line with the site QMS and to the requirement of the Electricity at Work regulations.

All electrical works on site are controlled by the sites PTW system that mandates adequate planning, supervision and the conduct of works only by competent personnel.

Communications

Safety critical communication is facilitated through various mediums (2-way radio are available, job briefings are co-ordinated, personnel are afforded the opportunity to ask questions, clarify doubts and safety critical instruction are documented in risk assessments and method statements.

The system transmitter is located in a secure server room and is supplied power via a dedicated un-interruptible power supply (UPS). The UPS is designed to maintain system power for upto

5 hours in the event of total power loss (Black site) to the site. Furthermore, the radios are programmed to communicate directly (back to back comms) via channel 16 in the event of a transmitter failure.

For emergency situations a mobile phone is kept charged in the security gatehouse, programmed with key contact numbers. Several Atex 2-way radios are kept charged in the control room, It is normal for the majority of operational staff to carry 2-way radios as part of their day to day activities, therefore the ability to contact operational staff in the event of an emergency would be easily achieved.

Key activities which require communication include those associated with the Permit to Work System. As part of supervisors shift handover a section of the document is dedicated to permits and there status. A pictorial view of the site is adjacent to the control room, PTW tasks are identified on the map to consider the conflict of works. Site personnel employment contract stipulates the needs to resume work in time to allow an overlap between shifts to facilitate a handover including communicating key information regarding high risk activities. Where contractors are involved, communication of hazards and risks is provided through Pre-construction information prior to attending site to carry out works. The relevant details from the PCI is expected to be used in developing a safe system of work as documented in the RAMS. All contractor to site receives a site induction and are issued a safety information booklet that conveys key safety information including what to do in an emergency, site rules, reporting incidents and stopping unsafe conditions / behaviour.

Changes to procedure is controlled under the requirements of site QMS and relevant details are communicated to relevant users of the procedure both verbally and via email. Also, key documents are controlled including archiving obsolete document to ensure it can’t be referred to accidently.

5.2.4. Maintenance

5.2.4.1. Maintenance Scheme

Mechanical / EC&I

The site has reviewed and improved its maintenance strategy including identifying safety critical equipment, a risk-based approach to preventative maintenance etc. The site has also rolled out a computerised maintenance management system (Express Maintenance) which is used to prioritise, coordinate and develop work plans. This system is currently being reviewed to ensure that all key assets are present within the system. The system not only identifies each asset uniquely but also groups the assets together such that all valves and in-line items are associated with a major plant item such as a bulk storage tank (see Appendix 5.47 for detail of the Express Maintenance Asset Register structure and content).

All plant items are also shown on up-to-date plant P&IDs, with every item having a unique number.

A maintenance programme is in existence, based on manufacturers' recommendations and operating experience. Simple maintenance regimes are carried out by site personnel; more complex activities requiring specialised skills or tools are carried out by contracted maintenance organisations. The maintenance programme is a request driven process continually reviewed by weekly management meetings. Due to the mode of operation and the availability of spares for critical equipment it is effective. The site's personnel who maintain equipment work within their levels of competence. Competence is determined by virtue of education or experience or combination thereof. A process is in place to call out maintenance personnel, in the event of equipment breakdown.

Competent persons appointed by the site's insurance underwriter carry out statutory inspections on pressure systems and hazardous area electrical schemes. Non-statutory inspections of equipment, plant items and piping are carried out by contractors appointed by the site on an as needed basis.

All contractors used for maintenance and engineering work on site are required to produce method statements and risk assessments detailing the tasks they are due to undertake before any work commences. Procedures prevent the issue of purchase order numbers to the contractors without the submission of risk assessments and method statements. This procedural step ensures that all contractors:

- Familiarise themselves with the site, and the work to be undertaken;
- Identify the hazards of the site;
- Identify the hazards associated with their tasks;
- Ensure that all reasonable steps are taken to prevent the risks from identified hazards;
- Prepare suitable method statements, and ways of working; and
- Decide whether existing precautions are adequate or more should be done.

The site has a complete Asset Register, within which all new equipment and pipework will be included. Maintenance regimes will be developed from this Register; these will include a list of inspections for critical equipment. The total number of Assets is being reduced. Relevant details associated with key assets are held within the site computerised maintenance management system (Express Maintenance). This system includes maintenance management functionality including work order management and prioritisation (based on criticality).

Existing maintenance procedures for ROSOVs and PVRVs will be reviewed to ensure new equipment is included.

Tanks being refurbished and returned to service as part of the ongoing development are subject to inspection.

Examples of inspection histories for existing tanks, including a hydrostatic test certificate, an ultrasonic thickness survey report, and a Magnetic Particle Analysis report, are also shown at Appendix 5.48. These cover two tanks (T18 and T813) to be returned to service, and one (T406) to be taken out of service due to corrosion.

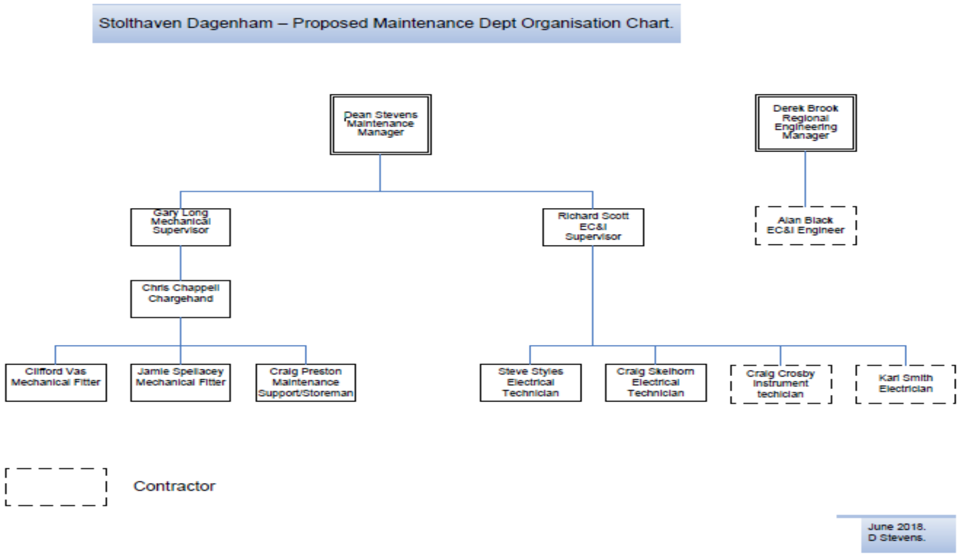
Maintenance Procedures

Equipment maintenance is generally based on manufacturers recommendations, good industry practice and operating experience.

