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SIMON STORAGE LTD

IMMINGHAM EAST TERMINAL

GASOLINE IMPORT

LAYERS OF PROTECTION ANALYSIS

Rev	Date	By	Checked	Approved	Description	Client Ref.
A	31.01.2007	DSR	DRR	[Client]	Original Issue	
B	19.02.2007	DSR	DRR	[Client]	Revised following Client meeting 16/02/07	**Document No.** SI057001_RPT
C	01.08.07	DSR	DRR	[Client]	Actual SIL 2 IPL Data added	
D	08.07.10	DSR	DRR	[Client]	Environmental and Financial Scenarios added	
E	30.06.11	DSR	MM	[Client]	LOPA reviewed and rewritten	
F	31.08.11	DSR	MM	[Client]	Clients Comments Incorporated	
G	29.06.12	DSR	MM	[Client]	Following FSA Stage 3	

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BS EN 61511
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1 REVISION HISTORY

Rev	Description
A	Original Issue
B	Revised following Client meeting 16/02/07
C	Actual SIL 2 IPL Data added
D	Environmental and Financial Scenarios added
E	Total LOPA rewrite following decision to store gasoline on the Immingham East terminal and incorporating PSLG guidelines and C.A. comments on other Simon Storage terminals.
F	Clients comments incorporated with various Typographical error corrections and units added. Page 4 - Simon Competence statements added Section 3 modified Section 4 modified Page 13 - Individual risk modified as per client comments Section 5.1.1 modified as per client comments Section 5.1.2 modified as per client comments Section 5.3.2 modified as per client comment Section 5.3.8 modified as per client comment
G	Following FSA Stage 3 Section 2.2 Modified: "A mid-range SIL2 protection layer which would close individual tank-side pipeline fail-safe actuated valves on initiation of that tank's high high level switch." Section 4.1 Modified: "It was considered that the number of people on-site should be stated as typically up to 20-30 during the day." Section 4.1.3 Modified: "No tertiary containment is available. In the LOPA no credit has been taken for the Environmental case, Scenario 3." Section 5.1.2 Modified: … the jetty line actuated import lines will not close on activation the fire alarm. However, the actuated tank import valves will close. (For tank 561 = 6931mm, time to overfill after high high level activated: 5.4 minutes) (For tank 564 = 8662mm, time to overfill after high high level activated: 9.9 minutes) (For tank 568 = 8662mm, time to overfill after high high level activated: 9.9 minutes) Section 5.3.3 paragraph added: It is considered that this Protection Layer can be used for all initiating events as all of the gasoline tanks are protected by individual tank-side valves that will close on activation of the level switch on that particular tank. Within the scope of this LOPA, a gross misrouting of gasoline into any other tanks on the terminal has not been considered."

2. INTRODUCTION

The Process Hazard and Risk Assessment (PHRA) for Gasoline Import to the storage facility at Immingham East identified that a Layer of Protection Analysis (LOPA) study should be carried out for protection of Tank overfill. The method considered was import from a ship. The method of analysis has been detailed below to introduce this method of review.

The conclusions from this LOPA study are summarised in section 2.2.

The site is a multi-chemical storage facility located at Immingham, South Humberside on South side of the River Humber and the east side of the Docks on indigenous clays and is not confined by any topographical features or vegetation. The site bounded on the northern side by water and on the Southern side by dockyard facilities. The river Humber constitutes a Site of Special Scientific Interest and EU protected area.

2.1 Attendance at Meetings

Identified below are those who attended the Risk Assessment meeting associated with the Risk Assessment of the Gasoline Storage Facility using the Layer of Protection Analysis (LOPA) method. (Ref. PSLG Guidelines, Clause 18, 19)

A meeting was held on Thursday 30th June 2011 as gasoline storage within the terminal is imminent.

Simon Storage Ltd.	P & I Design Ltd
Mike Cook	Mr M. Morgan
Alan Hall	Mr D.S. Regan
Paul Jobling	
Steve Waterman	
Mike Plaskitt	

The competency of the Simon Storage personnel above can be demonstrated from the individuals job description and training files. The required knowledge of the operational requirements and the possible risks associated with the operation can be readily demonstrated by ISCo.

Mike Cook is the Group Technical & Environmental Advisor. He is a graduate Mechanical & Electrical Applications Engineer. He has 30 years' experience in the chemical industry, including Terminal & Project Engineering. In the last 5 years he has gained in-depth experience in Major Hazard Identification & Risk Assessment.
Alan Hall is the Project Engineering Manager. He has an honours degree in Applied Engineering and a HNC in Electrical & Electronic Engineering. He has over 20 years' experience in Chemical, Petrochemical & Storage industries.
Paul Jobling is the Group Safety Compliance Manager. He has an honours degree in Chemistry. He is an Industrial Chemist with 27 years' experience in Loss Prevention in the Oil & Chemical Storage Industry.
Steve Waterman is the Plant Engineer. He has a City & Guilds Certificate in Electrical Installation Engineering. He has 30 years' experience in Process Plant Engineering.
Mike Plaskitt is the Terminal Operations Superintendent. He has a City & Guilds Certificate in Process Plants Operations Part 2. He has over 25 years' experience in Process Plant Operations.

The competency of the P&I Design Ltd. personnel above can be demonstrated from the P&I Design Quality System.

Martin Morgan has an honours degree in Instrumentation and Control Engineering. He has over 20 years' experience in the Chemical and Process Industry.
David Regan is a Process Engineer with a degree in Chemical Engineering. He has specialised in Process Instrumentation for over 25 years, with specific expertise in hazard and risk assessment.

2.2 Summary of LOPA Study

The results of the study are summarised below:

Scenario 1 - Overfill of gasoline tank during import from a ship leading to a potential open vapour cloud explosion causing up to 3 on-site fatalities and up to 6 off-site fatalities.

Risk Tolerance Criteria = 1.0×10^{-6} per year

Frequency of Mitigated Consequence = 7.58×10^{-7} per year

The risk tolerance criteria is within the Broadly Acceptable region for up to 10 fatalities (Table 2 - Tolerable Risk Criteria). The frequency of Mitigated Consequence with a mid-range SIL 2 SIS is well within the “Broadly Acceptable” region.

Scenario 2 - Overfill of gasoline tank during import from a ship leading to a potential flash fire causing up to 1 on-site fatality and no off-site fatalities.

Risk Tolerance Criteria = 1.0×10^{-5} per year

Frequency of Mitigated Consequence = 8.81×10^{-7} per year

The risk tolerance criteria is within the Broadly Acceptable region for up to 1 fatality (Table 2 - Tolerable Risk Criteria). The frequency of Mitigated Consequence with a mid-range SIL 2 SIS is well within the “Broadly Acceptable” region.

Scenario 3 - Overfill of gasoline tank during import from a ship leading to a potential open vapour cloud explosion and a release to the River Humber corresponding to a potential short-term major environmental consequence to the River Humber which could constitute a threat to the environment. (Consistent with Table 4 - Environmental Tolerable Risk Frequency).

Risk Tolerance Criteria = 1.0×10^{-6} per year

Frequency of Mitigated Consequence = 6.06×10^{-7} per year

The risk tolerance criteria is within the Acceptable region for a severe environmental consequence (Table 4 - Environmental Tolerable Risk Frequency). The frequency of Mitigated Consequence with a mid-range SIL 2 SIS is well within the “Broadly Acceptable” region.

The above were achieved with the following:

- A mid-range SIL2 protection layer which would close individual tank-side pipeline fail-safe actuated valves on initiation of that tank’s high high level switch. This protection layer has been installed and commissioned and full SIS documentation is available. The actual credit available from the SIS is calculated as: 2.5×10^{-3}. See SIS Design Report SI277001_RPT. The protection layer is auditable via the SIS maintenance and testing records.

2.3 Definitions and Abbreviations

The following details the definitions and abbreviations used in this document.

APT	Associated Petroleum Terminal
ATG	Automatic Tank Gauging
BPCS	Basic Process Control System
BS EN 61511	British Standard – Functional Safety – Safety Instrumented systems for the process industry sector
CM	Conditional Modifiers
IEF	Initiating Event Frequency
IPL	Independent Protection Layer
LOPA	Layer of Protection Analysis
MATTE	Major Accident to the Environment
MOV	Motor operated valve
OFCE	Open Flammable Cloud Explosion
OPRT	Overfill Protection Regulatory Team
PFD	Probability of Failing on Demand
PL	Protection Layer
ROSOV	Remotely Operated Shut-Off Valve
SCADA	Supervisory Control & Data Acquisition
SIF	Safety Instrumented Function
SIL	Safety integrity level – A numerical number, 1 to 4 stipulating the level of integrity the system shall perform to, 1 being the lowest 4 the highest
SIS	Safety Instrument System – A SIS comprises of sensors, logic solvers and final elements
TASCS	Terminal Automation Stock Control System
VTW	Virtual Tank for Windows

3 LAYER OF PROTECTION ANALYSIS (LOPA)

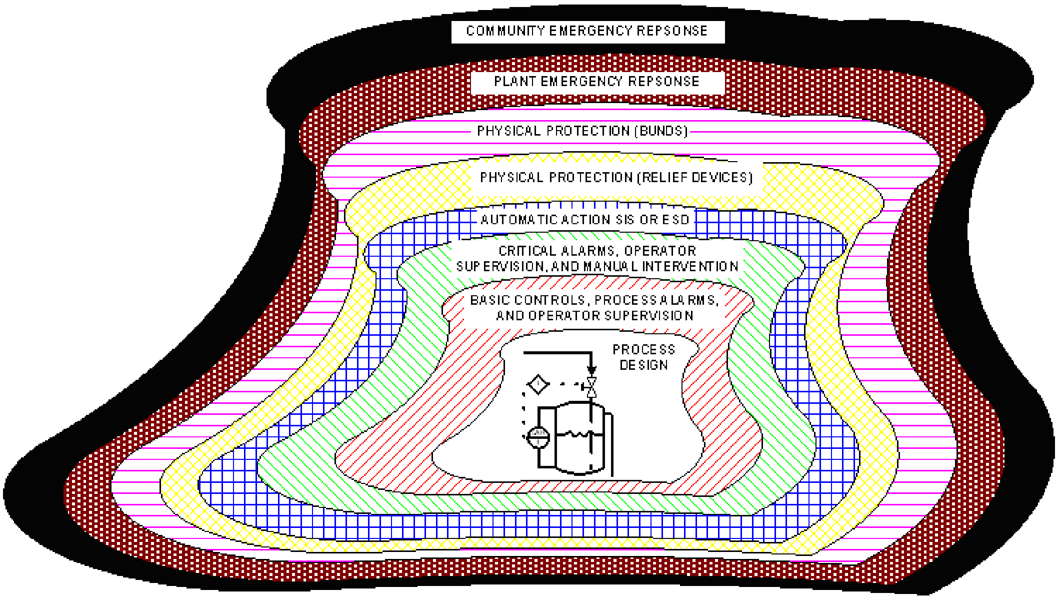
The technique analyses risks which have been identified associated with the defined operations. The event likelihood for the identified scenarios are assessed as well as the consequences both in safety and environmental terms. The consequence of the failure determines the risk reduction required.

The term LOPA (Layer of Protection Analysis) is applied to a family of techniques used for carrying out a simplified quantified risk assessment of a defined hazardous scenario. LOPA is often used to identify the shortfall in meeting a predetermined dangerous failure target frequency. This shortfall, if it exists, is associated with the average probability of failure on demand of a safety function required to meet the target dangerous failure frequency. The identified shortfall (if it exists) is equated to the required SIL of a safety instrumented function (SIF), as defined in BS EN 61511. This potential shortfall is referred to as the Risk Reduction Factor (RRF) or the failure rate that should be achieved by the SIS. The link between the RRF factor and the required SIL is shown in Table 1.

Safety Integrity Level	Range of Average PFD	Range of RRF
1	$10^{-2} \leq PFD < 10^{-1}$	$100 \geq RRF > 10$
2	$10^{-3} \leq PFD < 10^{-2}$	$1000 \geq RRF > 100$
3	$10^{-4} \leq PFD < 10^{-3}$	$10000 \geq RRF > 1000$
4	$10^{-5} \leq PFD < 10^{-4}$	$100000 \geq RRF > 10000$

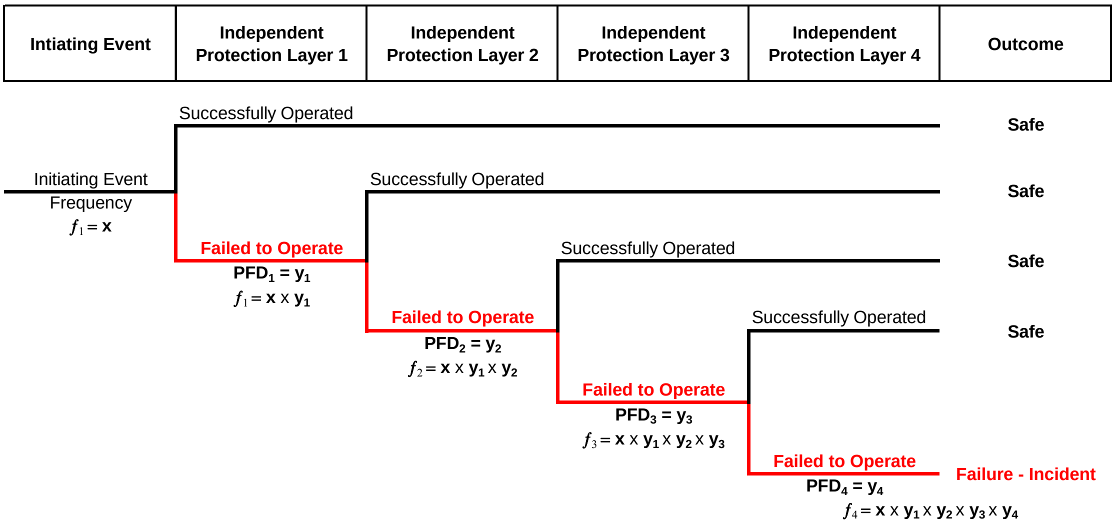
Table 1 - Definitions of SILs for Demand Mode of Operation from IEC 61511-1

3.1 Independent Protection Layers



3.2 LOPA Model

The following figure shows the principle of the Layer of Protection technique. It is essential that each layer is independent from each other to ensure that protection is achieved.



