Petroleum Jetty ESIA Volume 3
Fire Risk Assessment and Fire Training Plan

Massawa Port Authority
State of Eritrea
Petroleum Jetty ESIA

Independent Category A Environmental and Social Impact Assessment and Management Plan Study: Construction of Petroleum Jetty at Hirgigo Bay - Massawa
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Executive Summary

A Fire Risk Assessment and Training Plan has been prepared for the Front End Engineering Design (FEED) Phase of the new jetty project for Massawa, Eritrea. This document will then be updated during the system definition phase of the project.

Central to the Fire Risk Assessment and Fire Training Plan are the identification of fire locations along the new jetty and the fire types that can occur due to the products being offloaded at Massawa.

This fire risk assessment is based upon the fire locations provided in the original base data and the fact that LPG and a range of white products and black products are to be offloaded.

Statistical release sizes during product offloading operations have been obtained from international data based upon vessel sizes which will offload at Massawa. This data may be seen in Appendix A.

The physical properties of the products to be offloaded (in particular the flammability data and recommended firefighting methods for small, large and huge fires) at Massawa have been obtained from representative Material Safety Data Sheets (MSDS), which are given in Appendix B.

The causes, consequences and a coarse risk assessment for these fire types, sizes and locations has been documented in the Hazard Register given in Appendix D. Also on this register is documented the design and operational safeguards that have been detailed in the FEED documents. The impact of the safeguards on the raw risk levels is seen by the resulting level of residual risk. The recommended actions for the Massawa Jetty Fire Team to tackle the fires are then documented.

This semi-quantitative risk assessment has been the result of table top exercises at EPConsult’s London offices, and it is recommended that operations personnel become familiar with the register and participate in keeping the document up to date so as to become familiar with the process of control of major accident hazards.

Given that huge fires are associated with product storage and not jetty operations per se, two matrices are produced in the document, which give for small and large fires at the locations identified for the jetty, the relevant firefighting approach, equipment, media and personal protective equipment.

Thus the resulting FEED level firefighting training plan is seen to be hazard based and proportionate. It is then a short step to design the training segments and refreshers and the manning requirements of the fire team for the new jetty.

This FEED level fire risk assessment and fire training plan raises the following design issues, which may be in consideration:

- Windsocks are provided for the new jetty for LPG releases.
- Leak detection devices are considered for offloading product.
- The possibility of providing passive fire protection for the slops tank should be considered if this does not constitute corrosion under insulation risk.
- Passive fire protection should be considered for critical shutdown valves and ESD initiation stations.
- Strict no smoking and speed restrictions should be in force on the jetty.
- All work on the jetty should be subject to the appropriate permit to work, including electrical.
- Water sprays, including for personnel protection should be considered for confirmed gas release.
- A fixed inert gas / fresh water spray system should be considered for the electrical switchgear room and the firewater pump house due to gas oil fuel and electrical supply the fire pumps.
- Passive fire protection is considered for the roadside and piperack-side walls of the firewater pumphouse, with a fire rated wall between the switchgear room and the firewater pump house. Consideration should be given to providing passive fire protection to the roof of this building.

- Consideration should be given to locating each fire water pump in a separate pump house on the jetty.

- Clearly flanges should be minimized in this area.

- Consideration should be given to the option of providing foam induction at hydrants, with drums of foam stationed along the jetty.

- Hose reel cabinets to be provided with the necessary lengths of hose, couplings and nozzles.

- Spare firefighting BA to be provided on the jetty.

- Careful design, construction and siting of the operator huts.

It is recognized that many of these measures cannot be considered without cost benefit analyses, and thus it is recommended that this document is revised in the next engineering phase so as to provide the basis for doing this.

This document should be read in conjunction with the companion Oil Spill Risk and Contingency Plan.
1 Introduction

1.1 General

The existing jetty at Hirgigo Bay, Massawa will be demolished and removed and will be replaced with a new jetty. New pipelines will run along the jetty to tie-in to the existing tank farm. A future project will increase the storage capacity of the tank farm by installing additional tanks.

The existing petroleum jetty serves the Hirgigo Power Plant, the Shell Petroleum depot and the Erigas depot. The existing petroleum jetty was constructed by Italians in the 1930’s and is in very poor condition and now which requires replacement. The Department of Maritime Transport (DMT) has commissioned Royal Haskoning to produce a preliminary design to replace the jetty. The jetty is of strategic value to Eritrea and so the existing jetty will be kept operational while the new jetty is under construction and will not be decommissioned and demolished until the new jetty is operational. Figure 1 gives the location of Massawa on the map of Eritrea.