Personnel

The Maintenance Department comprises of a Maintenance Manager, Mechanical Maintenance Supervisor (copy of Job description may be found in Appendix 4.3), Electrical Maintenance Supervisor a Mechanical Chargehand, 2 time served mechanical fitters, 2 time served CompEx Electricians and a storeman. Where necessary, competent contractors are used to carry out maintenance and construction requirements on site. The structure of the maintenance department is presented in figure 5.2.4.1 below.

Figure 5.2.4.1 – Maintenance Structure



Maintenance Manager / Supervisor

Responsibility for preserving plant integrity in compliance with site policy is the responsibility the Maintenance Manager with functional guidance and assistance from specialists. The responsibilities of the Maintenance Manager include:

- Provision of specialist support and advice to the Site Management on engineering matters at all stages of the Company's operations so as to mitigate against a major accident.
- Implementation and control of standards used in the construction, inspection, operation and maintenance of plant and equipment to maintain the appropriate level of integrity.
- Liaison with statutory, industry and academic bodies on matters relating to construction, inspection, operation and maintenance of chemical manufacturing facilities.

- Responsible for the installation of new plant, and changes to existing plant and equipment, to appropriate standards within the Managing Change system.

The individuals reporting to the Maintenance Manager have the following within their responsibilities:

Maintenance Chargehand / Fitters

For maintenance work there are two 3 technicians and a storeman, all four reporting to the Maintenance Manager. The 3 technicians are responsible for the maintenance and inspection of the plant and equipment in line with statutory requirements and Company policies, standards and procedures.

Where necessary approved contractors are used in times of high workload, to cover holidays and other absences or when specialist skills are required.

Maintenance Electricians

There are 2 CompEx trained EC&I technicians both reporting to the Maintenance Manager, they are responsible for the maintenance and inspection of safety critical EC&I assets.

They support specialist third parties engaged to design / specify EC&I systems.

Work Prioritisation, Scheduling and Implementation

Planned Maintenance

The Company operates a documented maintenance management system to control all engineering work on site. The companies Express Maintenance system controls the scheduled (planned) and reactive (un-planned) maintenance, with a limited amount of work history held in the Express Maintenance system. Technical detail, maintenance manuals, certificates, P&IDs and electrical schematics and extended work histories are held in the documented maintenance management system.

This includes all planned and unplanned engineering work, statutory and non-statutory inspections safeguard checks, environment checks. The system uses the following methodology:

- Routine preventative maintenance activities are scheduled and carried out to pre-set work plans by competent engineers. Scheduling is carried out by the relevant competent person, in consultation with the Site Services and / or Operations Manager, and is based on criticality to safe operation, industry standards and local experience. Feedback from the crafts teams carrying out the work is recorded and is used to optimise the scheduling. Compliance with the Preventative Maintenance schedule is monitored
- Inspection and Test requirements are determined by the relevant competent person according to statutory regulations, design data / hazard study output, industry best practise or previously achieved performance. A schedule of Inspection and Testing is

drawn up to meet requirements by the relevant Competent Person. This work is then carried out by appropriate competent craftsmen and engineers. At each stage, the relevant competent person may be a site employee or third party contractor. This includes statutory equipment, safeguarding checks on instrument work, electrical continuity checks, etc.

Unplanned Maintenance

All unplanned (breakdown) maintenance is control by the site FD28-01 Maintenance Request Form (a copy of which can be found in Appendix 5.49). Maintenance requests made are reviewed by the site Maintenance Supervisor and priorities set. The Competent Person maintains a monitoring programme for pressure systems and electrical installations and notifies the site in a timely manner when equipment is due for inspection. As and when necessary the Maintenance Manager / Supervisor schedules the equipment for inspection before the due date.

The basic maintenance philosophy is that equipment will be maintained fit for purpose in compliance with Regulations and good engineering and operating practices. Items of plant equipment and control systems whose failure would cause an unacceptable risk to the environment, health or safety, are identified at the design stage. These items are registered in the company’s Express Maintenance System and are subject to defined programmes of inspection, testing and rectification throughout their life to ensure that they remain fit for purpose. The inspection and maintenance regime is reviewed annually.

Maintenance of critical equipment on site (fire water pumps, fire water main valves, boilers, compressors, relief valves on tanks, fork lift trucks, etc.), is also controlled by Express maintenance.

Organisation of Maintenance Activities

Good practices have been developed to ensure maintenance work is carried out in a safe and constructive manner. All maintenance work is generated through a work order request scheme, (using the FD28-01 form) and these can be submitted by anyone at the site. The work orders are prioritised and authorised by the site Maintenance Supervisor. There is no written priority system that determines the priority of the work; the Maintenance Supervisor (supported by the Operations and site SHEQ Manager) uses their experience and judgement to determine when the work is to be done. The decision is based on safety, health, environmental considerations as well as operating expediency. Due to the mode of operation the work scheduling is simple. Where possible maintenance is done during:

- The next period the plant or equipment is out of service; or
- The day of issue or as soon as possible thereafter, call out of maintenance support is possible out of hours.

Work packs are generated for Maintenance tasks including work request, MSDS, COSHH, test results etc. Records are kept of all maintenance work completed on plant and equipment and stored electronically.

Maintenance of Critical Equipment

Equipment addressed by legislation such as lifting equipment, electrical equipment, pressure systems and safety equipment has been identified and is inspected and maintained in accordance with the regulations and good industry practice. Equipment failure that could lead to a Major Accident is considered to be safety critical. This includes the containment systems such as the storage tanks (including the pressure vacuum valves or free vent), pipework, secondary containment systems such as the bund walls and emergency equipment such as the fire water pumps and back-up generator. Stolthavens approach to defining Safety Critical Items of equipment is presented in Appendix 5.50.