3.3 Calculations

The following calculations are used within this LOPA study:

Frequency of Mitigated Consequence =

CM x{(IEF1 x PL1 x PL2 x PL3 x etc)+(IEF2 x PL1 x PL2 x PL3 x etc)+ (etc)}

Where CM = Conditional Modifiers i.e CM1 x CM2 x CM3 x CM4

IEF = Initiating Event Frequency
PL = Protection Layer

4 RISK TOLERANCE CRITERIA (Ref. PSLG Guidelines, Clauses 36-39)

The Layer of Protection Analysis (LOPA) SIL selection method is a quantitative method that considers the initiating event frequency and probability of failures of the various layers of protection. This method is based on BS EN61511-3 (CDV) Annex F. The unmitigated event frequency is calculated using the initiating event frequency and probability of failures of the various layers of protection. Based on the consequence of the hazard a tolerable frequency is determined. From tolerable frequency and unmitigated event frequency the required risk reduction and therefore required target SIL is determined. Risk Tolerance criteria can be defined for process safety and environmental risks.

The PSLG final report into the Buncefield explosions provides some tolerable frequencies and states that these figures, or a similar matrix, should form the basis of the assessment. The tolerable risk frequency is the boundary between the 'tolerable if ALARP' and the 'Broadly acceptable' regions.

Likelihood of 'n' fatalities from a single scenario	Risk Tolerability		
10^{-4}/yr – 10^{-5}/yr	Tolerable if ALARP	Tolerable if ALARP	Tolerable if ALARP
10^{-5}/yr – 10^{-6}/yr	Broadly acceptable	Tolerable if ALARP	Tolerable if ALARP
10^{-6}/yr – 10^{-7}/yr	Broadly acceptable	Broadly acceptable	Tolerable if ALARP
10^{-7}/yr – 10^{-8}/yr	Broadly acceptable	Broadly acceptable	Broadly acceptable
Fatalities (n)	**1**	**2 - 10**	**11 - 50**

Table 2 - Risk Matrix for Scenario Based Risk Assessments

Hence the following target risk criteria will be used:

No. Fatalities	Tolerable Risk Criteria
1	1×10^{-5}.
2 to 10	1×10^{-6}
11 to 50	1×10^{-7}

Table 3 - Tolerable Risk Criteria

For Environmental Hazards the tolerable risk levels are based on those given in Appendix 2 of the Process Safety Leadership Group (PSLG) final report into the Buncefield explosion. These figures are based on information in document Integrated Pollution Prevention and Control (IPPC) and Environmental Assessment and Appraisal of BAT.

Consequence	Definition	Acceptable if frequency less than	Unacceptable if frequency more than
Minor:	Nuisance onsite only. No off-site effects.	All shown as acceptable	-
Noticeable	Minor breach of permitted emission limits, but no environmental harm	10^{-2} per year	~ 10 per year
Significant	Major breach of permitted emissions limits with possibility of prosecution	10^{-4} per year	10^{-1} per year
Severe	Public warning and offsite emergency plan invoked Hazardous substance releases into water course with ½ mile effect	10^{-6} per year	10^{-2} per year
Major	Serious toxic effect on beneficial or protected species Widespread but not persistent damage to land	10^{-6} per year	10^{-4} per year
Catastrophic	Major airborne release with serious off-site effects Site shutdown Serious contamination of groundwater or watercourse with extensive loss of aquatic life	10^{-6} per year	10^{-4} per year

Table 4 - Environmental Tolerable Risk Frequency

4.1 Determination of Consequence

4.1.1 Consequence to People (Ref. PSLG Guidelines, Clauses 40-42)

Importing from Ship.

Weather data extracted from the 2007 COMAH report was provided for this LOPA. Appendix 4.

All gasoline operations leading to overfill of a single tank which could lead to an open flammable cloud explosion and possible on-site multiple fatalities (up to 3) with possible off-site multiple fatalities up to 6. From 4PM to 8AM, the most likely time for a Buncefield type explosion, the number of personnel on site is low (less than 5). (Ref. PSLG Guidelines, Clause 18, 19)

The site is not confined by any topographical features or vegetation, with no buildings immediately at the outside of the site boundary. The site is bounded on the northern side by water and on the south western side by storage tanks and dock facilities also bounded by water and any vapour cloud is unlikely to be confined.
The prevailing wind is from the South West and the likelihood of an open vapour cloud explosion is low. The likelihood in the 250m Zone, in the event of a vapour cloud explosion, of causing multiple fatalities on-site is high, the likelihood of off-site fatalities is also possible. (250m from tank being the HSE hazard zone derived from the PSLG report). The number of people on-site within the 250m zone is stated as 20 - 30 during the day and 3 on the night. Off-site personnel within the 250m zone has been stated, typically as 20 during the day and 0 on a night time (see Appendix 5). A worst case of Off-site personnel of 35 during the day and 20 during the night is quoted, however the night time case has been discussed as being drivers arriving and leaving overnight and it is considered likely that no more than 6 will be within the 250m zone at any one time.

In the 400m zone there are dock facilities and other storage facilities. Off-site injuries are likely with no off-site fatalities.

A risk tolerance criterion for a scenario based safety assessment of 1 x 10^{-6}/year is considered as a reasonable frequency for an open flammable cloud explosion causing up to 3 on-site fatalities and up to 6 off-site fatalities.

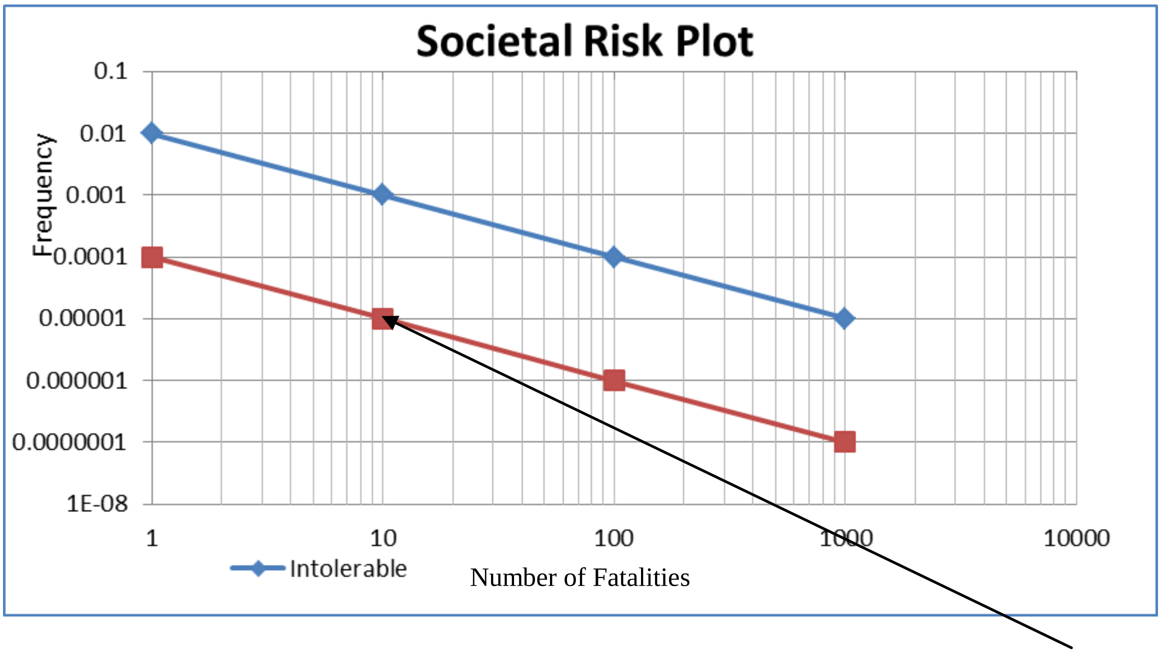
A risk tolerance criterion for a scenario based safety assessment of 1 x 10^{-5}/year is considered as a reasonable frequency for a flash fire causing up to 1 on-site fatality and no off-site fatalities.

These are considered as within the ALARP broadly acceptable region. (Consistent with Table 8 of Reference Document, PSLG report)
This is based on a figure of the possible number of fatalities during the hours of 4PM to 8AM.

Societal Risk

In this case, societal risk is not considered an issue as there are no population areas within 400m of the terminal. However, the Societal Risk plot is shown for information (Ref. PSLG Guidelines, Appendix 2, Clauses 44-50). A detailed plan showing the surrounding area is shown in Appendix 5. It can be seen that, within the anticipated extent of the gas cloud, there are no population areas and the number of people in the adjacent industrial buildings overnight is considered as low < 10.
The criteria adopted by HSE [R2P2] for addressing societal concerns arising when there is a risk of multiple fatalities occurring in one single event is given below. These were developed through the use of so-called FN-curves (obtained by plotting the frequency at which such events might kill N or more people, against N). HSE proposes that the risk of an accident causing the deaths of 50 people or more in a single event should be regarded as intolerable if the frequency is more the 1 in 5000 years (i.e. more than 2×10^{-4} per year).

Historical analysis of accidents has shown that on logarithmic plots (F-N) curves have a slope close to minus 1. Hence an F-N curve that passes through the intolerable criteria point with a slope of minus 1 is considered the upper criterion line above which the risk is intolerable. The 'Broadly acceptable' region is a region below a criterion line parallel to the upper line, but two orders of magnitude lower. The region between the two lines is the 'Tolerable if ALARP' region.



In this case the anticipated number of fatalities is considered to be in the order of 10. Thus the broadly acceptable risk would be in the order of 1×10^{-5} per year and the intolerable risk would be in the order of 1×10^{-3} per year. For the scenario discussed in this LOPA of an open flammable cloud explosion causing up to 10 fatalities, the calculated frequency is 7.58×10^{-7} per year, thus this is below the 'Tolerable if ALARP' region.

Individual Risk

This is not directly related to an individual's risk of on-site fatality. (Ref. PSLG Guidelines, Appendix 2, Clause 43).

For the above scenario of an open flammable cloud explosion, the calculated frequency is 7.58 x 10^{-7} per year. For any employee on the normal shift pattern. The following apply:

No of hours per shift:	8
No of shifts per year (Average):	4 x 52
Total hours per year:	1664
Fractional exposure:	0.19
Frequency of above event:	7.58 x 10^{-7} per year
Individual Risk from the above scenario	1.44 x 10^{-7} per year

Thus this a small fraction of the overall individual risk to an operator

A worst case scenario for an Open Flammable Cloud Explosion (Buncefield type) on this particular site, at a point during a normal working day for 8 hours per day (8AM till 4PM) 5 days per week, could be up to 45 fatalities. (Made up of 10 on site personnel and up to 35 offsite personnel within the 250m zone). The prevailing weather conditions and site location and topography would mitigate against the required flammable cloud being generated during normal working day hours.

Thus the following scenarios will be studied

Scenario 1: Overfill of gasoline tank during import from a ship leading to a potential open vapour cloud explosion causing up to 3 on-site fatalities and up to 6 off-site fatalities.

Scenario 2: Overfill of gasoline tank during import from a ship leading to a potential flash fire causing up to 1 on-site fatality and no off-site fatalities.

Off-site Domino effects have been examined. It is considered unlikely that there could be potential offsite domino effects as there are no susceptible sites within the 250m zone.

Onsite domino effects could also lead to an expansion of a possible fire after the initial explosion, which is unlikely to cause any further fatalities but would potentially lead to an environmental release, which is discussed below.

4.1.2 Consequence to the Environment (Ref. PSLG Guidelines, Clauses 51-53)

The environmental consequences resulting from a tank overflow may be direct (e.g. pollution of aquifer by released substance) or indirect (pollution from fire fighting efforts). The following summarises the ecological effects of fuel:

- **Gasoline:** Classified as Dangerous to the environment R51/53. Acute effects, but no chronic effects. The effects on the natural environment of even a total spill are considered to be slight to moderate. Bioaccumulation effect is not seen as significant.

The ISCo East terminal is located on the south side of the Humber River on indigenous impervious clay The area does however overlay an aquifer but this is protected by the significant clay cover which has been demonstrated to achieve a permeability of less than 10^{-9} m/s and hence sensitivity of the ground and groundwater in respect of a MATTE potential can be considered to be very low. The site is effectively built on flat ground, which limits the horizontal movement of releases. The major environmental receptor of interest is thus the River Humber located to the north of the terminal, some 50 m from the gasoline storage tanks.

With reference to Table 4 - section 4, a risk tolerance criterion of 1×10^{-6} /year is considered a tolerable frequency for a single scenario major environmental consequence.

Possible environmental issues following a tank overfill event and ignition would be as follows:

- OFCE – overpressure damage
- OFCE – thermal radiation damage
- OFCE – harm from fuel / firewater run-off
- Fire – thermal radiation damage
- Fire – harm from fuel / firewater run-off

All events have the potential to escalate.

OFCE – overpressure damage

Due to the location of the facility and absence of local habitat (See Appendix 7) it is not considered likely that overpressure damage would cause any significant threat to the environment.

OFCE – thermal radiation damage

Again due to the location of the facility and lack of habitat (See Appendix 7) it is not considered likely that thermal radiation damage would cause any significant threat to the environment.