![Figure 1.1 Map of Eritrea](image)

Figure 2 is a satellite image of Hirgigo Bay, which shows the location of the existing jetty. The location for the new jetty is indicated. The existing tank farm can also be seen on the image. Figure 3 provides further detail of the existing and new jetty.
Figure 1-2: Satellite Image of Hirgigo Bay

Figure 1-3: Location of the Existing & Proposed New Jetty
This document is the Fire Risk Assessment and Training Plan for the new jetty at Massawa (preferred Alternative 3). The study basis, which contains the relevant base data is given in Appendix A. The Material Safety Data Sheets for the oil products are given in Appendix B. The basis for the communications plan is given in Appendix C and the Hazard Register is given in Appendix D.
## 2 Glossary of Terms

The following table gives a glossary of terms used in this report.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFP</td>
<td>Active Fire Protection</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>API RP</td>
<td>American Petroleum Institute Recommended Practice</td>
</tr>
<tr>
<td>BA</td>
<td>Breathing Apparatus</td>
</tr>
<tr>
<td>BLEVE</td>
<td>Boiling Liquid Expanding Vapour Explosion</td>
</tr>
<tr>
<td>BMT</td>
<td>British Maritime Transport</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
<tr>
<td>COMAH</td>
<td>Control of Major Accident Hazards</td>
</tr>
<tr>
<td>DMT</td>
<td>Department of Marine Transport</td>
</tr>
<tr>
<td>DWT</td>
<td>Dead Weight Tonnage</td>
</tr>
<tr>
<td>ESD</td>
<td>Emergency Shut Down</td>
</tr>
<tr>
<td>F&amp;G</td>
<td>Fire and Gas</td>
</tr>
<tr>
<td>FEED</td>
<td>Front End Engineering Design</td>
</tr>
<tr>
<td>FWPH</td>
<td>Fire Water Pump House</td>
</tr>
<tr>
<td>HAZID</td>
<td>Hazard Identification</td>
</tr>
<tr>
<td>HAZOP</td>
<td>Hazard and Operability</td>
</tr>
<tr>
<td>HS&amp;E</td>
<td>Health Safety and Environment</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organisation</td>
</tr>
<tr>
<td>LEL</td>
<td>Lower Explosive Limits</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
</tr>
<tr>
<td>MSDS</td>
<td>Material Safety Data Sheet</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>OCIMF</td>
<td>Oil Companies International Marine Forum</td>
</tr>
<tr>
<td>PFP</td>
<td>Passive Fire Protection</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
</tr>
<tr>
<td>PTW</td>
<td>Permit To Work</td>
</tr>
<tr>
<td>PSV</td>
<td>Pressure Safety Valve</td>
</tr>
<tr>
<td>RPE</td>
<td>Responsible Person Electrical</td>
</tr>
<tr>
<td>STOP</td>
<td>Safety Training Observation Programme</td>
</tr>
<tr>
<td>UEL</td>
<td>Upper Explosive Limits</td>
</tr>
<tr>
<td>VCE</td>
<td>Vapour Cloud Explosion</td>
</tr>
</tbody>
</table>
3 Scope of Work and Objectives

3.1 Scope of work
The scope of work of this document is to:
1) Conduct a qualitative risk assessment of fires occurring at points along the new jetty import route through consideration of the hydrocarbon products that will be imported across the new jetty and the size of each fire.
2) For each fire at each location on the jetty import route, identify the safeguards and equipment required to prevent, detect, control, mitigate against and recover from each fire.
3) From this, derive a firefighting training plan for the new jetty that is hazard based.

3.2 Objectives
The objective of this document is to produce a firefighting training plan for the new jetty facilities. For the fire training plan to be proportionate and applicable to the new jetty facilities, it is hazard based.

That is to say, the scope of the firefighting training is based on the fire types, fire sizes and fire locations that can be expected along the new jetty import route; and the firefighting equipment that has been scoped and identified for the new jetty facilities.

The plan will also be risk based in that the relative importance and hence duration of a given training segment will be determined by the assessed likelihood of occurrence of a particular fire type. A preliminary assessment of this is given in the Hazard Register in Appendix D. This document gives the basis for such training segments.
4 Facility Overview

4.1 Existing Jetty and Pipelines
There are three pipelines running the full length of the Jetty as follows:

- 10" Fuel Oil line;
- 10" White Product line (gasoline, gas oil and jet fuel/kerosene);
- 6" LPG line.

The lines run along the seabed at the seaward end the end of the Jetty. Both the white product and the LPG seabed lines end in fixed manifold connections on the dolphin. The fuel oil line is connected to an 8" flexible submarine hose and the end is hoisted to a vessel at a marker buoy located to the seaward of the dolphin.