Service Contracts

The site has a number of service contracts in place covering critical equipment, these are;

Steam Boilers	→	Flare
Air Compressors	→	CPC
Relief Valves	→	Assentech
Electrical Inspections	→	Sneath
Jetty Cranes	→	Ernest Doe

Pressure Relief Devices

All relief devices are designed, acquired, installed and maintained so that they will adequately protect equipment against over pressure and vacuum. Proposed changes to a relief system are subject to the Managing Change Procedure (see Section 5.2.5).

Relief valves are inspected in-line with the site’s Written Schemes.

Boiler Pressure Safety Valves are tested in situ and witnessed by the Competent Person.

Inspection records are held in the site’s documented maintenance system as part of the pressure systems records; the site owner is the Maintenance Manager

Internal Corrosion

The initial design of the bulk storage tanks, piping, and other installations takes into consideration the most likely duty they will be used on. The choice of material for the equipment at the site is based on the many years of operational experience. 316L stainless steel is the material used for all process lines and vessels due to its low carbon content and increased corrosion resistance. Service lines are constructed in either mild steel or where appropriate galvanized mild steel again due to its corrosion resistance; steam lines are constructed from mild steel pipe to API 5L grade B.

Pressure vessels, boilers, air and steam receivers are, however, routinely inspected by the Competent Person.

Control and Instrumentation Systems

All level, temperature and pressure loops are calibrated routinely on either a 6 monthly or 12 monthly schedules. A service agreement is in place with a contract company to calibrate and a service all site level measuring equipment.

Any IS loops are checked for electrical integrity on a 3-year scheme as part of the site's hazardous area electrical inspections; the work is scheduled through the Express Maintenance system. The work is undertaken by an external contractor certified for this work. This includes testing the integrity of the enclosures, shielding and the integrity of the flame paths on all motors in accordance with BSEN 60079:2003 PART17. The specific requirements are documented with Stolthaven procedure (DAG-ENG-EMS-009) and the results are maintained in the site hazardous area manuals.

Earth and Lightning Protection Systems

The site no longer has a lightning conductor system.

The plant is provided with an earth protection system that meets the recommendations and requirements of Earthing Code of Practice BS7430:1991, Static Protection BS5958:1991 and Equipotential Bonding, 16th Edition IEE Wiring Regulations. New installations are in accordance with the 18th Edition of these regulation.

Where it is necessary to use flexible earthing leads, these are inspected prior to use by the operators and any defects are immediately reported and the associated equipment is taken out of use until a certified and tested repair has been made.

During the installation on new pipework containing flammable materials, earth continuity checks are undertaken. The site does not undertake routine re-testing of pipework systems as the nature of the pipework (being all metal, with metal face to face bolting) is such that there are no isolated sections where a charge could develop.

All records are maintained by the site Maintenance Manager, and an example of maintenance and testing is presented in Appendix 5.51.

Registered Machines and Equipment

Lifting Beams and lifting tackle are registered and inspected by the Competent Person.

Fork Lift Trucks

The FLTs are checked before use by the operator and are on a 3 monthly maintenance schedule by the leaser. They are also routinely inspected by the Competent Person every 6 months as part of the lifting tackle inspections.

Scaffolding

Fixed towers are installed and inspected by an approved contractor. The site operates the ‘Scaftag’ system under which scaffolding is inspected every seven days by a competent person from the scaffolding contractor.

Flexible Hoses

Stolthaven recognises vulnerability and the major accident risk associated with the use of flexible hoses, as such robust procedures (see DAG-EMS-MECH-011 in Appendix 5.52) have been put in place to ensure associated risk assessments are carried out. The site where possible have replaced flexible hoses with rigid pipework, and the remaining hoses are subjected to annual testing / inspection by a competent third party / specialist contractor. An example is the MOC to remove flexible hoses used in the transfer of diesel to Area 6 and install rigid pipelines. Single hoses are used where possible to minimize flanges. A robust process is in place for ordering hoses, a detailed design, separate risk assessment for each hose is completed and hoses procured to meet product specification and the installation location.

Firewater Pumps

Items of plant that are safety critical such as the fire water pumps are maintained by their original manufacturer, Hayward Tyler and Nuform provide service of the newly installed firefighting system, weekly checks are conducted on all fire pumps.

Inspection and Calibration of Relief Valves

All relief devices are designed, acquired, installed and maintained so that they will adequately protect equipment against over pressure and vacuum. Relief valves are inspected and tested annually.

A competent service company who inspect, maintain, calibrate and test the equipment services them off-site.

Boiler PSV’s are tested in situ and witnessed, on load, by the Competent Person. All records of the inspection are documented and stored on site.

Monitoring Corrosion

Stolthaven has instigated a storage tank inspection programme through an independent specialist contractor. The tank inspection programme is in place in accordance with EEMUA 159 guidelines

The latest technology is utilized including thickness testing of the floor, wall and roof plates using magnetic flux leakage (MFL) and ultrasonic testing.

Insulated tanks are now included in the inspection programme.

The programme (for insulated and uninsulated) testing has been agreed and is based on a risk factors such as age and capacity of the storage tank and the Hazard phrases (H400, H411, H225, etc.) associated with the product stored.

Maintenance of Utility Systems

The philosophy of maintaining the utility systems is similar to that employed for maintaining the facilities, i.e., work orders are raised for identified problems and statutory inspections completed on a scheduled basis. Specific utility generating equipment such as the nitrogen evaporators that is provided on contract hire or lease the responsible leasing company maintains agreements.

Installed Spares or Stock

Installed spares are kept to a minimum taking into consideration safety and production requirements and operating experience, this is an ongoing process

Stolthaven recognise the importance of maintaining spare / stock integrity as such have put in place relevant procedures that assures optimum condition of the stored components. Regular inspections and audits of the maintenance warehouse is carried out.

A stock of everyday consumable items such as bolts and flange gaskets which are used by operations department is held on site. As most items of plant are repaired or serviced via external contractors, spares for equipment such as pumps are generally not held on site but are brought in as required.