Fire – thermal radiation damage

Again as above (See Appendix 7) it is not considered likely that thermal radiation damage would cause any significant threat to the environment.

Fire – harm from fuel / firewater run-off

In the event of a considerable escalation of the fire and damage to nearby on-site facilities and to bund walls following a flammable cloud explosion, it is possible that a limited release of chemicals, fuels, or fire-fighting water from the site could flow north initially via the East Riverside ABP road surface and drains, to potentially enter the Humber and generate a short-term low consequence MATTE. **This is viewed as the worst case scenario from an environmental viewpoint.**

Information has been supplied from the Competent authority which states that:

For fire / un-ignited events

- Concrete or earth bunds, PFD = 0.1 (this may increase, e.g. to 0.25 if the bund is not upgraded due to the operator demonstrating it meets requirements SFAIRP – e.g. if it includes a gravity drain system)
- Tertiary containment = 0.1

Thus the maximum credit claimed by operators for fully upgraded secondary and independent tertiary containment is a combined PFD of 0.01 for un-ignited and fire scenarios. It has been noted that no tertiary containment was available. In the LOPA no credit has been taken for the Environmental case, Scenario 3.

For an explosion case, the probability of bund failure has been taken as 0.8 using information supplied from the Competent authority.

The environmental consequence in respect of a release but a ‘non-ignition’ is however considered to be low, as all of the tanks are all installed in impervious bunds with adequate bund capacities and wall strength. Temporary pumping facilities could also be made available to transfer liquids from bund to bund, if required. There would be little environmental damage as little or no water and/or fire-fighting chemicals would be released.

Environmental Scenario to be studied

Scenario 3: Overfill of gasoline tank during import from a ship leading to a fire and a release to the River Humber corresponding to a potential short-term major environmental consequence to the River Humber.

The worst environmental case described above is thus presumed to result in a breach of the bund wall, causing a potential release to the River Humber. This might constitute a short-term MATTE, subject to the volume, components and duration of the release actually reaching the river. The likely pathway is via the Riverside road and its associated road drainage system. In the event that the pollutants did reach the water surface, they would be likely be carried away on the tide. It is conventionally considered that gasoline would evaporate rapidly on the water surface before causing any permanent damage although fire-fighting agents and other pollutants may constitute a short-term concern.

5 GASOLINE IMPORT REVIEW

5.1 Storage Facility

Gasoline is imported to three tanks on the ISCo East site (561, 564 & 568).

Super unleaded gasoline is imported to tank 561 typically in $2267m^3$ (1700 Te) batches. The capacity of the tank is $3282\ m^3$.

Premium unleaded is imported to tanks 564 & 568 typically in $8000m^3$ (6000 Te) batches. The capacity of the tanks are $5412m^3$ for tank 564 & $5625m^3$ for tank 568.

All batches are checked before and after transfers using the Automatic Tank Gauges (ATG), manual dipping by the client's surveyor and the checking of the book stock records.

The transfers are carried out by connecting the ship import line to the selected receiving tank using hoses at the 4 East Hose Pit within the storage facility. The routing to the tanks is controlled by manual routing valves.

5.1.1 Routing

The possible routings are described in a sketch of the system, See Appendix 8.
There are two Pipeline feeds (JP27 – 10" & JP32 – 8") from the Simon terminal jetty. Gasoline is pumped direct from ship to pipeline and for Super-unleaded into a single storage tank. For Premium unleaded the gasoline is pumped to two tanks consecutively. Note: There is also a possible route through JP32 via the 700 series tank area & Bridge Line, though it is not the terminal's intention to use this line for import of gasoline.

There is a 14" line (JP41) from the jetty which can also feed to the gasoline storage tanks. It is not the terminal's intention to use this line for import of gasoline.

There is a 10" line (JP37) from the jetty which can also feed to the gasoline storage tanks via 4 East hose pit. This line is out of service at present but is due to be cleaned and repaired. It is not the terminal's intention to use this line for import of gasoline.

There are two pipeline feeds (APT10 & APT12) from the refineries via APT and these lines will not be used at present. These lines are already protected by actuated valves which close on the activation of a high high level switch in any of the three tanks. (561, 564 & 568)

There are two cross dock lines which could be used to import gasoline, however it is not the intent of ISCo East to use these for import. These lines will be used to export gasoline from the three tanks to ISCo West.

There are no other routes from the jetties or APT. All other lines to 4 East hose pit are dedicated to other products. The terminal controls the manifold route selection.

The complete pipeline system runs through the area under control of ISCo. Normal direct public access is not allowed. There are 3 gasoline tanks and the receiving tank is selected by the client and validated by ISCo.
Only one tank will be selected for import at any one time. All tanks have ATG systems with software alarms activated at high level. Alarms are identified on the Control Room Annunciator and broadcast on the Terminal's Radio System. There is an independent high high level trip which again sounds an alarm, is identified on the Annunciator, broadcast over the Radio and also closes the Automated Shutdown Valve on the inlet of the tank receiving product.

5.1.2 Operation

Example documents relating to the various steps described below are included in Appendix 6.

Prior to an import taking place, ISCo receive a client nomination with details of the ship, parcel size and timings and the bill of lading is received from the ship's agent. An ISCo work order is then prepared. The book stocks are checked by operations and stocks to confirm ullage available. If the details are confirmed and ullage is available, the cargo is accepted. If there is not enough ullage available the client is contacted and advised that the cargo will not fit. It is then incumbent on the client to export product from the tank pre-ship, or else lower the import quantity.
Once the ship is berthed, A third party surveyor then checks the stock on the ship and records it. The surveyor then dips the receipt tanks to check the quantity in the tank prior to import and that the book-stocks are correct and correlate to the ATG reading. This is written in the dip book and entered in the TASCS. If there is now a discrepancy, further checks will be carried out to confirm the quantities in the tanks.
There is a meeting between the ship and jetty operator to discuss and record import procedures, start-up and shutdown.
This is all recorded on the ship/shore checklist and jetty booklet.

The third party surveyor and operations are given a nomination from the client detailing the receipt tanks and in which order they will be selected.

The gauge readings are checked monthly by ISCo and compared with the monthly dip values to confirm that they are in working order and within calibration tolerance. If the dip values and gauge readings are not within tolerance, the dip values will be used to decide whether the import will be started.

There is no export from the tank whilst an import is taking place, as there is a common import/export line, thus the level readings should always be increasing during an import operation.

Once the ship is berthed and the dips and ullage checks have been carried out, the routing operation is carried out by connecting the ship import line to the selected receiving tank using spool pieces, manual valves & hoses via No. 4 East Hose Pit, within the storage facility. The routing is then recorded as complete on the work order. Once the routing has been carried out, there is an independent check that the route is correct. The transfer line (from the jetty to the hose pit including the hose to the dedicated tank import/export line) is then leak tested at 25 psig using air/nitrogen, for 30 minutes, and the route is then walked and visually inspected. The dedicated line from the hose pit to the tank is not leak tested, as it is normally left full of gasoline. The tank-side valve is always left open. The pressure is released using the hose pit valve to ensure that the ATG is not disturbed by the release of pressure through the storage tank.

Once the route is open in the hose pit and the tank, the operator walks to the tank side and informs the jetty operator (by radio) to start the ship's pumps at a low rate and open the jetty valve. The operator then confirms that import is taking place into the selected tank using the ATG at that tank. The start of import is recorded on the bulk movement sheet. Shipping Operations transfer log sheet includes the recording of the tank number and level in the tank at the start of import. The Operator radios this information to the jetty operator for recording The ISCo jetty operator and the ISCo operator will be in constant radio contact when import operations are taking place.

As there are only two tanks for premium unleaded and normal import will be to both tanks consecutively, the risk of overfill from the selection of an incorrect premium unleaded gasoline tank is minimal.

As there is only one tank for super unleaded it is not possible to connect to an incorrect Super unleaded tank.

For ship imports, the pumps are under the control of the ship. Simon operational procedures are that all import operations are stopped on any high level alarm. The jetty operator can stop the import by instructing the ship to stop pumping or by closing the jetty manual valve. The jetty operator can also set off the fire alarm using the site phone system which will close the actuated tank import valves. Radio communications are constant between the ship and Simon Operations.

Checks are carried out at a maximum interval of 2 hours. The charge hand/No.1 operator uses the ATG display in the control room to record the level, the flow rate (at that time) and cumulative total received in the tank. (Recorded on bulk movement sheet). The jetty operator records time and flowrate (at that time). Shipping Operations transfer log sheet includes the recording of the cumulative quantity discharged from the ship. Jetty operator radios this information to the charge hand/ No.1 operator for recording and comparison on the modified bulk movement sheet. Any discrepancies will be investigated and if necessary the import stopped.

The control room is not permanently manned.

A manual calculation is performed to estimate predicted batch completion but it is not currently recorded.

When filling a tank to its normal fill, or any selected level, within the predicted final stages, the level readings are regularly monitored by the ISCo operator using the gauge at the actual tank side. The ISCo operator will be at tank-side during the final stages of predicted import to monitor the local gauge and to shut off the transfer to the initially selected tank. The operator normally attends the tank half an hour prior to the tank final level being reached. This time interval is derived by the charge-hand.
As the tank reaches its predicted fill level, the tank-side operator contacts the jetty operator approx. 15 minutes before the predicted fill level to warn the ship operator that a stop order is imminent. At the predicted fill level the ship is instructed to stop pumping and the jetty operator closes the jetty valve. The tank-side operator attends the No. 4 East hose-pit and isolates the tank. The operator then clears the hose exchange hose into the tank in preparation for routing to the next tank. The operator then routes the hose to the next tank,

leak tests the hose and restarts the import to the new tank. The operator attends the tank as before to confirm that the import starts.

At the end of the import, the ship will stop automatically having completed the export of its cargo. There will be contact between the tank-side, jetty operator and the ship to confirm the completion of the import. Once the import is complete the ship will stop its pumps and isolate the ships manifold. The jetty hose will be cleared of product into the import line and isolated. The hoses will then be disconnected. The jetty line to the hose-pit will then be pigged clear. There is a maximum amount of 50 m^3 that will be sent to the tank during this operation.

No tank to tank transfers are routinely carried out. If a tank is to be taken out of service then any transfer is carried out under management procedures.

ATG Alarms via VTW System
Topping Off Alert (Facility available, set 60 minutes from predicted finish time)
Normal Fill Level Alert (Set at 95% at present)
High Level Alarm (Set at 96% at present)
The normal fill level alert and high alarms are purely audible alarms within the control room and transmitted through the radio system.

Other alarms
There is an independent high high level switch and shutdown system which closes the Automated Shutdown valve on the receiving tank inlet. The activation of the switch is transmitted to a control room annunciator and repeated to the radio system. (Set at 97% at present)

(For tank 561 = 6931mm, time to overfill after high high level activated: 5.4 minutes)
(For tank 564 = 8662mm, time to overfill after high high level activated: 9.9 minutes)
(For tank 568 = 8662mm, time to overfill after high high level activated: 9.9 minutes)

Power Failure
In the event of a site wide power failure the terminal operator will contact the jetty to stop transfer.
The VTW, annunciator and radio base station are powered by a UPS. Level monitoring on tanks will fail. The high high level switches will activate and the shutdown valves will close.

5.2 Ship Import

Gasoline is imported from a ship in packages of up to 8,000 m^3, although the ship could be carrying more. The amount to be imported is transmitted to the site management and the client's surveyor. The management team check the receiving tank to confirm level in the tank and ullage available. The import operation is carried out under operational procedures with radio contact between the ship and the terminal operator. Any problems with the operation are advised and the operation is stopped.

5.3 LOPA Review

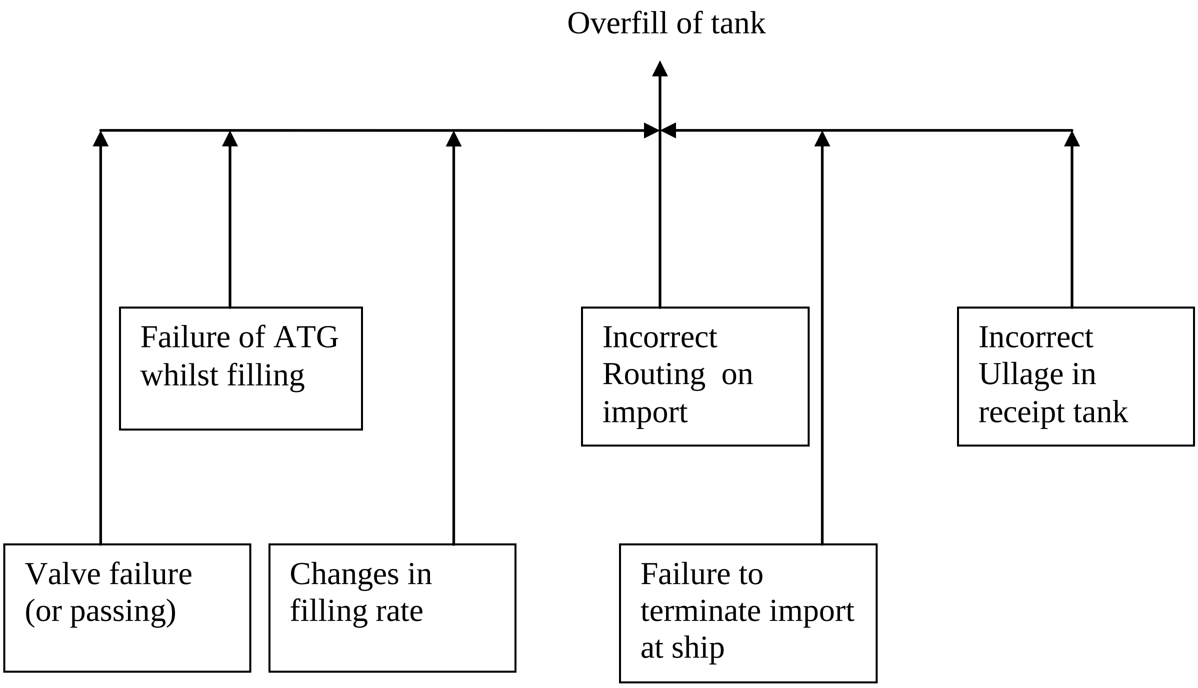
5.3.1 Enabling Events Gasoline Import

	Grade of Product	
	Super Unleaded Gasoline	Premium UL Gasoline
Number of Import Operations per year	6	12
Average quantity transferred	2267m^3	8000m^3
Number of Tanks	1	2
Maximum flowrate	250Te/hr	250Te/hr
	333.3 m^3/hr	333.3 m^3/hr
Total time transfer occurs	40.8 hrs/yr	288 hrs/yr
Time transferring to 1 tank	40.8 hrs/yr	144 hrs/yr
Fraction of year transferring to a tank	(40.8/8760) = 0.0047	(144/8760) = 0.0164