All lines are located on roller type or Y-type shoe supports. The pipe work and fittings are reported generally in reasonably condition but pipe supports are in poor condition.

4.2 New Jetty and Pipelines
The proposed new Jetty will be located to the south of the existing Jetty as shown in Figure 1.3). The new Jetty is proposed to be a total length of 1125m, of which 625m will be built as a rock bund with 500m as a concrete trestle to support the pipelines to the unloading platform. The requirements for the new Jetty are as follows:

- The existing Jetty will remain in operation throughout the construction of the new Jetty.
- The new jetty will be designed to receive a 50,000 DWT vessel.
- The new jetty will be able to handle a wide range of oil products.
- A new 16" Fuel Oil line will be installed along the full length of the new Jetty and will run to the boundary of the existing Tamoil terminal with a spur to the boundary of the Hirgigo power plant.
- A new 16" White Products line will be installed along the full length of the new Jetty and will run to the boundary of the existing Tamoil terminal.
- A new 8" LPG line will be installed along the full length of the new Jetty and will run to the boundary of the existing Erigas terminal.
- Provision will be made for a future additional pipeline for bitumen.
- The new Jetty will be equipped with fire fighting equipment.

A composite drawing of the new Jetty is given as Figure 5.1. This figure has been constructed from facility layout drawings of the new jetty given with the Feasibility and Preliminary Design Report. [1]

4.3 Firefighting Equipment for New Jetty
Fire fighting and fire prevent equipment will be provided for the hazardous zones around the vessels and along the new Jetty. A water spray will be provided to enable escape of personnel from the jetty head in the event of fire. The firefighting equipment for the new Jetty is given in Figure 4.1.
Figure 4.1 Firefighting Layout for the New Jetty.
Equipment layout of the new Jetty facilities will include the following preventive safeguards against unignited and ignited releases:

- Good natural ventilation to provide for rapid dissipation of vapours to prevent build up of flammable pockets and atmospheres;
- Protection of piping and equipment by barriers against vehicle collisions;
- Automatic product transfer isolation devices and leak detection instrumentation.

Sea water will be the main medium for fire fighting and will be supplied by a sea water pump house that will be located on the new Jetty at least 50m away from the Jetty head. Firewater pumping will consist of one automatically controlled electrically driven main fire pump and one automatically controlled gas oil driven fire pump as standby. Small pressure losses due to minor leakage will be made up with a submersible self priming centrifugal Jockey pump.

A high voltage sub station will be located adjacent to the fire pump house outside the hazardous area associated with the jetty transfer lines and gas oil supply to the standby firewater pump.

The firewater mains will be located on the pipe rack spanning the whole length of the Jetty. Pillar type wet-barrel above ground hydrants will be connected to the firewater main along the Jetty and will be spaced no more than 80m apart. Each hydrant will have two hose reels with nozzle connections located in an accessible cabinet close to the hydrant.

Two manually controlled firewater/foam monitors will be located on towers with sufficient height to project a firewater / foam spray on to a berthed vessel and the Jetty head. The firewater / foam monitors will be incorporated with a water spray to protect the operator platforms and monitor tower from fire and heat radiation. It will also provide for a means of escape.

Additional equipment will be provided for first aid fire fighting. This equipment includes:

- Fire Extinguishers;
- Fire buckets;
- Fire Trailer with monitor;
- Hand foam extinguisher;
- Portable firewater / foam monitor;
- Mobile foam extinguisher.

This equipment will be additional to the fixed firewater / foam monitors and will be positioned in the new Jetty buildings and along the new Jetty span for fighting small fires.

At the new Jetty head, Fire Alarm activation devices and Fire Alarms (both visible and audible) will located at regular intervals and at convenient locations.

Telecommunication facilities will be provided for day to day operations. In the event of an emergency, contact will be made with the local emergency services. In addition to the Fire Alarms, operators will be able to activate the firewater pumps, to stop product transfer pumps and to arrest product transfer. These emergency shutdown facilities will be located remote from the valve and pump locations.

A sprinkler system will be provided along the pipe rack to cool pipes and to protect against fire exposure for escaping personnel.