Critical parts of equipment were identified when the equipment was purchased, and appropriate spares purchased, and a maintenance schedule set up. The maintenance schedules and spares have been rationalised through years of operating experiences.

The basic operations on site are segregated therefore a loading pump breaking down on a tank does not have any impact on the rest of the site operation. In an example such as this, an air driven mobile pump would be temporarily utilized until the loading pump had undergone repair.

The Maintenance Supervisor is responsible for spaces stock control.

There is a pre-qualified list of suppliers of spares and services so that if an unforeseen failure occurs, downtime is minimised by not having to tender for bids. This list includes suppliers of cranes, generators, scaffolding etc.

The limited use of 'Installed Spares' also improves availability.

Instrumented Protective Systems – Trips and Alarms

Instruments are generally sent off site to be maintained, there are no facilities on site to carry out instrument repairs.

Electrical Systems in Hazardous Environment

All plant areas have been subject to a Hazardous Area Classification Study and the various locations designated as, Zone 1, Zone 2 or non-hazardous. A plan of the site identifying the Hazardous Areas is available - see Appendices 5.11, 5.12 and 5.13. This information allows work in these areas to be assessed and planned.

All electrical equipment is selected with protection appropriate to the area classification of the location where it is installed. New equipment complies with Code IEC 79. All installed cables, switchgear, starters and all electrical equipment used in hazardous areas are checked and inspected by competent people, who are CompEx trained. An example certificate of competence is presented in Appendix 5.39.

Results of inspections are recorded on hardcopy and are reviewed, as appropriate, by the site management and inspection frequencies determined based on results. Minor faults found during this inspection are, where possible, repaired immediately. Where immediate repair is not possible the equipment is made safe or shut down. Significant defects / major remedial work required is logged within the express maintenance CMMS and managed accordingly. An example detailed inspection record is presented in Appendix 5.40.

Safety during Maintenance

Compromising Relief Systems

Safety is maintained during maintenance work by the use of the site's permit to work system and isolation procedures. Should it be necessary to remove, isolate or otherwise impair a relief system then the asset being protected will be taken out of service until such time that the relief device is re-commissioned.

Overriding Safety Systems

Safety is maintained during maintenance work by the use of the site's permit to work system and isolation procedures. Should it be necessary to override or otherwise impair a safety system then the asset being protected will be taken out of service until such time that the safety system in question is re-commissioned or a safety override request is submitted and signed off by senior management if additional layers of protection are mitigating the risk.

Systems of Work

The Permit to Work procedure identifies and controls all work and access to equipment that might contain a hazardous substance or be a potential source of hazardous energy. Hazardous energy includes electricity, motive power and pressure.

Each activity, such as “hot work”, “entry”, “gas testing”, maintenance (general) and electrical isolation has a Permit or Certificate to ensure the activity is properly assessed and safe conditions exist prior to the work commencing.

Permit to Work System

The Stolthaven Dagenham Permit to Work system is a formal written system used to control any types of work, which are potentially hazardous. Stolthaven Dagenham ensures the effectiveness of the PTW system by the following measures:

- Clear identification of Stolthaven Dagenham personnel who are authorised to issue a PTW;
- Training of personnel in the issue and use of permits to ensure competency;

Before any contract work can commence, a risk assessment for the work is to be carried out by the contractor and reviewed by the permit issuer. A detailed method statement is required to be produced by the contractor for more complicated works. Each job should be planned by a competent person and submitted at the same time as the price for the job. The majority of statements can be prepared around a standard work format so that all routine or common tasks are carried out to a set formula.

To ensure that the requirements are complied with, it will be normal procedure for the permit issuer NOT to issue a permit to work without a valid risk assessment and method statement provided by the contractor if the permit issuer considers it necessary.

Permits to work should be considered whenever it is intended to carry out any work, which may adversely affect the safety of personnel, the environment or the plant. However, any work that is required on safety critical equipment must have its own permit to work form. Generally work will fall into 4 main categories:

- General engineering and improvements;
- Routine or periodic maintenance;
- Emergency repairs and breakdown;

- Operations department procedures (tank cleaning, etc).

It will be necessary for the permit to work to cover specified tasks carried out within the work category. These specified tasks will fall into 6 main headings:

- Electrical work; Covered by a General PTW
- Hot work, including welding, grinding and cutting;
- Work at height;
- Confined space entry
- Excavation works
- Breaking of containment

Thus, if the work involves welding inside a tank then 2 permits would be issued a Hot work permit (FD 29-2) and a Confined Space Entry Permit (FD 29-3)

Permit to Work Issuer confirms through the Withdrawal from Service Procedure, as described in Section 4 of this manual, that the facility or plant has been released and is in a safe condition for the work requested. The Permit to Work Issuer then checks the plant or equipment personally and completes the rest of the permit to work by providing the necessary authorisation. A copy is given to the contractor for display at the location if practicable or to be kept on their person if impracticable.

The Permit to Work Issuer is generally the Maintenance Supervisor. In the absence of the Maintenance Supervisor, the following may complete these sections:

- Operations Supervisor;
- Assistant Operations Manager;
- Operations Manager;
- Quality and Safety Manager.

Where a permit to work is continued after the original Permit Issuer leaves site, the permit must be handed over (normally to the Operations Supervisor) to ensure continuous control over the contractor.

The person doing the work or the person in charge of the work on site completes the relevant section of the permit to work. Access to the work area is not permitted until the person doing the work has a completed and authorised permit.

When the work has been certified as complete by the contractor, the plant or equipment will be inspected by the Permit Issuer, in conjunction with the Operations Department and the Quality and Safety Manager (where appropriate). This ensures the work has been completed satisfactorily and no hazards or potential hazards exist. If this is the case, the contractor who has carried out the work and the Permit Issuer then sign off the permit as complete, which this is done no further work will be carried out on that plant or equipment unless a new permit is issued.

Isolation and Preparation

The Permit to Work ensures only competent personnel are allowed to carry out electrical isolations. Electrical isolations are done using a “Isolate, “Check” and Try” operating method i.e. the Operator identifies the equipment, isolates the pump The Operator then returns to the equipment and attempts to start it, this ensures the correct equipment has been isolated. A Lock Out Tag Out register is maintained, and all site isolations are entered in this document, isolations may include the inserting of a blind or spade, padlocking a valve, electric isolations etc.