Fraction of year transferring any individual tank (0.0047 + 0.0164) = 0.0211

5.3.2 Initiating Event Likelihood (Ref. PSLG Guidelines, Clauses 55-57)

Initiating events were determined using a demand tree



Three of the initiating events were identified as the controlling factors in a possible overfill:

Incorrect Routing on import
Incorrect Ullage in receipt tank. (Not enough ullage to take full import quantity)
Failure of ATG (Sticks or reads low)

Initiating Event 1

Cause	Description	Notes	No of events/year
1	Whilst importing from a ship, overfill of Gasoline Tank due to incorrect line up.	Operator lines up to an incorrect tank. There are 18 Imports per year. (Consideration should be given to incorrect product introduced by incorrect lineup) Probability of incorrect line-up: 9.69×10^{-3} based on HEART Data. (See Appendix 2). Probability based on historical group site date, for operator making error over 10 years = 1.35×10^{-4} (See Appendix 3). Conservative probability of operator error assumed = 0.1 (Total Frequency using HEART: 18 x .01 /yr)	1.8×10^{-1}
AND	I.E. Modifier 1	Cross Check: Operator attends selected tank at start of import and confirms that, whilst the transfer is at a low flowrate, flow has started to the correct tank. Once the operator confirms the tank number and that flow has started with the jetty operator, then the flowrate is increased. The start level is recorded on the bulk movement sheet. It is considered that the jetty operator has sufficient independence from the person carrying out the original action and the check is designed to highlight errors that may have occurred ion routing. The jetty operator has a copy of the Work Order and is aware of the tank designated on that sheet. If the routing is incorrect then flow will not start to the correct tank and the tank-side operator will pick up the error. The Probability that incorrect routing is not picked up by checks and corrected = 0.065 based on HEART Data (See Appendix 2). Probability based on historical group site data, for operator making error over 10 years = 6.74×10^{-5} (See Appendix 3) Conservative probability assumed = 0.1	0.1

Overall Frequency of Initiating Event :
$(1.8 \times 10^{-1}) \times (1 \times 10^{-1})$
$= 1.8 \times 10^{-2}$ per year

Initiating Event 2

Cause	Description	Notes	No of events/year
2	Whilst importing from a ship, overfill of Gasoline Tank with correct line up due to the capacity of the tank being less than expected.	Surveyor performs manual dip prior to the start of each import operation. 18 Ship Imports per year. Probability that the manual dip is incorrect and under-dipped by a metre or more. (This is the amount considered between normal fill alert and overfill where the dip reading could lead to a problem) $9.69x\ 10^{-3}$ based on HEART Data. (See Appendix 2). Probability based on historical group site data, for operator making error over 10 years = 1.35×10^{-4} (See Appendix 3). Conservative probability of operator error assumed = 0.1. (Total Frequency: 18 x .01 /yr). This is conservative as here it has assumed the worst case scenario where the quantity being charged is in excess of the available ullage.	1.8×10^{-1}
AND	I.E. Modifier 1	Cross Check: Operator / Stock clerk confirm dip figure with book-stock figures prior to import. (Using Software) Book-stock is updated from receipts (from imports) and exports. The cross check also compares the Bill of lading against physical dip/ullage. Probability that incorrect ullage is not picked up by checks and corrected = 0.065 based on HEART Data (See Appendix 2). Probability based on historical group site date, for operator making error over 10 years = 6.74×10^{-5} (See Appendix 3) Conservative probability assumed = 0.1	0.1

Overall Frequency of Initiating Event :
(1.8×10^{-1}) x (1×10^{-1})
= 1.8×10^{-2} per year

Initiating Event 3

Cause	Description	Notes	No of events/year
3	ATG Failure (Sticks or reads low). This can happen during import.	The most conservative allowable failure data for an ATG (Not SIL rated) is a frequency of not better than $1e^{-5}$ /hr. Site reliability data suggests a figure much lower than this however this is not readily verifiable. Manufacturer gives a MTBF (all modes) of 53 years for ENRAF Gauges.	0.1
AND	Enabling Event 1	The Tank has to be on fill and the total proportion of the year when import to the tank is ongoing. Probability = 2.11×10^{-2} (see 5.3.1) This explicitly assumes that the ATG has not failed at the start of import. The ATG is monitored at the start of import, thus the ATG not failed is confirmed.	2.11×10^{-2}

Overall Frequency of Initiating Event :

$(1 \times 10^{-1}) \times (2.1 \times 10^{-2})$

$= 2.1 \times 10^{-3}$ per year

Note 1:Reliability Data for ATG/BPCS
The LOPA uses an order of magnitude 0.1 PFD for the level and control system. This is the maximum that can be taken for a non SIS system not designed to BS EN 61511. However, there is a modern control system which has been designed with a significant amount of diagnostics utilising modern process control instrumentation.

Note 1: PSLG Guidelines, Appendix2, Sections 73 - 76

The role of cross checks:

Many tank-filling operations include a number of cross-checking activities as part of the operation. These may include checks before the transfer starts (eg routing valve line-up, tank dips, available ullage) and periodic checks during the filling operation (eg to confirm the filling rate, carry out tank dips or check for unusual behaviour of instruments).

Depending on the circumstances, cross-checks may be represented in the LOPA as modifiers to the initiating event frequency or as part of a protection layer. If the initiating events include a contribution for misrouting, then the frequency of misrouting may be adjusted if a suitably rigorous cross-check is carried out. If the tank filling operation requires an initial tank dip to be carried out, the frequency of the dip being incorrectly carried out or recorded may be affected by a suitable cross-check. If the tank filling operation requires periodic checks of the level to be carried out, this may provide an opportunity to identify that a level gauge has stuck or that the wrong tank is being filled.

Cross-checks can provide an opportunity to detect and respond to an error condition, whether the condition has been caused by a human error or an equipment failure. The amount of credit that can be taken for the cross-check will depend on the specifics of what is being checked and the degree of independence of the check. This is discussed in more detail in Annex 6.

Various human reliability assessment techniques may be used to evaluate the effectiveness of cross-checking activities – for example THERP (Technique for Human Error Rate Prediction). It is important that any assessment is made by a competent human reliability specialist and that it is based on information provided by the operators who actually carry out the filling operation.

Note 2: The cross checks credited above are effective and auditable and are signed for on the shipping instruction sheet for each import operation. Some cross checks are not fully independent due to dependencies between the person carrying out the task and the person checking and where necessary the probability of failure assumed has been increased to account for this.

Other causes not assessed in detail as their contribution is significantly lower than causes 1 through 3.

Cause	Description	Notes
4	Valve failure (or passing) on a route where import is not expected.	All routes have at least two isolation valves with automated tank inlet valves. Probability of this failure leading to an overfill is very low compared to other initiating events.
6	Changes in the filling rate due to changing operations on other tanks.	Not considered as an issue, as only one tank is filled at a time. The maximum quoted rate for a ship import is 250te/hr (333m^3/hr)
7	Failure to terminate filling at the ship on request from terminal	The ship operators and ISCo operations are monitoring the transfer and will normally stop at the required parcel quantity. Contact is made with the ship operations to warn that the tank is reaching its required quantity. The ship is highly unlikely to export more than the contracted quantity.

5.3.3 Independent Protection Layers (Ref. PSLG Guidelines, Clauses 78-86)

Protection layers are totally independent, effective and auditable.

Protection Layer 1
BPCS with Level Indication and alarms monitored by Operator
A VTW (SCADA) system enables the operator to view the tank levels.
ATG Alarms
Topping off alert
Normal fill alert
High Level Alarm
The normal fill level and high alarms are software derived from the VTW. The alarms are audible within the control room and transmitted by radio.

This is primarily the function of the shift supervisor & No. 1 operator. The credit taken for the layer above is calculated as:
((1-PFD(sys) x (PFD(Operator)) + PFD(sys)
i.e. ((1 - 0.1) x (0.1)) + 0.1 = 0.19

Experience from other sites for modern Control Systems suggests reliability data much better than 1 in 10 years.

Note 1: Reliability Data for VTW/BPCS
The LOPA uses an order of magnitude 0.1 PFD for the level and control system. This is the maximum that can be taken for a non SIS system not designed to BS EN 61511. However, this is a modern control system which will be designed with a significant amount of diagnostics utilising modern process control instrumentation.
The credit taken for the layer above is taken as 0.19

The protection layer is auditable via the site maintenance records for failures of level measuring devices and associated SCADA systems. The level monitoring function of the control system includes the ATG, VTW and Radio Alarms.

Protection Layer 2
High High Level alarm and automatic closure of import valves
Mid Range SIL 2 SIS
The actual credit available from the SIS is calculated as: 2.5×10^{-3}. See SIS Design Report SI277001_RPT. The protection layer will be auditable via the SIS maintenance and testing records.
It is considered that this Protection Layer can be used for all initiating events as all of the gasoline tanks are protected by individual tank-side valves that will close on activation of the level switch on that particular tank. Within the scope of this LOPA, a gross misrouting of gasoline into any other tanks on the terminal has not been considered.

Protection Layer 3
Cross Check: Quantities transferred from ship is compared to total quantity imported to the tank.
Probability that cross check by the sender of what has been exported from the ship compared to what has been received in the tank send fails = 0.1
The protection layer is auditable via the movement transfer records.

5.3.4 Mitigation Layer – All Scenarios.

1. Failure of Detection of overflow and action – Mitigation Layer

A large release may not be detected and even if detected may not be stopped. A manual operation to shut down the transfer is possible but an operator may be required to approach close to the vapour cloud. The area ESD may or may not shut-down the transfer. The most realistic method of stopping the release is to stop the import of gasoline by shutting the ship down.

Site operations consider that, in this case, the possibility of preventing a large release is low thus no credit for this layer has been taken.

Probability of not detecting and stopping the release. 1.0

5.3.5 Conditional Modifiers - Scenario 1, Overfill of gasoline tank during import from a ship leading to a potential open vapour cloud explosion.

1. Probability of required meteorological conditions for OFCE

The probability of the weather conditions being conducive to allow a build up of vapour such as to cause an open flammable cloud explosion is extremely low. The figure considered in this LOPA assumed that the weather conditions had to be E& F conditions (Stable) with wind speeds less than 2m/s. (Site data indicates E conditions with probable wind speeds of 4.4 m/s for 5% of the time and F conditions with probable wind speed 2.8m/s for 3% of the time (See Appendix 4). Assumed probability for wind speeds of <= 2m/s and conditions E & F = 0.043. See sensitivity analysis for further details)

Probability 0.043

2. Probability of delayed ignition producing an explosion of a large flammable cloud

The vapour/mist cloud will be large and may drift. There may be sources of ignition outside the bund. The most probable source of ignition is deemed to be either road vehicles, a switchroom or the road outside the site. The site is not confined by any topographical features or vegetation and is open to water on the North Side. The probability of a delayed ignition leading to an explosion was discussed in detail and it was felt that on the terminal it should not be assumed to be unity. However, offsite sources of ignition are uncontrollable and thus the overall probability of ignition will be taken as unity. There are no continuous sources of ignition.

Probability 1.0

3. Probability of personnel being in affected area

The chance of any personnel being present is considered as 100% as an OFCE, as at Buncefield, would extend over a large enough area (250m radius) to affect personnel.

Probability 1.0

4. Probability of a fatal injury

The likelihood of fatality is considered as absolute. (This figure is felt to be extremely conservative, and is based upon explosion risk).

Probability 1.0

5.3.6 Conditional Modifiers - Scenario 2, Overfill of gasoline tank during import from a ship leading to a potential flash fire.

1. Probability of required meteorological conditions

The probability of the weather conditions being conducive to allow a flash fire is unquantifiable as flash fires can occur in most weather conditions. The assumed probability is 100%

Probability 1.0

2. Probability of ignition producing flash fire

The vapour/mist cloud will be large and may drift. There may be sources of ignition outside the bund. The most probable source of ignition is deemed to be either road vehicles, a switchroom or the road outside the site. The probability of an ignition leading to a flash fire was discussed in detail and it was felt that on the terminal it should not be assumed to be unity. However, sources of ignition are uncontrollable and thus the overall probability of ignition will be taken as unity. There are no continuous sources of ignition.

Probability 1.0

3. Probability of personnel being in affected area

The chance of any personnel being present in the area affected by the fire, essentially within the Bund area, is considered very low as there are a low number of personnel out on site at any one time.

Probability 0.1

4. Probability of a fatal injury

The likelihood of fatality in a flash fire is not considered as absolute. Typically most would survive a flash fire.

Probability 0.5

5.3.7 Conditional Modifiers - Scenario 3, Overfill of gasoline tank during import from a ship leading to an explosion, fire and a consequent release to the River Humber corresponding to a potential short-term major environmental consequence to the River Humber.