The new Jetty roadway will be accessible to local emergency service trucks/ fire engines to attend to the Jetty head in the event of fire, with piping and the firewater pump house being protected by crash barriers. Fire main manifold facilities will be available at the Jetty head for the provision of fire water to the fire trucks. Figure 4.1 gives the fire fighting and fire prevention equipment for the new Jetty.
Table 4.1 Fire fighting and fire Prevention Equipment

<table>
<thead>
<tr>
<th>Number</th>
<th>Size &amp; Type</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12” Schedule 40</td>
<td>Salt water fire main</td>
</tr>
<tr>
<td>1</td>
<td>8” Schedule</td>
<td>Fire Mains Distribution pipe work</td>
</tr>
<tr>
<td>1</td>
<td>6” schedule</td>
<td>Pipe spray and personnel protection</td>
</tr>
<tr>
<td>1</td>
<td>3” Schedule</td>
<td>Pipe spray</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Fire monitor towers</td>
</tr>
<tr>
<td>Multiple</td>
<td></td>
<td>Hydrants &amp; Fire hose cabinets</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Foam generation tank and header</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Mobile foam extinguisher</td>
</tr>
<tr>
<td>Multiple</td>
<td></td>
<td>Fire buckets/Extinguishers/Blankets</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Fire Trailer with monitor</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Hand foam extinguisher</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Portable monitor</td>
</tr>
</tbody>
</table>

Good housekeeping and the prevention and quick clean up of releases and spills of product are key to the prevention of fires. The Port of Massawa has oil spill recovery equipment, which is stored close to the main berth areas. This equipment includes:

- skimmer pump;
- 200m inflatable harbour booms;
- a self propelled barge for the collection of recovered oil; and
- various other pieces of clean up and spill response equipment.

For the new Jetty, in the event of a spill, the recovery equipment will be launched from the Jetty head and installed/operated by a local work boat. The recovery equipment consist of a floating boom to contain the spillage and a skimmer device, which separates the spilled product from the sea water, recovers and delivers the residues to slops tank. This equipment will be stored at the rear of the jetty head so that it will be readily accessible. It will also be reachable by firefighting equipment.
5 Hazard Identification

5.1 General

This section outlines the hazard identification review conducted for the new Jetty. The potential causes and consequences of releases of product during unloading operations along the new Jetty have been identified and documented on to a hazard register, which is given in Appendix D. For each ignited release scenario, which can involve LPG, White Product and Black Product, a coarse qualitative risk ranking is given and the firefighting equipment required to tackle each of these fires is documented.

Depending on the product being handled, a range of fire types are possible ranging from pool fires, jet fires, flash fires and possible explosions.

This hazard register serves to link the firefighting equipment to the identified ignited releases, which will provide the hazard based context to the firefighting training plan.

5.2 Location of Ignited Release

Based on the Feasibility and Preliminary Design Report [1], the following release locations have been identified as a potential cause of fire hazards:

A. Vessel entering and leaving the harbour.
B. Fire on the surface of the sea, beneath or around the seaward end of the Jetty resulting from a spillage of petroleum products in a vessel moored.
C. Fire on the seaward end of the Jetty offloading hoses resulting from a spillage and subsequent ignition of petroleum products.
D. Fire at any point of the connections during discharge:
   a. Quick Connect / Quick Disconnect;
   b. Flange or seal;
   c. Valve.
E. Fire at the slops tank.
F. Fire along the pipeline rack from:
   d. Fractured pipe;
   e. Leaking Valves;
   f. Flange or seal leaks.
G. Fire on the roadway surface arising from vehicle impacts.
H. Fire in the electrical switchgear room/ operator hut facilities.
I. Fire at seawater pump house.

The location of these ignited releases are given in Figure 5.1, which is a composite diagram constructed from facility drawings of the new Jetty, given with the Feasibility and Preliminary Design Report. [1]

The hazard register given in Appendix D details which fire types have the potential to exist at each location and the consequences of these fire types. The register given in Appendix G of the Oil Spill Risk and Contingency Plan [4] also provides similar details for unignited releases, which translate to spills and vapour clouds. Both these registers derive from a source hazard register.
Figure 5.1 Location of Ignited Releases
5.3 Preliminary Fire Risk Assessment

The following table gives an indication of the statistical release sizes encountered during tanker ship and port operations. The statistics would in general apply to the loading of product on to tanker ships as opposed to the unloading of product across the jetty, but are considered to give a good indication of the release sizes (and hence fire sizes) likely to be encountered at Massawa.

A closer analysis in Detail Design, which addresses the following aspects, would confirm these volumes, release rates and their frequency of occurrence, but for FEED, the following figures, when taken in conjunction with the coarse risk assessment are applicable.