Isolation and maintenance of high voltage equipment is contracted to suitably qualified contracting organisations.

Audit Arrangements

Audits of the PTW issued is carried out, a schedule of audits is issued annually and monitored by the SHEQ Manager for completion. The internal audit schedule also includes relevant maintenance processes including identifying opportunities to improve and preventative measures. Also, reviews are required by line management prior to commissioning / handback of maintained equipment

Training

A formal training process is in place with sign off from the Maintenance Manager and SHEQ department.

<u>Maintenance Records</u>

Details of all maintenance work requested, completed and outstanding are held by the maintenance Manager / Supervisor. In most cases these records are held electronically on the Company’s CMMS system, but paper copies are also retained where appropriate (such as records of formal inspections etc.)

5.2.4.2. Hazardous Conditions

Mechanical / EC&I

Hazards posed by Electrical Equipment

The facility has been subjected to a Hazardous Area Classification Study and the various locations designated as, Zone 1, Zone 2 or non-hazardous. This information allows work in these areas to be planned and assessed. The standards used for the study were:

- IP Model Code of Safe Practice, Part 15 – *Area Classification Code for Petroleum Installations*
- BS EN 60079 *Electrical apparatus for use in explosive gas atmospheres* Part 10:2015 *Classification of hazardous areas.*

The plant has been suitably zoned in relation to the materials that are associated with the process, and area classification drawings have been produced. This information allows work in these areas to be properly assessed and planned.

A DSEAR compliance programme is underway with the Hazard Identification and risk assessment, Hazardous Area Classification and the Identification / Assessment of electrical ignition sources already complete. Work to assess identify and assess non-electrical ignition sources is included in the Improvement Plan - see Action 5.2.1.3.b

The Permit to Work controls all work related to working on electrical equipment. This is supported by the Isolation Procedure that details how equipment is to be isolated and locked off. The preferred isolation is the removal of fuses or RCB and locking the isolator in the “off” position. The isolation has to be proved before work on the equipment is permitted. The “lock off keys” are held by the engineer or contractor for the duration of the work. Isolation and / or switching on the HV systems is only under taken by suitably trained personnel

Risks associated with Hot Work

The Permit to Work Procedure controls hot work; this has been described in Section 5.2.4.1. The issuer ensures the area is free of combustible or hazardous materials. A gas test is done using a portable gas detector to ensure there is no flammable vapour in the vicinity of the hot work. People performing hot work also wear portable gas monitors.

Underground Services

Should excavation work be required, this is control under the Permit to Work System. Before any permit is issued suitable method statements and risk assessments must be completed. A prerequisite for all excavation work is a format survey of the area to be excavated, this will normally involve have the area CAT scanned to locate any buried services. IN it recognized that CAT scanning is not fool prove and if buried services are expected or suspected the excavation will be hand dug to confirm or not their existence.

Permit to Work System

- Details of the permit to Work System are given in 5.2.4.1
- The permit to work system is a formal safety control system designed to prevent accidents, particularly when work with a foreseeable risk is undertaken. Permits to work are issued to contractors working on the Company's behalf and employees who may be carrying out a high-risk activity. An example permit is included in Appendix 5.53.

Before any work commences, the method and nature of the work to be carried out must be fully discussed and agreed with the employee or contractor. This will include:

- The details of the work to be undertaken, e.g. what, how, where, when and by whom.
- The equipment and materials to be used to complete the work and the hazards and risks associated with the work.
- Consider how the work of the contractor and that of the process will affect each other.

Permit to Work Training

The SHEQ Manager ensures that Permit Officers, Permit Recipients and other relevant personnel identified in the specific Permit Work Instructions are all trained to appreciate the need for the system, the practice, the hazards involved, and the safe systems required for this procedure to operate effectively. In addition, specific training is provided in the use of Oxygen and Flammability Testing equipment.

Audits of the PTW system are carried out. All contractors that are new to the site must successfully complete the contractor safety induction procedure that includes;

- Viewing a site presentation describing the hazards on site, the Permit to Work system and actions to be taken in the event of a site emergency
- An assessment of understanding of the information given in the presentation.
- A safety information booklet is given to each contract that is inducted.
- The nominated Stolthaven contact will review the essential elements of the risk control aspects of the site, after which the contractor is required to acknowledge understanding by formal signature which is retained by the site as a record of induction.

The induction includes a discussion on site safety culture, including the MAPP, to ensure full understanding of the level of safety awareness that is expected of them whilst performing their activities on site.

No contractor is allowed to commence work on site unless in possession of a current Permit to Work, ensuring that all work is appropriately controlled and supervised by site personnel.

To ensure that the permit recipient is aware of the precautions and conditions of the permit a visit to the proposed work area is undertaken by the Permit Officer and Permit Recipient to discuss all details of activity to be performed, inspect the work area and identify any hazards and potential risks in the work area. The permit recipient(s) performing the work is then informed of their responsibility to follow the permit's stated requirements and for taking all necessary steps to prevent the development of unsafe work practices. This requirement applies to all employees and outside contractor personnel.

Isolations and Vessel Entry

Lines are blown through and cleared before any break-ins are undertaken. Valves are closed off, and procedures stipulated in method statements developed from specific risk assessments are adhered for work on lines containing hazardous substances.

If vessel entry is to be made all connections have to be positively isolated through the disconnection of lines or the insertion of spades. Valves are not relied upon. Before entry the atmosphere is sampled to determine the level of protection the persons entering must wear. It is site policy to work in vessels without respiratory protection if the environment can be achieved but due to the nature of the products there may be circumstances when respiratory protection is required.

5.2.4.3. Examination of Critical Plant and Systems

Mechanical / Human Factors

The examination of critical plant and systems including pressure vessels, pressure relief streams, piping systems, control valves, orifice plates, monitoring and control instrumentation, detection systems and electrical installations are all undertaken as determined by the relative site procedures. A programme of work is currently underway to consolidate all such inspections and examinations under a single system – the sites Mechanical Integrity Programme (MIP).