1. Probability of required meteorological conditions for OFCE
The probability of the weather conditions being conducive to allow a build-up of vapour such as to cause an open flammable cloud explosion is extremely low. The figure considered in this LOPA assumed that the weather conditions had to be E& F conditions (Stable) with wind speeds less than 2m/s. (Site data indicates E conditions with probable wind speeds of 4.4 m/s for 5% of the time and F conditions with probable wind speed 2.8m/s for 3% of the time (See Appendix 4). Assumed probability for wind speeds of <= 2m/s and conditions E & F = 0.043 See sensitivity analysis for further details)
Probability 0.043

2. Probability of ignition

The vapour/mist cloud will be large and may drift. There may be sources of ignition outside the bund. The most probable source of ignition is deemed to be either road vehicles, a switchroom or the road outside the site. The site is not confined by any topographical features or vegetation and is open to water on the North Side. The probability of a delayed ignition leading to an explosion was discussed in detail and it was felt that on the terminal it should not be assumed to be unity. However, offsite sources of ignition are uncontrollable and thus the overall probability of ignition will be taken as unity. There are no continuous sources of ignition.
Probability 1.0

3. Probability of bund failure

The probability of gasoline liquid and other components escaping from the bunds in the event of a fire is dependent on the period of the fire. The tanks are all installed in impervious bunds with adequate capacity, wall strength, and fire-resistance, but it is acknowledged that a long period fire may cause some sections of the walls and joints to become compromised.
Reference "Bund effectiveness in preventing escalation of tanks farm fires", Davies, Harding, MaKay, Robinson and Wilkinson, IChemE symposium series No 139. Also published as Process safety and environmental protection, Trans IchemE vol. 74, n°2, pp. 88-93, 1996
Probability of bund wall failure is taken as 0.8

4. Probability of release into the River

Liquid gasoline and fire-fighting components would need to travel along the ABP Riverside road or its drainage system to reach the River Humber and be of a sufficient quantity and duration to constitute a major Environmental Consequence. This is seen to be a low probability, however it is unquantifiable and thus no credit has been taken.
Probability of a release reaching the river is taken as 1.0

5.3.8 Sensitivity (Ref. PSLG Guidelines, Clause 150)

The calculations of frequency and probability for the initiating events are necessarily subjective but the following sensitivity can be shown:

The frequency of an overfill, without the SIL 2 layer of protection or any conditional modifiers is calculated as 3.81×10^{-2} per year. HSL have suggested that there are about 300 Buncefield type sites worldwide, with an event frequency of around 3 – 10 years suggesting a frequency of around 10^{-4} per year per site. The frequency calculated via this LOPA is approx. 2 orders of magnitude greater than that suggested by HSL.

The frequency of the ATG failure, for Initiating Event 3, has been taken as 0.1 per year which is the maximum that can be claimed for non SIL rated equipment. If this was increased to unity, then the probability of an explosion would be raised to 9.6×10^{-7} per year. Even if the ATG was failed during every gasoline import, the effect is not significant.

For initiating events 1 or 2, if the HEART data was used to show a more conservative probability of human error approaching 0.1, then the initiating event in Scenario 1 or 2 would be raised to 0.18 per year and thus the frequency of an explosion would be raised to 7.38×10^{-6} per year and would predict that the overfill probability increases to greater than 1 per 2.76 years which is unlikely.

The frequency of an overfill, without the SIL 2 layer of protection or any conditional modifiers is calculated as 2.14×10^{-4} per year. This is comparable with the HSL figures discussed above.

Conditional Modifiers are not generic and should be subject to local site conditions, properties of materials and location of facilities.

There is uncertainty about the figures used for the conditional modifiers and mitigation layers and it was felt that a conservative approach has been taken. However, the sensitivity of the figures used above have been considered.

The assumed probability for wind speeds <2m/s and E & F conditions has been assumed as 4.3%.
The data for wind speeds <2m/s and E & F conditions is not available however Site data indicates E conditions with probable wind speeds of 4.4 m/s for 5% of the time and F conditions with probable wind speed 2.8m/s for 3% of the time (See Appendix 4). We have allowed for E conditions with wind speeds <2m/s for ((2/4.4) x 5) = <2.27 % of the time and for E conditions with wind speeds <2m/s for ((2/2.8) x 3) = <2%. Total = 2.27+2 = 4.27 % of the time.
If this probability was raised to 5% then the Risk tolerance criteria would still be met

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APPENDICES

Appendix 1 – Layer of Protection Analyses
LOPA Calculation Sheets

P & I Design Ltd - LOPA Calculation (Multiple Initiating Events)

Project:	LOPA Review
Client:	Simon Storage
Client Ref:	Immingham East Terminal
Document:	SI057002_CAL
Title:	Immingham East LOPA Review - Safety Case, OFCE

Originator:	DSR	DSR	DSR		
Checked:	DRR	DRR	DRR		
Approved:	Simon	Simon	Simon		
Issue:	A	B	C		
Date:	16/02/2007	01.01.2007	30.06.2011		

	Scenario	Initiating Event Frequency IEF	Conditional Modifier	Conditional Modifier	Conditional Modifier	Conditional Modifier (Others)	Protection Layer 1	Protection Layer 2	Protection Layer 3	Protection Layer 4	Mitigation Layer 1	Total PFD for all PL's	Frequency of IEF x PL's
Description	**Major Release of Gasoline from any single on-site tank leading to possible fire/explosion and major Damage to Storage Facility**		Probability of required meteorological conditions for OFCE	Probability of ignition	Probability of personnel in affected area	Probability of fatal injury	BPCS with Level Transmitter and level alarms monitored by Simon Operator	SIL2 High High Level and Shutdown	Cross Check: Quantities discharged from ship is compared to quantity imported to tank.		Failure of Detection of overflow and action		
	Description												
IE No.	**Initiating events**	**Events/year**											
1	Whilst importing from a ship, overfill of Gasoline Tank due to incorrect line up.	1.80E-02					1.90E-01	2.50E-03			1.00E+00	4.75E-04	8.55E-06
2	Whilst importing from a ship, overfill of Gasoline Tank with correct line up due to the capacity of the tank being less than expected.	1.80E-02					1.90E-01	2.50E-03			1.00E+00	4.75E-04	8.55E-06
3	During ship import, failure of Level Instrument on the Gasoline Tank. Sticks or reads low and a charge imported to the tank is greater than expected.	2.11E-03						2.50E-03	1.00E-01		1.00E+00	2.50E-04	5.27E-07
	Total of Initiating Events = IEF1 + IEF2 + IEF3 + IEF4 + IEF5 + IEF6 + IEF7 + IEF8 + IEF9 + IEF10 + IEF11	3.81E-02	0.043	1.000	1.000	1.000	Incident Frequency = (IE1 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE2 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE3 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE4 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE5 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE6 x PL1 x PL2 x PL3 x PL4 x PL5)						1.76E-05

Conditional Modifiers = CM1 x CM2 x CM3 x CM4
0.043

LOPA Summary	
Risk Tolerance Criteria	1.0E-06
Frequency of Unmitigated Consequence	1.64E-03
Frequency of Mitigated Consequence	7.58E-07
Risk Tolerance Criteria Met	Yes

LOPA Calculation
Frequency of Unmitigated Consequence (per year) = Initiating Event Frequency (IEF1 + IEF2 + IEF3 etc) x Conditional Modifiers (CM1 x CM2 x CM3 etc)
Frequency of Mitigated Consequence (per year) = CM x {(IEF1 x PL1 x PL2 x PL3 etc) + {(IEF2 x PL1 x PL2 x PL3 etc) + {(IEF3 x PL1 x PL2 x PL3 etc) ....}

P & I Design Ltd - LOPA Calculation (Multiple Initiating Events)

Project:	LOPA Review	**Originator:**	DSR			
Client:	Simon Storage	**Checked:**	DRR			
Client Ref:	Immingham East Terminal	**Approved:**	Simon			
Document:	SI057003_CAL	**Issue:**	A			
		Date:	30.06.2011			
Title:	Immingham East LOPA Review, Safety Case - Flash Fire					

Scenario		Initiating Event Frequency IEF	Conditional Modifier	Conditional Modifier	Conditional Modifier	Conditional Modifier (Others)	Protection Layer 1	Protection Layer 2	Protection Layer 3	Protection Layer 4	Mitigation Layer 1	Total PFD for all PL's	Frequency of IEF x PL's
Description	**Major Release of Gasoline from any single on-site tank leading to possible flash fire and a potential single fatality**		Probability of required meteorologic al conditions for flash fire	Probability of ignition	Probability of personnel in affected area	Probability of fatal injury	**BPCS with Level Transmitter and level alarms monitored by Simon Operator**	**SIL2 High High Level and Shutdown**	**Cross Check: Quantities discharged from ship is compared to quantity imported to tank.**		**Failure of Detection of overflow and action**		
	Description												
IE No.	Initiating events	Events/year											
1	**Whilst importing from a ship, overfill of Gasoline Tank due to incorrect line up.**	**1.80E-02**					**1.90E-01**	**2.50E-03**			**1.00E+00**	**4.75E-04**	**8.55E-06**
2	**Whilst importing from a ship, overfill of Gasoline Tank with correct line up due to the capacity of the tank being less than expected.**	**1.80E-02**					**1.90E-01**	**2.50E-03**			**1.00E+00**	**4.75E-04**	**8.55E-06**
3	**During ship import, failure of Level Instrument on the Gasoline Tank. Sticks or reads low and a charge imported to the tank is greater than expected.**	**2.11E-03**						**2.50E-03**	**1.00E-01**		**1.00E+00**	**2.50E-04**	**5.27E-07**
	Total of Initiating Events = IEF1 + IEF2 + IEF3 + IEF4 + IEF5 + IEF6 + IEF7 + IEF8 + IEF9 + IEF10 + IEF11	**3.81E-02**	**1.0**	**1.0**	**0.1**	**0.5**	Incident Frequency = (IE1 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE2 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE3 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE4 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE5 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE6 x PL1 x PL2 x PL3 x PL4 x PL5)						**1.76E-05**

Conditional Modifiers = CM1 x CM2 x CM3 x CM4
0.05

LOPA Summary	
Risk Tolerance Criteria	**1.0E-05**
Frequency of Unmitigated Consequence	**1.91E-03**
Frequency of Mitigated Consequence	**8.81E-07**
Risk Tolerance Criteria Met	**Yes**

LOPA Calculation
Frequency of Unmitigated Consequence (per year) = Initiating Event Frequency (IEF1 + IEF2 + IEF3 etc) x Conditional Modifiers (CM1 x CM2 x CM3 etc)
Frequency of Mitigated Consequence (per year) = CM x {(IEF1 x PL1 x PL2 x PL3 etc) + {(IEF2 x PL1 x PL2 x PL3 etc) + {(IEF3 x PL1 x PL2 x PL3 etc) ....}

P & I Design Ltd - LOPA Calculation (Multiple Initiating Events)

Project:	LOPA Review	**Originator:**	DSR
Client:	Simon Storage	**Checked:**	DRR
Client Ref:	Immingham East Terminal	**Approved:**	Simon
Document:	SI057004_CAL	**Issue:**	A
		Date:	30.06.2011
Title:	Immingham East LOPA Review, Environmental Case - OFCE		

Scenario		Initiating Event Frequency IEF	Conditional Modifier	Conditional Modifier	Conditional Modifier	Conditional Modifier (Others)	Protection Layer 1	Protection Layer 2	Protection Layer 3	Protection Layer 4	Mitigation Layer 1	Total PFD for all PL's	Frequency of IEF x PL's
Description	**Major Release of Gasoline from any single on-site tank leading to possible fire/explosion and consequent relase of gasoline and/or fire fighting chemicals**		**Probability of required meteorological conditions for OFCE**	**Probability of ignition**	**Probability of bund failure**	**Probability of release into the River**	**BPCS with Level Transmitter and level alarms monitored by Simon Operator**	**SIL2 High High Level and Shutdown**	**Cross Check: Quantities discharged from ship is compared to quantity imported to tank.**		**Failure of Detection of overflow and action**		
	Description												
IE No.	**Initiating events**	**Events/year**											
1	**Whilst importing from a ship, overfill of Gasoline Tank due to incorrect line up.**	**1.80E-02**					**1.90E-01**	**2.50E-03**			**1.00E+00**	**4.75E-04**	**8.55E-06**
2	**Whilst importing from a ship, overfill of Gasoline Tank with correct line up due to the capacity of the tank being less than expected.**	**1.80E-02**					**1.90E-01**	**2.50E-03**			**1.00E+00**	**4.75E-04**	**8.55E-06**
3	**During ship import, failure of Level Instrument on the Gasoline Tank. Sticks or reads low and a charge imported to the tank is greater than expected.**	**2.11E-03**						**2.50E-03**	**1.00E-01**		**1.00E+00**	**2.50E-04**	**5.27E-07**
	Total of Initiating Events = IEF1 + IEF2 + IEF3 + IEF4 + IEF5 + IEF6 + IEF7 + IEF8 + IEF9 + IEF10 + IEF11	**3.81E-02**	**0.04**	**1.0**	**0.8**	**1.00**	Incident Frequency = (IE1 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE2 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE3 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE4 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE5 x PL1 x PL2 x PL3 x PL4 x PL5) + (IE6 x PL1 x PL2 x PL3 x PL4 x PL5)						**1.76E-05**
			Conditional Modifiers = CM1 x CM2 x CM3 x CM4										
			0.0344										

LOPA Summary	
Risk Tolerance Criteria	**1.0E-06**
Frequency of Unmitigated Consequence	**1.31E-03**
Frequency of Mitigated Consequence	**6.06E-07**
Risk Tolerance Criteria Met	**Yes**

LOPA Calculation
Frequency of Unmitigated Consequence (per year) = Initiating Event Frequency (IEF1 + IEF2 + IEF3 etc) x Conditional Modifiers (CM1 x CM2 x CM3 etc)
Frequency of Mitigated Consequence (per year) = CM x {(IEF1 x PL1 x PL2 x PL3 etc) + {(IEF2 x PL1 x PL2 x PL3 etc) + {(IEF3 x PL1 x PL2 x PL3 etc) ....}

APPENDIX 2

HEART ASSESSMENT

Manual Task	Generic Task Type selected	Proposed Nominal Human Unreliablilty	EPC 1				EPC 2				EPC 3				Resultant Error Probability
			EPC	Modifier	APOA	Assessed Affect	EPC	Modifier	APOA	Assessed Affect	EPC	Modifier	APOA	Assessed Affect	
	F	0.003	2	10	0.1	1.9	7	8	0.1	1.7	n/a	n/a	n/a		9.69E-03
Incorrect Routing. The operator line-up to selected tank and walks the selected route.	Restore or shift a system to original or new state following procedures with some checking		A low signal to noise ratio		Low affect due to number of gasoline import operations		No obvious means of reversing an action		Low affect due to type of operation.						
	E	0.02	31	1.2	0.8	1.16	3	10	0.2	2.8	n/a	n/a	n/a		6.50E-02
Operator Cross Check	Routine, highly practiced, rapid task involving relatively low level of skill		Low Workforce Moral		High Affect taken for terminal personnel and due to generic task selected		A low signal to noise ratio		Low affect due to type of operation.						
	F	0.003	2	10	0.1	1.9	7	8	0.1	1.7	n/a	n/a	n/a		9.69E-03
Incorrect Dip. The surveyor dips the tank prior to gasoline import.	Restore or shift a system to original or new state following procedures with some checking		A low signal to noise ratio		Low affect due to number of gasoline dipping operations		No obvious means of reversing an action		Low affect due to type of operation.						