<table>
<thead>
<tr>
<th>Location</th>
<th>Description of Spill Event</th>
<th>Typical Release Size [ tonnes]</th>
<th>Release Size (Assuming Fuel Oil) [BBL]</th>
<th>Release Size (Assuming LPG) [m³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A) Operational spill/release (emptying of bilge water, oily waste water of ballast water)</td>
<td>&lt;2</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>B, C, D, E</td>
<td>Accidents during loading or unloading cargo</td>
<td>&lt;10</td>
<td>65</td>
<td>18</td>
</tr>
<tr>
<td>F, G</td>
<td>Accidents during terminal operations of bunker oil</td>
<td>2-20</td>
<td>13-130</td>
<td>4-36</td>
</tr>
<tr>
<td>F, G</td>
<td>Accidents during terminal operations of crude oil</td>
<td>&lt;100</td>
<td>652</td>
<td>184</td>
</tr>
</tbody>
</table>

5.4 Safeguards to minimize spill sizes

The minimization of release volumes will be achieved by the provision of the recovery tank underneath the loading arms beneath the Jetty head deck. The use of Quick Connect Disconnect Couplers and integral isolation valves on the end of the loading arms will reduce the amount of the spillage caused during the separation of the two mating flanges.

Fire Alarms, Gas detection and Fireproof Communications systems will be provided as the first step to dealing with release, both ignited and unignited.

5.5 Fighting Fires at Massawa

Table 4.2 gives the firefighting means for small fires that can occur at Massawa, as given by the base data in Appendix A and the Material Safety Data Sheets.

The firefighting training segments given in Section 5 are based on this table and the information given in Appendix A and Appendix B.

Table 4.3 gives the firefighting means for large fires that can occur at Massawa in locations A through H, as given by the base data in Appendix A and the Material Safety Data Sheets in Appendix D.

The firefighting training plan given in Section 5 are based on these tables and the information given in Appendix A and Appendix B.
<table>
<thead>
<tr>
<th></th>
<th>Preventative Measures</th>
<th>Detection Systems</th>
<th>Portable Extinguishers</th>
<th>Fixed Systems</th>
<th>Response Measures</th>
<th>Skills and PPE</th>
<th>Skills and PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Fire Type (Applicable to all locations at Massawa)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>LPG jet fire</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPG (residual) spill</td>
<td>x x x x x</td>
<td>x x x x x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline spill</td>
<td>x x x x x x x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas oil spill</td>
<td>x x x x x x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kerosene spill</td>
<td>x x x x x x x</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jet – A1 spill</td>
<td>x x x x x x x</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fuel Oil spill</td>
<td>x x x x x x x</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>x x x x x</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Cellulosic</td>
<td>x x x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 5-5: Fighting Large Fires at Massawa

<table>
<thead>
<tr>
<th>Fire Location</th>
<th>Fire Type</th>
<th>Preventative Measures</th>
<th>Detection Measures</th>
<th>Fire Suppression and Control Measures</th>
<th>Mitigating &amp; Response</th>
<th>Skills and PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>LPG</td>
<td>x</td>
<td>x</td>
<td>x x x x x x x x x x x x x x x x x</td>
<td>x x x x x x x x x x x x x x x x x</td>
<td>x x x x x x x x x x x x x x x x x</td>
</tr>
<tr>
<td></td>
<td>Gasoline</td>
<td>x</td>
<td>x</td>
<td>x x x x x x x x x x x x x x x x x</td>
<td>x x x x x x x x x x x x x x x x x</td>
<td>x x x x x x x x x x x x x x x x x</td>
</tr>
<tr>
<td></td>
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6 Firefighting Training Plan

6.1 General Training Requirements for All Staff

All personnel assigned to new Jetty operations at Massawa should receive a basic grounding in the HS&E aspects of the operation. Such basic induction should include workshops for staff and should deal with such topics as:

- Products handled and physical properties;
- Basic first aid;
- Basic firefighting using hand held extinguishers;
- Incident reporting and STOP programmes;
- Permit to Work System and safe systems of work;
- Task Risk Assessments and Hazard Identification;
- Environmental impact.

A register should be kept of all personnel who attended the course, and bi-annual refresher sessions should be scheduled for staff.

6.2 General Training Requirements for Fire Safety Staff

This training segment will commence with the basic HS&E induction segments given above in Section 5.1. It will also include the participation in:

- Process and Electrical HAZOPs;
- HAZIDs.

The purpose of this will be to provide a grounding in HAZOP and HAZID techniques as well as maintain live hazard registers (as given in Appendix D) as a first step in developing risk assessment skills and attaining a COMAH type culture at the new Jetty.

Also fire safety staff should attend a week long course at a municipal fire station, so as to become proficient in:

- Choice and use of appropriate extinguishing mediums;
- Fire and combustion theory;
- Use of hydrants and monitors with and without foam.
- Use of hose reels;
- Isolating fuel sources (including electrical);
- Use of fire team BA sets.
- Rescue skills and first aid.
- Team work and working in pairs

Once proficiency has been attained in these basic grounding courses, staff will move on to fire location training at the new jetty, which will have a practical element and a written element.