Examination of safety critical plant and equipment

Competent Persons have been appointed to inspect and test plant and equipment that might be subject to regulations or where the Company does not have the necessary resources, skills or equipment. For example, a Competent Person, currently British Engineering has been appointed to inspect pressure vessels and lifting equipment. Table 5.2.4.3.1 below details the external examinations.

Table 5.2.4.3.1: External Examinations

System	External Body
Pressure vessels	British Engineering
Lifting Equipment	Medway Lifting

Relief Devices	Assentech
Portable electrical equipment	Electrical Testers

Competence and Independence of Examiner

Several inspection companies have been contacted to carry out inspections they are considered Competent Persons and they work to the regulations. Their independence can be demonstrated by considering the In-Service and Out-of-Service inspection reports. (Copies of which can be found in Appendix 5.18). The pipework from the jetty to storage tanks is another example of an asset which would be considered as safety critical. Example inspections of this asset is presented in Appendix 5.53.

For equipment that is subject to the Regulations the periodic inspection and test requirements are specified and carried out by competent persons or organisations nominated or approved by the Competent Person, or an approved design contractor. This includes ensuring that appropriate technical advice is obtained before repairs on registered equipment are carried out.

The Maintenance Manager / Supervisor is responsible for organising and managing the activities of the Competent Person.

Selection Criteria

Critical equipment has been identified by considering regulations such as the Pressure Systems (Safety) Regulations, LOLER, PUWER and other pertinent regulations. The basic requirements of the regulations have been added to by internal assessment of maintenance experience with the equipment. A programme of work is currently underway to consolidate such information under a single system. Safety critical equipment has been identified within Express Maintenance in accordance with DAG-42. (see Appendix 5.50)

Inspection Frequency

The inspection frequency of all equipment is based on regulations, manufacturers' recommendations and experience. For example, pressure vessels such as reactors and air receivers are inspected by the Competent Person annually, in accordance with the Written Scheme of Examination (WSE).

The inspection frequency of these and other equipment is demonstrated in the table below.

Table 5.2.4.3.2: Critical Equipment Inspection Frequency

Critical Plant and Equipment	M/nance	Inspection	Inspection Interval	Record Holder
Boilers and steam receivers	In-house & Flare	British Engineering	3m-12m-60m	Stolthaven
Air	CPC	British Engineering	12m	Stolthaven

Critical Plant and Equipment	M/nance	Inspection	Inspection Interval	Record Holder
Fire extinguishers	Thameside	Thameside	12m	Stolthaven
Electrical systems	In house	Sterling Electrical	36m-60m	Stolthaven
Lifting machines	Linde	Linde	6m 3m-12m	Stolthaven Stolthaven
Lifting equipment	In house	Medway Lifting	12m	Stolthaven
Fire and security systems	Nuform	Nuform	1w & 3m	Stolthaven

Frequencies used are mostly the stricter of either Stolthaven Standards or the relevant standards associated to the applicable equipment / system. For Example, EEMUA 159 related to storage tanks. Future inspection frequencies take into account site conditions, equipment history and safety criticality risks. The key lessons learned are captured with Express Maintenance including revising future works / inspection methodology, as necessary while prioritisation is facilitated by Express maintenance including as it relates to inspection, maintenance and testing of safety critical equipment.

Examination Techniques

Examination techniques used for pressure equipment vary according to the equipment, service and inspection history. Initial examination is visual, supported with ultrasonic thickness checks. Thereafter, specialist testing such as Dye Penetration, Magnetic Particle Inspection or Ultra Sonic testing in suspect areas may be required; in the case of lined vessels spark testing is done to prove the lining is not damaged. The Competent Person determines the inspection required, reviews the reports, initiates the appropriate remedial work and approves the repair.

When required by regulations or the Competent Persons equipment is proof tested to ensure it remains fit for purpose. Such tests can include pressure tests and blowdown checks on boilers, pressure or use testing of fire extinguishers.

For general inspection work, such as storage tank internal and thickness inspections, the approved Inspection Engineer carries out the work. Comparisons are made with design specifications and previous reports to ascertain for instance, corrosion rates and access whether the equipment is fit for use and its next date of inspection. Reference is also made to best industry practice.

For more specialised work, under the Pressure Systems Regulations, third party inspectors are used. The UK Accreditation Service, under the DTI, certifies them competent in their area of expertise. They are registered to BSEN 45004, ISO 9001.

Examples where such third-party specialists would be used are:

- Non-destructive testing. This is carried out on a regular basis on a range of equipment considered critical. Trends are analysed and problems identified so that maintenance can be targeted and carried out before failure occurs.

- Thermographic analysis. Used predominantly to inspect electrical equipment, it can also be used to gather additional information on equipment highlighted by Vibration Monitoring or Oil Analysis. It is also used to inspect equipment such as burner settings for hot spots, indicating internal damage and lagging deficiencies.

Planning

The site Maintenance Supervisor is responsible for planning and scheduling the inspection and examination of equipment. Scheduling of the work is discussed during the daily and weekly operations team meetings with input from the Health & Safety and the Operations Managers. Although no schedule is published the agreed schedule is visible on the site’s Express Maintenance system

In the case of “statutory” equipment the Competent Person issues reminders that equipment is due for inspection.

Equipment Susceptible to Defects

Degradation mechanisms are assessed during the HAZOP / HAZID studies prior to the introduction of new substances and processes to prevent equipment damage. Where information on the suitability of materials of construction does not exist then the company undertakes coupon testing in the laboratory.

Where problems are identified the company undertakes a fault tree analysis followed by the introducing of an engineering solution where applicable.

Temporary Repairs and Monitoring Regime

Temporary repairs are only made to the service systems and only until to the plant can safely be made available for a full repair. No temporary repairs are made to any systems containing process fluids.