Appendix 3
Operator Reliability

Simon Storage Operator Reliability Survey

Historical critical error data

Errors during routine operations

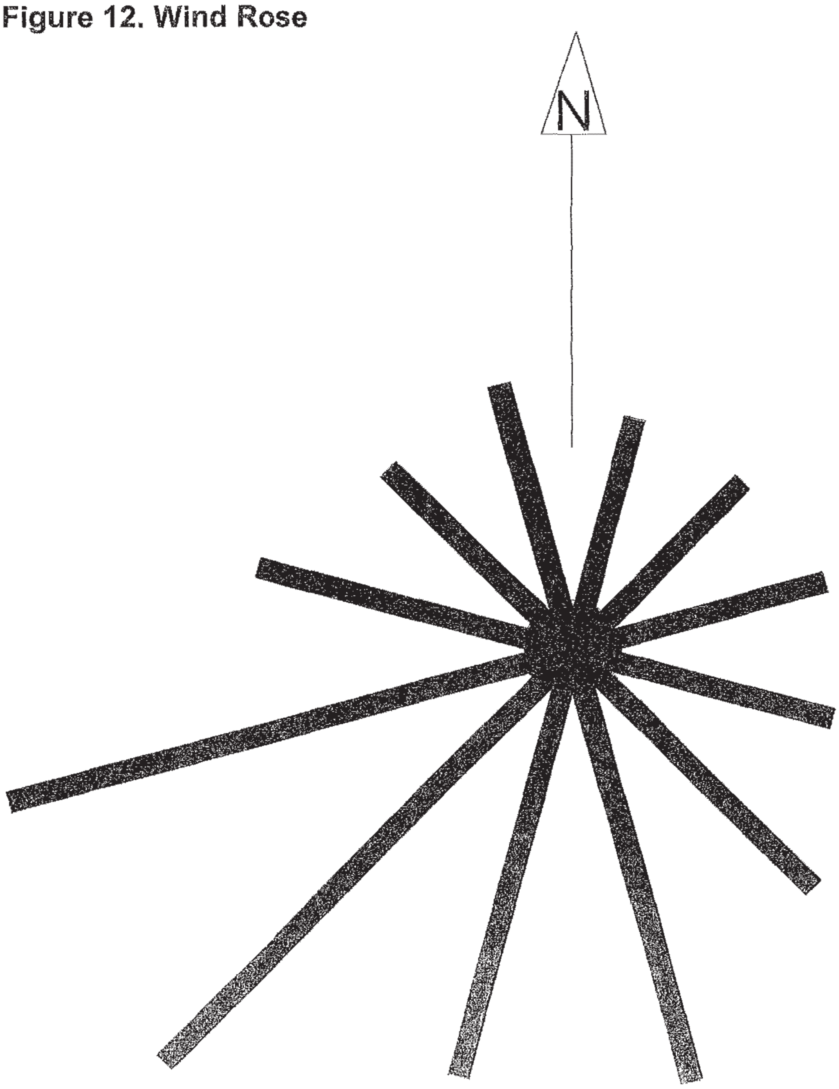
	HISTORICAL DATA (1998 - 2008)						Error probability (based on historical data)
	Seal Sands	**ISCO West**	**ISCO East**	**Tyne**	**Riverside**	**TOTAL**	
N^o. ship imports in last 10 years	3840	8185	1956	1110	853	**15944**	
N^o. pipeline imports (from external sites) in last 10 years	10920	12025	1119	1070	3804	**28938**	
N^o. tank-to-tank transfers in last 10 years	3650	5365	1874	2349	1255	**14493**	
Error: N^o. imports/tank transfers in which operator failed to rig up transfer line correctly	1	2	3	1	1	**8**	**1.35E-04**
Error: N^o. transfers in which supervisor/2^nd operator failed to identify operator's error (inadequate check or check not carried out). *Includes failures to check all aspects of the system set-up, not just rigging of transfer line)*	0	2	0	1	1	**4**	**6.74E-05**

Errors during emergency response

	HISTORICAL DATA (1998 - 2008)						Error probability (based on historical data)
	Seal Sands	**ISCO West**	**ISCO East**	**Tyne**	**Riverside**	**TOTAL**	
As a result of operator error during imports/tank transfers:							
N^o. release events (from pipelines/hoses)	0	3	3	0	0	6	*Note - very small data set makes following figures unreliable
N^o. times product sent to wrong tank	1	0	0	1	5	7	
N^o. tank overfill events (HLA went off)	2	1	1	1	0	5	
N^o. tank over-top events (product release)	0	1	0	0	0	1	
N^o. failures to respond correctly when:							
Error: Product was released	0	0	0	0	0	0	**0.00E+00**
Error: HLA was activated	0	0	1	0	0	1	**5.26E-02**

APPENDIX 4

Figure 12. Wind Rose



DIRECTION (Degrees)	% ANNUAL FREQUENCY
340 - 10	6.4
10 - 40	5.7
40 - 70	5.6
70 - 100	6.1
100 - 130	6.3
130 - 160	7.8
160 - 190	10.9
190 - 220	10.4
220 - 250	13.5
250 - 280	13.6
280 - 310	7.7
310 - 340	6.0

Pasquill Category	Stability	Most Probable Wind Speed (ms^{-1})	Weather Description	% Annual Frequency
A	Extremely unstable	1.0	Very sunny Warm weather	1
B	Moderately unstable	2.6	Sunny and Warm	4
C	Slightly unstable	4.4	Partial cloud during day	11
D	Neutral	7.0	Overcast day or night	76
E	Slightly stable	4.4	Partial cloud during night	5
F	Stable	2.6	Clear night	3

Table 1 Typical Meteorological Conditions

APPENDIX 5

Details of manning in areas local to Immingham (East) Storage Company

Area / Building	Description	Mon - Fri				Weekend			
		Typical		Worst Case		Typical		Worst Case	
		Days	Nights	Days	Nights	Days	Nights	Days	Nights
2	ABP - Bulk Park	20	0	35	20	0	0	15	15
9	ABP - Marine Control Centre	7	4	21	6	4	4	6	6
30	DFDS - shed 18	10	0	20	10	0	0	20	10
10	ABP - Engineers yard	30	0	40	4	0	0	10	2
17	ABP - Immingham Dock Office	31	1	50	4	5	2	6	5

Notes:
Only the ABP- Bulk Park is within the 250m zone of explosion.
The worst case figures for the ABP- bulk part include for the number of drivers entering and leaving the park during the day and night.
At night it can be assumed that, in general, only 1 or 2 drivers are on the site simultaneously. Worst case assumed – 6 personnel on site at night

APPENDIX 6

SIMON STORAGE - IMMINGHAM EAST TERMINAL
PROFORMA No.08 - SHIPPING OPERATIONS (Transfer Log Sheet)
Issued By K.D.Smith (31st January 1998)

VESSEL	AURILEA	**PRODUCT**	ULSD
CLIENT	MABANAFT	**SURVEYOR**	SGS
DATE 27/6/11	**TANK No.(s)** 618 603 602	**HEADER**	JP41.
RECORD HOSE NUMBERS	8" DEDICATED.		

INSPECTIONS	COMMENTS	COMP. (Initial)	INSPECTIONS	COMMENTS	COMP. (Initial)
Carry out Ship to Shore checks and record	Yes / ~~No~~	[signature]	Leak test result	Pass / ~~Fail~~	[signature]
Does line require leak testing	Yes / ~~No~~	[signature]	Leak test hoses when connected and record result	Pass / ~~Fail~~	[signature]
Leak test pressure required	Min 30 psi	[signature]	Walk line to verify integrity and record result	Pass / ~~Fail~~	[signature]
Are samples required	Yes / ~~No~~	[signature]	Samples draw and labelled	Yes / ~~No~~	[signature]
Record type of samples drawn	SHIPS MANIFOLD				

TIME	RATE	PRESS.	Initial	TIME	RATE	PRESS.	Initial
02:15	330 M³.	1.5 BAR.	[signature]	22,50	998 m³	4 Bar	KC
04:15	750 M³	5 BAR.	[signature]	0050	950 m³	4.2 Bar	KC
06:15.	750 M³	5 BAR	[signature]	0250	955 m³	4.2 Bar	KC
08:15	684m³	5BAR	N.E	04.30	STOP TO change Tank 602		
10:40	SHIP STOPPED FOR TANK CHANGE	—	N.E	04 50	ship RESTARTED TO 602		KC
10:50	SHIP RESTARTED INTO 603	—	N.E	300 m³ max For ROOF of LIFT *			
12:50	280m³	1 BAR	N.E		BERTH	23:20.	
14:50 (1500hr)	280 m³	0.8bar	[signature]		CON	00:25	
16.45	Ship increased Pressure to max		[signature]		START	01:15	
1650	285 m³	~~3.5~~	[signature]		FINISH	17.25	
1850	1006 m³	3.8	[signature]		DISCO.	17.40	
2050	1005 m³	3.8	[signature]		PTO	↓	

* SHIPS RADIO WHEN BATTERY DEAD GIVE TO SHIPS WATCHMAN TO CHANGE *
* MAKE SURE RADIO RETURNED TO SHIP WHEN FIN

SIMON STORAGE - IMMINGHAM EAST TERMINAL
PROFORMA No.08 - SHIPPING OPERATIONS (Transfer Log Sheet)
Issued By K.D.Smith (31st January 1998)

VESSEL	AuRiLea	**PRODUCT**	
CLIENT	page 2	**SURVEYOR**	

DATE		**TANK No.(s)**		**HEADER**	
RECORD HOSE NUMBERS					

INSPECTIONS	COMMENTS	COMP. (Initial)	INSPECTIONS	COMMENTS	COMP. (Initial)
Carry out Ship to Shore checks and record	Yes / No		Leak test result	Pass / Fail	
Does line require leak testing	Yes / No		Leak test hoses when connected and record result	Pass / Fail	
Leak test pressure required	Min 30 psi		Walk line to verify integrity and record result	Pass / Fail	
Are samples required	Yes / No		Samples draw and labelled	Yes / No	
Record type of samples drawn					

TIME	RATE	PRESS.	Initial	TIME	RATE	PRESS.	Initial
0650	SLOW 300 m³ max	0.8 Bar	KC				
08:50	Slow 235m³	0.8 Bar	LN				
Roof Lifted & increased to max 10.50	1000 m3	3 Bar	LN				
12.50	1002 m³	3.5 Bar	LN				
14.50	1032 m³	3.8 Bar	LN				
Ship Stopped For Stripping 15.25			LN				

(2)

SGS

SGS Oil Chemicals & Gas
a division of SGS (UK) Ltd

Middleplatt Road
Immingham
N.E Lincolnshire
DN40 1AH

Tel: 01469 557500
Fax: 01469 554511

To:	Simon Storage East Terminal ~~Simon Storage West Terminal~~	**Fax Ref:**	IMC
Attn:	ChargeHand East ~~Charge Hand West~~	**From:**	SGS OGC, Immingham
Our Re:	IMC	**Sender:**	P. Ellis
Fax No.	East : 563901 ~~West: 577010 / 554557 / 554560 / 554528~~	**Date:**	28/6/11

Vessel: AURELIA

Product: ULSD

All Fast	2336/27
Survey Completed	0036/28
Released to **Discharge/ ~~Shipping~~**	0100/28
Inspector	Paul Ellis
Authorizing SGS Chemist	—

	NL	@15	MT
Bill of lading	—	26373.454	21947.330
Vessel Figure	26283.185	26300.881	21887.593

Density	0.8333 in Vac
Vessel Ave Tank temp	14.2°c

Confirmed received by S.S.Co East/West

Name ______________ *Time & Date* ______________

Sent by Fax For SGS OGHC

Graypen
TANKER AGENCY SERVICES

To: SIMONSTORAGE EAST - FAX 3901

From: Lukasz Drucis

Date: 27/06/2011 07:46
Sent to: 563901

Subject: AURELIA BERTH

Number of Pages 1, including this page.

TO: SVITZER HUMBER.
CC: SIMON STORAGE EAST.