This should be backed up by weekly muster drills and fortnightly exercises, for night shift staff as well as day shift staff.
6.3 Training Plan for Fighting Small Fires

Jet Fires and Residual LPG Fires

Residual LPG fires can occur along the length of the new Jetty and should be tackled directly using a handheld portable foam extinguisher or a dry chemical powder extinguisher.

It is important that only a residual LPG fire should be tackled in this way. A small LPG jet or spray fire should not be extinguished as this will release unignited product to the atmosphere, which if allowed to accumulate in a confined area and in concentrations between the LEL and the UEL, could ignite causing a flash fire.

Thus a small jet fire should be allowed to burn itself out under controlled conditions, so as to avoid explosive re-ignition. This will include ensuring that the jet fire is not directed towards a product line, an escape route, a building (including the firewater pump house), pollution control equipment or other firefighting equipment.

Every effort should be made to shut-off the fuel to the fire. Deflector shields should be used to redirect a small jet fire and water spray cooling should be deployed on an impinged product line, either with a fixed water spray system or with a hose reel attached to a fire hydrant with a spray nozzle affixed.

Small jet fires should not be tackled by personnel not trained specifically to tackle such fires. The firefighting training programme for members of the fire response team should include a segment in tackling small jet fires.

It is important to keep LPG from flowing into drains and to ensure all jetty systems are correctly bonded to earth so as to avoid electrostatic discharges and fire.

Fire team members should not expose themselves to any smoke from a small jet fire, and should ensure they are wearing fire retardant coveralls, gloves and helmet. Goggles should be worn. It should not be necessary to don full firefighting PPE, but this remains the decision of the on scene commander.

It is important that an unignited release of LPG is detected quickly and unloading operations stopped quickly and the wind direction established via reference to the windsock.

Gasoline Fires

Gasoline fires can occur along the length of the new Jetty and should be tackled directly using a handheld portable foam extinguisher, a dry chemical powder extinguisher, a Carbon dioxide fire extinguisher or a water spray (from a hydrant and hose with a spray nozzle or from fixed water spray equipment) or using the mobile foam extinguisher.

An unignited spill of gasoline will result in the liberation of flammable vapour, which if allowed to accumulate in a confined area and in concentrations between the LEL and the UEL could ignite causing a flash fire.

Every effort should be made to shut-off the fuel to the fire and the area around a container involved in a fire should be isolated.

It is important to keep gasoline from flowing into drains and to ensure all jetty systems are correctly bonded to earth so as to avoid electrostatic discharges and fire.

Fire team members should not expose themselves to any smoke from a small fire, and should ensure they are wearing fire retardant coveralls, gloves and helmet. Goggles should be worn. It should not be necessary to don full firefighting PPE, but this remains the decision of the on scene commander.

Gas Oil Fires
Gas Oil fires can occur along the length of the new Jetty and should be tackled directly using a handheld portable foam extinguisher, a dry chemical powder extinguisher, a Carbon dioxide fire extinguisher or using the mobile foam extinguisher.

An unignited spill of gas oil can result in the liberation of flammable vapour, which if allowed to accumulate in a confined area and in concentrations between the LEL and the UEL could ignite causing a flash fire.

Every effort should be made to shut-off the fuel to the fire.

It is important to keep Gas Oil from flowing into drains and to ensure all jetty systems are correctly bonded to earth so as to avoid electrostatic discharges and fire.

Fire team members should not expose themselves to any smoke from a small fire, and should ensure they are wearing fire retardant coveralls, respiratory equipment, gloves and helmet. Goggles should be worn. It may be necessary to don full firefighting PPE, but this remains the decision of the on scene commander. Only trained personnel are to tackle gas oil fires.

Kerosene Fires
Kerosene fires can occur along the length of the new Jetty and should be tackled directly using a handheld portable foam extinguisher, a dry chemical powder extinguisher, a Carbon dioxide fire extinguisher or using the mobile foam extinguisher.

An unignited spill of kerosene can result in the liberation of flammable vapour, which if allowed to accumulate in a confined area and in concentrations between the LEL and the UEL could ignite causing a flash fire.

Every effort should be made to shut-off the fuel to the fire.

It is important to keep kerosene from flowing into drains and to ensure all jetty systems are correctly bonded to earth so as to avoid electrostatic discharges and fire.