The site operates a risk-based maintenance management system that where possible ensures a robust response to maintenance is taken, including permanent replacement instead of temporary repairs. When this is not possible a case specific risk management plan is implemented. For example, reducing operating parameters such as temperature, pressure or level. Operations are mandated to increase monitoring of equipment affected by temporary works. Relevant details associated with all works (including monitoring is coordinated and recorded within the site CMMS. (Express Maintenance)

Arrangements for Reporting, Recording and Acting on Examination Results

The Competent Person reports defects to the Company and if it is serious, as required by regulations, issues the appropriate notice that dictates the equipment remain/be taken out of service until it is repaired. The Company would then send a copy of this form to the HSE if falling under the RIDDOR regulations.

Repairs and repair procedures will be determined by the vessel code, but they will be approved by the Competent Person. Following repair, they will examine and test the repairs in accordance with the code.

Engineering reports are held in the engineering document system and are the responsibility of the Maintenance Manager / Supervisor. Certain safety reports such as records from the inspection of the fire alarm system and portable gas detectors are also held by the Maintenance Supervisor.

The frequency of inspections has been determined by adhering to regulatory requirements or Codes, or, when neither is available, the manufacturer’s or supplier’s recommendations.

5.2.4.4. Defect Significance and Appropriate Action

Mechanical / EC & I

Defects detected during maintenance or at inspection periods, especially during planned overhaul periods, are assessed for significance by the Maintenance Manager / Supervisor. Maintenance of some equipment is carried out on site, by trained craftsmen; however, some work requires specialised equipment or engineers certified to certain standards and, for these, use is made of third parties. If required, specialists are contracted from an outside organisation. Assessment procedures used are in line with equipment standards for example ASME, ANSI or BS standards for pressure vessels.

All craftsmen on site have been trained in recognising equipment certified for use in hazardous areas (Ex equipment). This type of equipment is always sent off site for repair to an approved company which carries out the repair and re-certifies the equipment to BASEEFA standards.

Other items of equipment requiring repair are normally returned to the original manufacturer or supplier. All materials going off-site are controlled and monitored by the Maintenance Supervisor or Electrical and Instrument Technician.

It is the Maintenance Manager / Supervisors, responsibility to ensure that the equipment is not returned to service until the repair is satisfactorily completed.

Defects in coded vessels and pressure systems are referred to the Competent Person for review and instruction as to the appropriate action. The Competent Person validates all remedial actions and ensures they are subject to inspection and approval by the Company Insurers before they are returned to service.

For Mechanical Handling Equipment the defect assessment is made by the Competent Person - LOLER applies. Repairs to the lifting mechanisms are approved by the Competent Person.

Equipment that has failed statutory or safety checks is immediately taken out of service until it has been repaired; similarly, equipment that has failed calibration checks is removed from service until repair or replacement can be undertaken.

Failure or removal of equipment effectively prevents the process from start-up, since all statutory and calibration checks are completed prior to campaign runs.

5.2.5. Modification

A management of Change (MOC) process is followed to ensure that relevant changes to the law, applicable standards, procedures, systems (including information technology), proposed change(s) to facility, products handled, key personnel etc. receive an appropriate level of review prior to its approval and implementation. This is to ensure that no unexpected results could lead to a major accident. Any significant changes that are made (for example to construction materials, quantity of chemicals stored or introduction of new processes) will be fully assessed to give a complete understanding of any changes to the overall level of risk of the site.

Such changes are controlled by a combination of the company's Managing Change Procedure (DAG-21) and the Procedure for the Introduction of New Products - FD24. A copy of the management of change procedure can be found in Appendix 5.55.

5.2.5.1. Reliability Built into the Installation Modifications

Mechanical / EC&I / Process Safety / Human Factors

Definitions

Change

Any permanent or emergency change (removal or modification) to Plant, Equipment, Organisation, Materials, Packaging, Process or Control philosophy that is not an exact replacement or a replacement in kind which may affect the integrity of the plant or protection systems, or violate in some other way the mechanical or other adequacy of equipment for its specified duty. If there is any doubt or dispute about what constitutes a change the Managing Change Procedure is used until advice can be sought.

As a normal activity pipelines are reconfigured for the transfer of bulk liquid chemicals to dedicated storage vessels. This is achieved by the application of standard operating procedures and reconfiguration instructions developed jointly by the operation and engineering teams. Such operations would not be considered to be changes.

Exact Replacement

Replacement of whole or part of plant / work equipment that is identical in all respects, exact replacements within the context of an Engineering change are normally carried out as routine maintenance or repair.

Replacement in Kind (RIK)

Replacement of an instrument, electrical or mechanical equipment, a chemical, piping or other component with an equivalent part or equipment that meets the specification, applicable standard and /or control philosophy of the original item.

Emergency Change

An “out of normal daytime hours” change required immediately to avoid imminent personal injury, loss or damage to equipment or the environment.

Equipment Change

Responsibilities

Suitably qualified and experienced personnel who have the necessary training and experience to know what they are looking for, to recognise it when they see it, and to recognise the need to consult others with specialist knowledge, where appropriate, are used for assessment.

Any employee can propose changes / improvements; however, it is the responsibility of the Department Manager to identify without fail all changes within their area of control.

It is expected that the Initiator, Managers and other specialists involved in the change communicate fully with the end customer to ensure the change meets their expectations/ requirements.

Initiator

Any employee can request the initiation of an MOC, however the initiation process is conducted and controlled by competent people. The initiator both initiates the change and is also the person who is expected to monitor and expedite progression of the Request for Change document (RFC) through the approval process to final completion.

Approver

The Approver is the General Manager or the person to whom they report in their absence together with the SHEQ Manager (2 persons). The Approver must have the skills, knowledge and competence applicable to the change. Where this is not the case such as for specialist changes, the Approver will seek expert advice prior to Approval.

MOC Procedure

An outline of the Management of Change Procedure is given below (a copy of a Managing Change Procedure and Template can be found in Appendix 5.55).

The Request for Change Form comprises a 4-page document, consisting of;

- Summary;
- Gap Analysis;
- Stakeholder Analysis; and
- Risks and Actions.

The Request for Change (RFC) form is completed by the Initiator with the core information related to the proposed change i.e. details concerning the Division, Operation and Site involved along with a brief title description of the change. A more detailed description of the change is also compiled by the Initiator.

An initial Gap Analysis is then performed, and details recorded accordingly. During the Gap Analysis any Risks associated with the change are recorded.