PLEASE SUPPLY 2 TUG - INWARDS

VSL	:	AURELIA / DDNW / 9327102
POSITION	:	ETA SPURN PILOT 2030/27TH
BERTH AT	:	IMM EAST JETTY - MAIN
TIME	:	2230/27TH
CONDITION	:	IN CARGO - 21947 MT ULSD 10PPM - UN 1202/IMDG 3375/CLASS 3.3 STOWAGE 1,2,3,4,5,6 P/S
DRAFT	:	9.00M
SDWT	:	24017
LAST PORT	:	PRIMORSK
TOTAL CREW	:	18

PLS INCLUDE OUR FILE NUMBER ON ALL INVOICES - HSB 13145.

Regards
Graypen Limited
Immingham

Tel: +44 1469 571567
Fax: +44 1469 552900
Email: Immingham@Graypen.com
Post: Queens Road, Immingham.
N.E. Lincolnshire. DN40 1QY

M A B A N A F T

To:	Vitol	Attn:	Peter Don	Fax:	E-mail
Cc:	Intertek	Attn:	Ivan Shabailov	Fax:	E-mail
Cc:	SGS	Attn:	Trevor Lovell	Fax:	E-mail
Cc:	ISCO East	Attn:	Andy Rhodes	Fax:	E-mail
Cc:	GAC	Attn:	Ian Fitzgerald	Fax:	E-mail
Cc:	Intertek	Attn:	Giorgio di Giorgio	Fax:	E-mail

From: Mark Rayner

Date: 23 Jun. 11

Our ref: VIT11(TP)0007

DOCUMENTARY INSTRUCTIONS

Aurelia / Sub

To load a cargo of:	ULSD 10ppm UK Summer Spec
Quantity:	21,976.999 mt
Loadport:	Primorsk
Product Origin:	Russian
Agents:	Eisa
ETA Loadport:	Loaded 23 June 2011
Load inspectors:	Intertek (costs 50/50 Vitol/Mabanaft Ltd)
Destination:	Immingham, East Jetty
Laycan Immingham:	25-30 June 2011
Disport inspectors:	SGS
Disport Agents:	Please confirm

Documentary instructions:	Bill of Lading	Certificate of Quality
	Customs Document	Certificate of Quantity
	Timesheet	Masters Receipt
(B/Ls to be made out or endorsed to "Mabanaft Limited")	Ullage report	Certificate of Cleanliness
	Certificate of Origin	Any other relevant shipping documents
	Certificate of Insurance	

All documents in one original and 3 copies.

Delivery Details:

Terminal name:	Immingham Storage Company Limited
Terminal address:	Immingham East Terminal, Immingham Dock, Immingham, NE Lincolnshire. DN40 2QW.
Warehouse Excise Code:	GB00002497107
Mabanaft VAT number:	GB744412154

Mabanaft Limited are the final receivers. AAD to be made out for an under-bond cargo.

SIMON STORAGE IMMINGHAM TERMINALS

1483

SHIP/SHORE SAFETY CHECK LIST

Ship's Name: Aiskaea

Berth: MAIN IMMINGHAM port: 1800 East

Date of Arrival: 27/6/11 Time of Arrival:

INSTRUCTIONS FOR COMPLETION

The safety of operations requires that all questions be answered affirmatively ☑. If an affirmative answer is not possible, the reason should be given and agreement reached upon appropriate precautions to be taken between the ship and the terminal. Where any question is not considered to be applicable a note to that effect should be inserted in the remarks column.

☐ — the presence of this symbol in the columns 'ship' and 'terminal' indicates that checks shall be carried out by the party concerned.

The presence of the letters A and P in the column 'Code' indicates the following:

A — the mentioned procedures and agreements shall be in writing and signed by both parties.

P — in case of a negative answer the operation shall not be carried out without the permission of the Port Authority.

PART A
Bulk Liquids - General

		Ship	Terminal	Code	Remarks
A1	Is the ship securely moored?	✓	✓		
A2	Are emergency towing wires correctly positioned?	✓	✓		N/A
A3	Is there safe access between ship and shore?	✓	✓		Gangway
A4	Is the ship ready to move under its own power?	✓		P	
A5	Is there an effective deck watch in attendance on board and adequate supervision of operations on the ship?	✓	✓		
A6	Is the agreed ship/shore communication system operative?	✓	✓	A	Verbal / Ship's Radio VHF CH.
A7	Have the procedures for cargo, bunker and ballast handling been agreed?	✓	✓	A	
A8	Has the emergency shut down procedure been agreed?	✓	✓	A	N/A
A9	Are fire hoses and fire-fighting equipment on board and ashore positioned and ready for immediate use?	✓	✓		
A10	Are cargo and bunker hoses/arms in good condition and properly rigged and, where appropriate, certificates checked?	✓	✓		
A11	Are scuppers effectively plugged and drip trays in position, both on board and ashore?	✓	✓		
A12	Are unused cargo bunker connections including the stern discharge line, if fitted, blanked?	✓	✓		
A13	Are sea and overboard discharge valves, when not in use, closed and lashed?	✓	✓		
A14	Are all cargo and bunker tank lids closed?	✓	✓		
A15	Is the agreed tank venting system being used?	✓	✓	A	Shore tanks / P/V
A16	Are hand torches of an approved type?	✓	✓		
A17	Are portable VHF/UHF transceivers of an approved type?	✓	✓		
A18	Are the ship's main radio transmitter aerials earthed and radars switched off?	✓			
A19	Are electric cables to portable electrical equipment disconnected from power?	✓	✓		
A20	Are all external doors and ports in the amidships accommodation closed?	✓	✓		
A21	Are all external doors and ports in the after accommodation leading onto or overlooking the tank deck closed?	✓	☐		
A22	Are air conditioning intakes which may permit the entry of cargo vapours closed?	✓	✓		
A23	Are window-type air conditioning units disconnected?	N/A			
A24	Are smoking requirements being observed?	✓	✓		
A25	Are the requirements for the use of galley and other cooking appliances being observed?	✓	✓		
A26	Are naked light requirements being observed?	✓	✓		
A27	Is there provision for an emergency escape possibility?	✓	✓		
A28	Are sufficient personnel on board and ashore to deal with an emergency?	✓	✓		
A29	Are adequate insulating means in place in the ship/shore connection?	✓	✓		
A30	Have measures been taken to ensure sufficient pumproom ventilation?	✓			

PART B
Additional Checks — Bulk Liquid Chemicals

		Ship	Terminal	Code	Remarks
B1	Is information available giving the necessary data for the safe handling of the cargo including, where applicable, a manufacturer's inhibition certificate?	✓	✓		
B2	Is sufficient and suitable protective equipment (including self-contained breathing apparatus) and protective clothing ready for immediate use?	✓	✓		
B3	Are counter measures against accidental personal contact with the cargo agreed?	✓	✓		
B4	Is the cargo handling rate compatible with the automatic shut down system, if in use?	N/A	✓	A	
B5	Are cargo system gauges and alarms correctly set and in good order?	✓	✓		
B6	Are portable vapour detection instruments readily available for the products to be handled?	N/A	✓		
B7	Has information on fire-fighting media and procedures been exchanged?	✓	✓		
B8	Are transfer hoses of suitable material resistant to the action of the cargoes?	✓	✓		
B9	Is cargo handling being performed with the permanent installed pipeline system?	✓	✓	P	

PART C
Additional Checks — Bulk Liquefied Gases

		Ship	Terminal	Code	Remarks
C1	Is information available giving necessary data for the safe handling of the cargo including, where applicable, a manufacturer's inhibition certificate?	☐	☐		
C2	Is the water spray system ready for use?	☐	☐		
C3	Is sufficient and suitable protective equipment (including self-contained breathing apparatus) and protective clothing ready for immediate use?	☐	☐		
C4	Are void spaces properly inerted where required?	☐			
C5	Are all remote control valves in working order?	☐	☐		
C6	Are cargo tank safety relief valves lined up to the ship's venting system and are by-passes closed?	☐			
C7	Are the required cargo pumps and compressors in good order, and have the maximum working pressures been agreed between ship and shore?	☐	☐	A	
C8	Is reliquefaction or boil-off control equipment in good order?	☐			
C9	Is gas detection equipment set for the cargo, calibrated and in good order?	☐	☐		
C10	Are cargo system gauges and alarms correctly set and in good order?	☐	☐		
C11	Are emergency shut down systems working properly?	☐	☐		
C12	Does shore know the closing rate of ship's automatic valves; does ship have similar details of shore system?	☐	☐	A	
C13	Has information been exchanged between ship and shore on minimum working temperature of the cargo systems?	☐	☐	A	

	Ship	Shore
Are tank cleaning operations planned during the ship's stay alongside the shore installation?	Yes/No*	Yes/No*
If so, have the port authority and terminal been informed?	Yes/No*	Yes/No*
Are applicable precautions observed?	Yes/No*	Yes/No*

*Delete Yes or No as appropriate

Declaration

We have checked, where appropriate jointly, the items on this check list, and have satisfied ourselves that the entries we have made are correct to the best of our knowledge, and arrangements have been made to carry out repetitive checks as necessary.

For Ship	For Terminal
Name: [signature]	Name: W. Butts
Rank: CO	Position: Jetty Op
Signature: [signature]	Signature: [signature]

Time: 00:45

Date: 28.06.2011

SIMON STORAGE - IMMINGHAM EAST TERMINAL

PROFORM No.032 - Ship / Pipeline Transfer Log
Issued By N.D.Smith 12th September 2007

Mode (circle or delete)	SHIP / ~~PIPELINE~~ RECEIPT or ~~DESPATCH~~	Vessel	AURELIA.
Surveyor	SGS	Berth (circle or delete)	MAIN / ~~AFT~~ / EXT
Client	MABANAFT	Date	27/6/11
Product	ULSD.	Tank No's	618 603 602
Agent	GRAYPEN.	Line No	J41

Shipping Transfer

Berthed	- Date 27/6/11	Time	23:20	Started	- Date 28/6/11	Time	01:15.
Connected	- Date 28/6/11	Time	00:25.	Completed	- Date 29-6	Time	17:25
Slopped	- Date	Time		Disconnected	- Date 29-6	Time	17:40

Bill of Lading / or Advised Figure

NOTIFIED M³ or Mt				
21947 mt.	21947.330 tonnes	21887.593 tonnes	0.8333	14.2°c

Pipeline Transfer

Tran. From		Tran. To	
Start - Date		Time	
Finish - Date		Time	
Product Temp		Product Density	

General Instructions

Tank No	Pre / Ind	Pre Dip/Ull
Tank No	Pre / Ind	Pre Dip/Ull
Tank No 602	Pre / Ind 0,373	Pre Dip/Ull 0,368

Comments

Russia.

Ref No E-10494.	To / From Primorsk	MSD LITRES	STD LITRES	TONNES
SHIP / BARGE - BILL OF LADING			26373454	21947330
VESSEL QUANTITY			26300881	21887593
METERED QUANTITY				
DIPPED QUANTITY				
PIPELINE - ADVISED QUANTITY				
ISCO ~ QUANTITY		26395950	26395397	21961138
DIFFERENCE BOL / ADVISED AGAINST RECEIPT QUANTITY			+21943	+13808
% DIFFERENCE-BOL/ADVISED AGAINST RECEIPT QUANTITY		%	+0.08%	+0.06 %

FIGURES AGREED WITH	Dave	**COMPANY**	SGS
DATE FIGURES AGREED	30/6/11	**TIME**	1030

New aft density		618 .8357	603 .8332	602 .8332
Parcel No				
T2L / C130 / W8 / AAD Required	Yes / No			
AWAITING DELIVERY NOTE / FIGURES / DIPS	Yes / No			

Stock Variation Report Y / (N)

STOCKS USE ONLY

SIMON STORAGE - IMMINGHAM EAST TERMINAL

Ship / Pipeline Transfer Details

TIME	TANK	M/FILL	T/H	IND	DIP/ULL	RATE	TOTAL	PRESS	TEMP	INT
01:15	618	22780		02238	23200				18.3.	
02:15				02943		221	221	+ LINE		
03:15				05400		771	992			
04:15				07780		747	1739			
05:15				10197		759	2498			
06:15				12700		786	3284			
08:15				17.061		684	4.653			
10:15				21.512		699	6.051			
10:40	FIN			22.318		253	6.304			
	314									

TIME	TANK	M/FILL	T/H	IND	DIP/ULL	RATE	TOTAL	PRESS	TEMP	INT
10:50	603	18067	21.630	8	9				15°	
13:50				958		231	693	6.997		
15:50				1600		234	1162	7466		
16.50				2324		529	1691			RF
18:50				05005		978	3647	9951		
20.50				07730		995	5637	11941		
21:50				09133		1024	6661	12965		
23:50				11854		993	8647			
00 50				13320		1070	9717			
02:50				15790		901	11520			
04:20	STOPPED.			17800		978	12987	19291		
	730									

TIME	TANK	M/FILL	T/H	IND	DIP/ULL	RATE	TOTAL	PRESS	TEMP	INT
04:50	602			373	368					
05:50				730		260	260			
07:50				01-313		286	832	20425		SW
08:50				01835		235	1067	21190		TJ
09:50				02-572		538	1605	21728		SW
11:50				05-215		965	3534	23658		SW
13:50				08-042		1032	5598	25,722		SW
16:00				10-112		697	7108	27,232		O.C.
	M/AH 730									

22-30
Berth

SIMON STORAGE – IMMINGHAM EAST TERMINAL
Proforma No 004 Operating Instructions (Shipping)
Issued By M Plaskitt (February 2006)