Fire team members should not expose themselves to any smoke from a small fire, and should ensure they are wearing fire retardant coveralls, respiratory equipment, gloves and helmet. Goggles should be worn. It may be necessary to don full firefighting PPE, but this remains the decision of the on scene commander. Only trained personnel are to tackle kerosene fires.

Jet –A1 Fires
Jet – A1 fires can occur along the length of the new Jetty and should be tackled directly using a handheld portable foam extinguisher, a dry chemical powder extinguisher, a Carbon dioxide fire extinguisher or a water spray (from a hydrant and hose with a spray nozzle or from fixed water spray equipment) or using the mobile foam extinguisher.

An unignited spill of Jet – A1 can result in the liberation of flammable vapour, which if allowed to accumulate in a confined area and in concentrations between the LEL and the UEL could ignite causing a flash fire.

Every effort should be made to shut-off the fuel to the fire and the area around a container involved in a fire should be isolated.

It is important to keep Jet – A1 from flowing into drains and to ensure all jetty systems are correctly bonded to earth so as to avoid electrostatic discharges and fire.

Fire team members should not expose themselves to any smoke from a small fire, and should ensure they are wearing fire retardant coveralls, respiratory equipment, gloves and helmet. Goggles should be worn. It may be necessary to don full firefighting PPE, but this remains the decision of the on scene commander.

Fuel Oil Fires
Fuel Oil fires can occur along the length of the new Jetty and should be tackled directly using a handheld portable foam extinguisher, a dry chemical powder extinguisher, a Carbon dioxide fire
extinguisher or a water spray (from a hydrant and hose with a spray nozzle or from fixed water spray equipment) or using the mobile foam extinguisher.

An unignited spill of Fuel Oil can result in the liberation of flammable vapour, which if allowed to accumulate in a confined area and in concentrations between the LEL and the UEL could ignite causing a flash fire.

Every effort should be made to shut-off the fuel to the fire.

It is important to keep Fuel Oil from flowing into drains and to ensure all jetty systems are correctly bonded to earth so as to avoid electrostatic discharges and fire.

Fire team members should not expose themselves to any smoke from a small fire, and should ensure they are wearing fire retardant coveralls, respiratory equipment, gloves and helmet. Goggles should be worn. It may be necessary to don full firefighting PPE, but this remains the decision of the on scene commander.

All tanker trucks / bowsers brought on to the jetty will be suitable for operation in the hazardous areas established for the jetty, have their cigarette lighters removed and be equipped with a Carbon dioxide extinguisher and water fire extinguisher.

**Electrical Fires**

Small electrical fires are to be tackled with portable Carbon dioxide extinguishers by the fire response team and are to be tackled with the advice of the Responsible Person Electrical so as to ensure that the power supply has been correctly and positively isolated.

Additional PPE may be required to protect fire team members from the hazards of electrical shock and the RPE should be consulted.

**Cellulosic Fires**

Small cellulosic fires are to be tackled using portable water extinguishers, fire buckets and hose reels connected to the fire hydrants. These types of fires should not occur on the jetty, as all matches, cigarette lighters and other sources of ignition will not be permitted on the new Jetty, which will also be a non-smoking area.

All electrical equipment and hot surfaces will be suitable for the hazardous zones established for the new Jetty and a berthed tanker vessel.

A risk assessment will be completed to determine whether the switchgear room and fire water pump house walls and ceilings require to have hydrocarbon pool fire rating (H). It is possible, but unlikely that the walls of these buildings facing the pipework (which should not be flanged in this area) will require to be rated to withstand jet fires (J) due to the low manifold pressures.

It likely will be the larger pool fires that will determine the fire rating of these walls.

### 6.4 Training Requirements for Fighting Large Fires

**Jet Fires and Residual LPG Fires**

In the first instance large LPG releases must be prevented through:

- Cleaning up the spill quickly using rapid dilution if necessary;
- Maintaining the integrity of pipework and fittings;
- Flange management;
- Careful driving of tanker trucks and strict adherence of the speed limit on the new Jetty;
- Maintenance of crash barriers to protect piping and the firewater pump house.

Secondly, the leak must be detected through:

- Alert new Jetty operations personnel raising the alarm and acting;
- The possible use of coupling position indicating alarms;
• The detection of LPG vapours.

Thirdly, should a leak occur it must be controlled immediately through:
• Shutting down the pumped import of product;
• Providing quick and effective segmentation and isolation of the source of the leak.

Then the leak must be mitigated by:
• Attempting to contain it;
• Diluting it with firewater;
• Good natural ventilation.