A Stakeholder Analysis is then undertaken by those departments / individuals involved in the change, during which any additional Risks associated with the change are recorded. Implementation responsibilities are assigned, and any constraints recorded along with proposed resolutions. Timescales are agreed for implementation before the RCF is passed for Approval and the Change Implemented. Any actions are tracked to completion in the Continual Improvement Register.

The MOC process considers organisational changes as well as changes to site equipment, additional site personnel are aware of the MOC process and take part in a multi discipline review.

Equipment Change

- Any change to equipment which is not a replacement in-kind must receive appropriate review and authorisation prior to installation.
- Operating procedures are revised as necessary before start-up of modified equipment and affected employees informed of the change and trained prior to the implementation.

Conceptual Design

The site operates a hierarchical approach when considering change, wherever possible the changes should be such that they increase the inherent safety of the plant and processes.

The concept of inherent safety, health and environmental protection is to prevent hazards by removing them completely. Although complete elimination may be difficult or even impossible in many cases, it is still important that a positive search is made to identify the alternatives.

These methods include:

- Hazard Elimination - eliminate hazards as a first priority (rather than accepting them and implementing a risk reduction strategy once they exist);
- Consequence Reduction - where hazards cannot be completely eliminated, find less hazardous solutions to accomplish the same design objective by techniques such as reducing exposure to a hazard, reducing inventory of hazardous materials, and substitution of less hazardous materials; and
- Likelihood Reduction - reduce the likelihood of events occurring by techniques such as simplification and clarity (lowering the likelihood of an initiating event), and layers of protection and redundancy of safeguards (to reduce the progression of an incident).

This approach includes human factors, in particular the opportunities for human error given the design and operating conditions and parameters. Finding an error likely situation, such as controls being too difficult to access or too complicated and working to reduce the clutter and confusion or to improve the accessibility to reduce the chance of a human error is an example of inherent safety in action.

Detail Design

The responsibility for designing and installing changed or new equipment is dependent on the complexity and extent of the change.

During the technical development phase of the modification processes the nominated competent persons will assess whether and to what extent additional internal or external resources are required. If the adequate resource and skill is available on site, then the design will be undertaken by site-based personnel. Where this is not the case the Maintenance Supervisor and SHEQ Manager would select suitable external contractors.

Installation

Where there is interaction with operating equipment or the activities might pose a risk then the Permit to Work is used to control the installation. The need for a permit is detailed in the Permit to Work Procedures.

Small changes will be undertaken utilising the sites own maintenance personnel. For changes of a significant nature or requiring specific / specialist knowledge then approved external contractors would be used.

Documentation

The site Maintenance Manager is responsible for ensuring the engineering files and all engineering drawings are updated and spares are organised after the modification is completed.

Once the modification is completed the CIMS.007a 'Management of Change Template' is returned to the SHEQ Manager for filing and controlled storage.

Commissioning

As part of the commissioning process a Pre-Start-Up Review Team may be appointed dependent upon the change. The duty of this team is to visit the effected workplace, verify the correct commissioning process and documentation to ensure all necessary actions have been completed, no unforeseen hazards have been introduced and that all issues between effected parties have been resolved. This process involves completion of a Pre-Start-up Checklist.

The Maintenance Manager (or Project Manager) is responsible for the generation of a formal commissioning plan. During commissioning numerous checks are undertaken (see section 5.2.2.2) in order to ensure the change is fit for purpose and to confirm that no residual risks remain and that no new risks have been introduced.

Any requirement for new or amendments to existing operating procedures, such as Work Instructions, is the responsibility of the Departmental Manager and would be undertaken in accordance with the procedures outlined in Section 5.2.3 of this report.

Any new or changed Work Instruction ready for issue is assessed as to the degree of training that is required. If the change is significant a training programme will be developed, and an individual record generated, if the change is minor it is acceptable that the document is signed for as read and understood by the recipients expected to use them.

Temporary Modifications and Reinstatement

Where temporary modifications are made these are designed to the same integrity as the original system. All changes are control under the sites Managing Change procedure, details of which can be found in Section 5.2.5 of this report.

Hoses are used in some circumstances for flexibility such as when connecting to ships or road tankers. The hose used is specified for the operating conditions. Flexible hoses are registered, inspected before each use and tested every 12 months.

Urgent / Out of Hours Changes

If a change was urgently required on site to protect people or the environment ***(Emergency Change)*** then verbal confirmation must be obtained from the Operations Manager. In such cases as with all changes documented evidence must be available to demonstrate that risks associated with the change have been assessed and the 'Management of Change Template' must be completed the next day.

MOC Procedure for Introduction of New Chemicals

Any new customer requests to store chemicals initiates a review of the compatibility of the chemical to the materials of construction of the transfer pipelines and storage tanks. This review is conducted between the SHEQ and Engineering personnel and is documented using the site's FD24 form (see Appendix 5.27 for a copy of the FD24 related Ultra 35 introduced to site in June 2017). The review also requires an inspection of the storage vessel and where necessary engineering modification to be undertaken.

An example of this approach occurred when the site was requested to store 'Ultra 35' for a customer. The earmarked storage tank was inspected and an assessment of the Ultra 35's chemical and physical properties was made and compared against the storage tank materials of construction and weld integrity. The outcome of the review deemed that the tank (and it associated pipework) was compatible as such did not require any modification before the chemical was stored.

MOC Procedure for Control of Process Software

The Management of Change System also considers alterations to software.

Decommissioning and Removal of Plant and its Significance to the Remaining Systems

Equipment removal or decommissioning is covered by the Management of Change procedure.

All construction activity on the site is managed by following the principles of the Construction, (Design and Management) Regulations 2015. Construction work that falls within the requirements of CDM is individually registered as a construction project with the Health and Safety Executive and managed in line with the CDM Regulations.

All engineering contractors are selected by a process that involves the completion of a prequalification. The contractors reply is assessed by the Project Manager, Maintenance manager and SHEQ Manager.

If considered appropriate an audit of the contractor will be undertaken prior to award of the contract. If the contract is for a project that is outside CDM then a separate Health and Safety Plan is produced for the project