Issued By	M Plaskitt			Vessel	Aurelia
Date Issued	27.06.11			Agent	Graypen
Customer	Mabanaft			**Special Instructions**	
Product	ULSD			1. Ensure caution barriers in position 2. Jetty security log to completed 3. Sample required from ships manifold 4. Ensure pre arrival received 5. Fill put 6300m3 ULSD into Tank 618 1st as per Mabanaft instructions 6. fill Tank 603 to max fill & balance to Tank 602 7. Ensure slow pumping rate (250m3 per hour) until Tank 603 & 602 roofs floats.	
Surveyor	SGS				
Quantity	21947t	Move	Rec		
Tankage	**603** **602** **618**	Berth	Main/Ext		
Pipeline	JP41				
Sufficient Ullage / Stock		Yes / No			

Topping-Up Procedure Required	Yes / No (Delete as appropriate) **(If Required See EG-051)**

	WORK INSTRUCTIONS	Completed	Signed By
01	Ensure That Tank(s) 618,603,602 are pre-dipped with SGS	618 603 SGS	A
02	Carry Out Formal Ship To Shore Checks & Record	✓	W. BUTTS.
03	Issue Shipping Procedures / Regulations To Vessel	✓	W.B.
04	Identify Clean & Serviceable Hoses	✓	W.B.
05	Hose Size & Type **1 x 8"**	✓	W.B.
06	Transfer Route Connections Required **(Specify below)** JP 41	✓	A
07	Transfer Route Inspection/Approval By **(Record Name)** **SGS**	✓ SGS.	A
08	See Special Instructions, Ensure Requirements are Met	✓	
09	Pressure/Leak Test The Transfer line **(30 P.S.I)**		
10	Verify Correct Transfer Route Has been Established	✓	A
11	On Approval Start Transfer **(Pump Slowly Initially)**	✓	A.
12	Verify The Integrity of the Transfer Route **(Visual)**	✓	A
13	Confirm Product Movement Into /Out Of Storage Tank	✓	A.
14	Check Integrity Of The Transfer System (2 Hourly)	✓	A
15	**On Completion** Pig Line to 618, After completion into 618	✓	B

5 **EMERGENCY AUTOMATIC SHUTDOWN SYSTEMS**

Vessel*

In order to prevent excessive surge conditions in the shore loading systems, a minimum shutdown time of 15 seconds is required of the vessel's automatic shutdown system.

State minimum automatic shutdown system time: 15 (seconds)

SIGN: FOR VESSEL * Ogilvie, CO
(Print Name)

SIGN: FOR TERMINAL W BUTTS
(Print Name)

Shore*

A number of receipt systems are fitted with Remote Operated Valves in order to prevent Terminal Tank overfill occurring. These valves are set to close over a minimum period of 30 seconds.

***Delete sections that are not applicable to transfer.**

6 **BULK LIQUIFIED GAS**

Minimum working temperature of cargo system: ______ °C

SIGN: FOR VESSEL ______
(Print Name)

SIGN: FOR TERMINAL ______
(Print Name)

7 **ACKNOWLEDGEMENT OF RECEIPT OF TERMINAL'S SHIPPING REGULATIONS**

We acknowledge receipt of a copy of Immingham Storage Company Limited, East Terminal, Shipping Regulations and undertake to comply with the requirements stated therein and the requirements stated in the 'Ship/Shore Checklist', which accompanies this document, throughout the course of the transfer operations whilst berthed at the East Jetty.

SIGNED: ON BEHALF OF VESSEL * Ogilvie, CO
(Print Name)

AGREEMENTS & PROCEDURES

VESSEL: MV AURELIA (Please Print) **DATE:** 27/6/11

1 **ORDER OF CARGO TRANSFER**

Order	Product Name	Vessel's Connection (Header Number)	Shore Connection (Header ID)	Quantity to Discharge	Maximum Rate of Discharge	Maximum Back Pressure
1ST	ULSD	COMMON LINE	JP41	2191	2100	10 BAR.

SIGN: FOR VESSEL (Print Name) * Ogilvie, CO

FOR TERMINAL (Print Name) L BUTTS

FOR SURVEYORS (Print Name) PAUL (SGS)

2 **COMMUNICATIONS AND EMERGENCY SHUT DOWN**

Communication between Vessel and jetty will be by:
RADIO* VERBAL* *(Delete as applicable)* + SHIPS RADIO

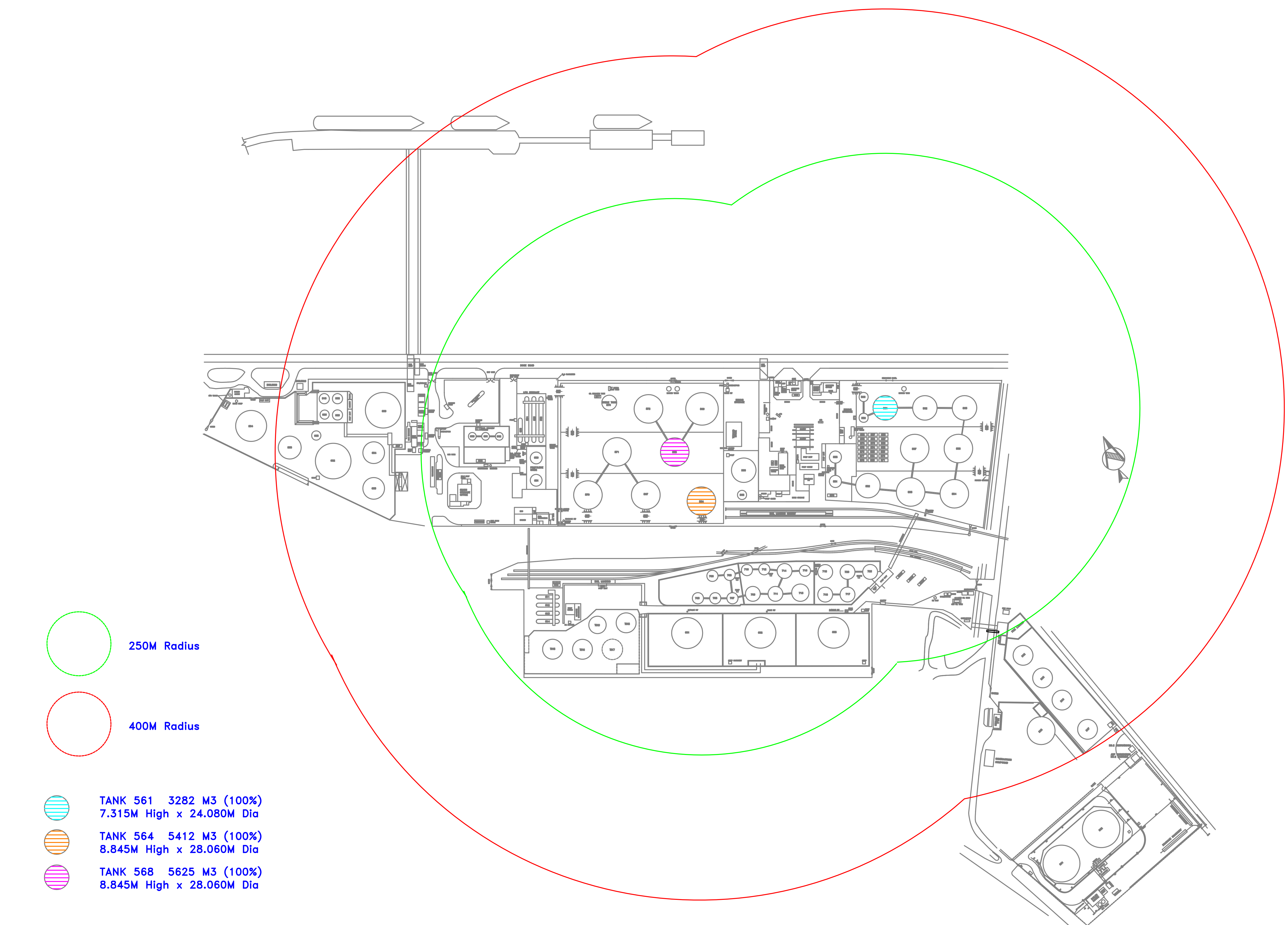
Emergency shut down of the Vessel's transfer system is by: MANUAL + AUTO
(Print Method Description)

Emergency shut down of the Shore transfer system is by: MANUAL + AUTO
(Print Method Description)

SIGN: FOR TERMINAL (Print Name)

FOR VESSEL (Print Name) * Ogilvie, CO

APPENDIX 7



REV.	AMENDMENTS	BY	DATE	CHK
0	ISSUED FOR APPROVAL	NDS	28.06.11	AMR

simon Storage

Simon Storage Group Ltd.
Priory House,
60 Station Road.
Redhill.
Surrey RH1 1PH.
Tel: 01737 778108

DRAWN N D Smith

SCALE

CHECKED AMR

APPROVED

DATE

simon Terminals

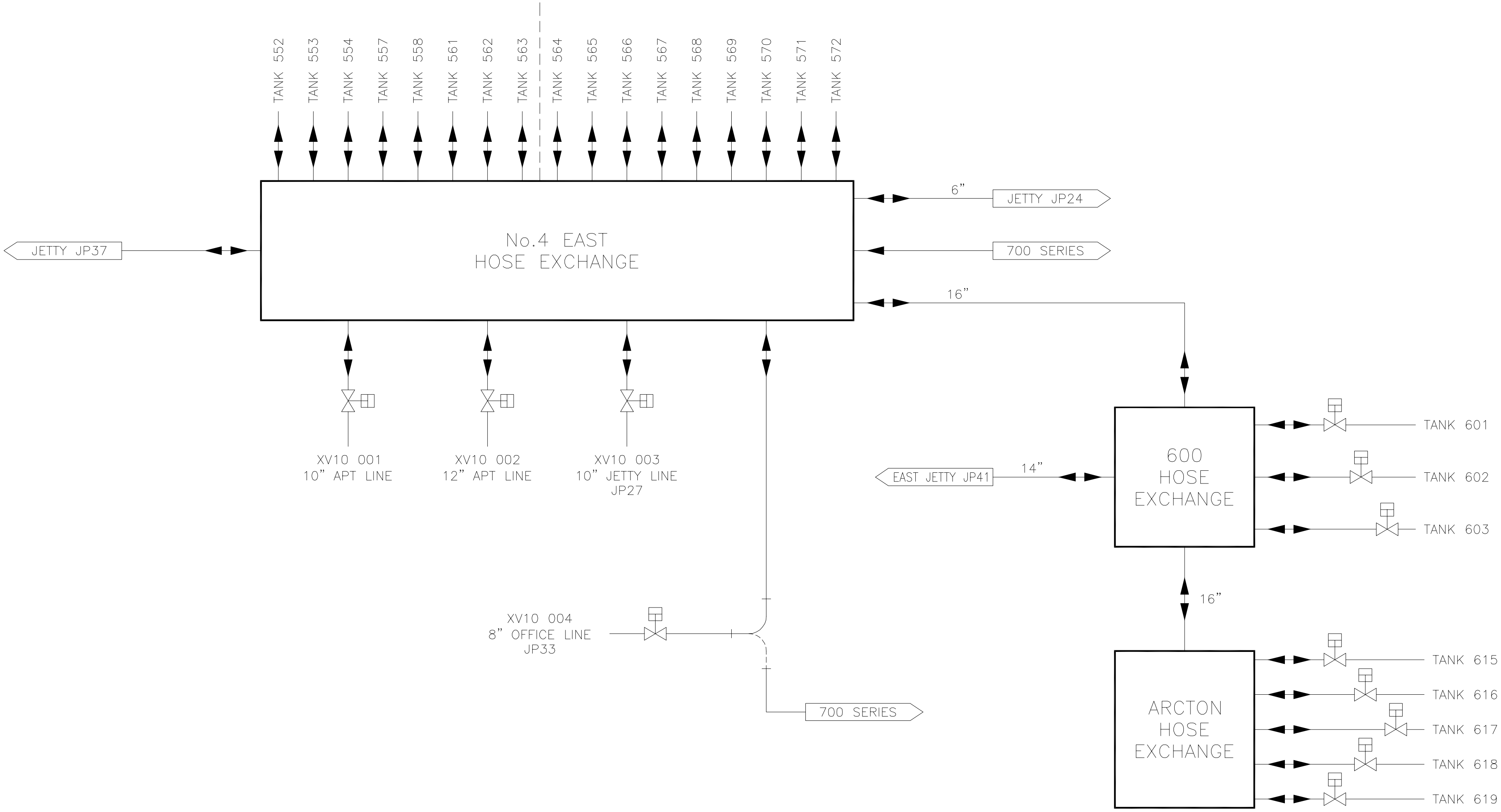
IMMINGHAM EAST TERMINAL
IMMINGHAM STORAGE CO. LTD.
IMMINGHAM DOCKS,
IMMINGHAM,
SOUTH HUMBERSIDE.
DN40 2LX
Tel: 01469 571241
Fax: 01469 571037

PROJECT
SITE LAYOUT

TITLE
SITE PLAN (LOPA STUDY)

DRG. No. 0

APPENDIX 8



IF NOT SIGNED THIS DOCUMENT IS UNCONTROLLED

REV	DATE	BY	DRN	CHK'D		APP'D		DESCRIPTION
A	02/08/11	P.P.	P.P.	D.S.R		D.S.R		ISSUED FOR INFORMATION

PLANT	IMMINGHAM STORAGE Co. – EAST TERMINAL
TITLE	GASOLINE IMPORT PIPELINE ROUTING DIAGRAM

SIMON

IMMINGHAM STORAGE Co Ltd,
IMMINGHAM EAST TERMINAL,
IMMINGHAM DOCK,
IMMINGHAM,
N.E. LINCOLNSHIRE.
DN40 2QW

P & I DESIGN
P & I Design Ltd
Tel. 01642 617444
www.pidesign.co.uk

SHEET 1 OF 1

CLIENT DRG. No.

P&I DRG No. SI057001_DWG