In order to prevent ignition, the following measures must be in place:
• The strict control of the hazardous area classification on the new Jetty, through carefully controlled modifications to design that might occur on the jetty;
• The strict control of permitted work on the new Jetty, allowing no work to occur without the correct permit;
• Strict controls on the suitability of mobile plant, vehicles, hand tools and power tools on the jetty in relation to the hazardous areas;
• Ensuring that ship shutdown and new jetty shutdown systems and communications are connected;
• Ensuring that good bonding and earthing is applied to a discharging ship.
• A strictly observed no smoking policy;
• The condition of personnel’s PPE is in good order and of the appropriate type, particularly boots.

LPG vapour may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to ignition source, flammable vapours can burn in the open or explode in confined spaces. Vapours may travel long distance to an ignition source and flash back.

It is prudent to initiate water spray equipment, particularly on personnel escape routes along the jetty on detection of gas or release of LPG, provided the equipment is well bonded to earth, as it is becoming established practice that release of water spray will mitigate against the creation of a flammable atmosphere.

Residual LPG fires can occur along the length of the new Jetty and should be tackled directly as per gasoline fires or small residual LPG fires.

It is important that only a residual LPG fire should be tackled in this way. A large LPG jet fire should not be extinguished as this will release unignited product to the atmosphere, which if allowed to accumulate in a confined area and in concentrations between the LEL and the UEL could ignite causing a flash fire.

Thus a large jet fire should be allowed to burn itself out under controlled conditions, so as to avoid explosive re-ignition. This will include ensuring that the jet fire is not directed towards a product line, an escape route, a building (including the firewater pump house), pollution control equipment or other firefighting equipment.

Every effort should be made to shut-off the fuel to the fire. Deflector shields should be used to redirect a jet fire and water spray cooling should be deployed on an impinged product line, either with a fixed water spray system or with a hose reel attached to a fire hydrant with a spray nozzle affixed.

Jet fires should not be tackled by personnel not trained specifically to tackle such fires. The firefighting training programme for members of the fire response team should include a segment in tackling jet fires.
It is important to keep LPG from flowing into drains and to ensure all jetty systems are correctly bonded to earth so as to avoid electrostatic discharges and fire.

Fire team members should not expose themselves to any smoke from a small fire, and should ensure they are wearing fire retardant coveralls, gloves and helmet. Goggles should be worn. It is important that an unignited release of LPG is detected quickly and unloading operations stopped quickly and the wind direction established via reference to the windsock.

It is recommended that a windsock is installed in a prominent location at the new Jetty.

**Gasoline Fires**

1) Large gasoline fires can occur along the length of the new Jetty and should be tackled with the utmost caution and only by qualified and trained members of the fire team using the appropriate equipment and PPE.

In the first instance large gasoline releases must be prevented through:

- Cleaning up the spill quickly using rapid dilution if necessary;
- Maintaining the integrity of pipework and fittings;
- Flange management;
- Careful driving of tanker trucks and strict adherence of the speed limit;
- Maintenance of crash barriers to protect piping and firewater pump house.

Secondly, the leak must be detected through:

- Alert new Jetty operations personnel raising the alarm and acting;
- The possible use of coupling position indicating alarms;
- The detection of gasoline vapours.

Thirdly, should a leak occur it must be controlled immediately through:

- Shutting down the pumped import of product;
- Effecting quick and effective segmentation and isolation of the source of the leak.

Then the leak must be mitigated by:

- Attempting to contain it;
- Diluting it with firewater.

In order to prevent ignition, the following measures must be in place:

- The strict control of the hazardous area classification on the new Jetty, through carefully controlled modifications to design that might occur on the jetty;
- The strict control of permitted work on the new Jetty, allowing no work to occur without the correct permit;
- Strict controls on the suitability of mobile plant, vehicles, hand tools and power tools on the jetty in relation to the hazardous areas;
- Ensuring that ship shutdown and new jetty shutdown systems and communications are connected;
- Ensuring that good bonding and earthing is applied to a discharging ship.
- A strictly observed no smoking policy;
- The condition of personnel’s PPE is in good order and of the appropriate type, particularly boots.

The effect of a fire is mitigated by ensuring redundancy and fire proofing of communication and fire and gas cables.

Gasoline vapour may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions. When mixed with air and exposed to ignition source, flammable vapours can burn in the
open or explode in confined spaces. Vapours may travel long distance to an ignition source and flash back.

2) For a major gasoline fire on a berthed ship or at the jetty head, the following equipment should be started automatically and should be checked as being operational by trained personnel:
   - Firewater pumps and salt water fire main and fire main distribution system;
   - Foam generation tank and header.

As a result, the following fire fighting equipment will be available for use:
   - Fire water foam monitor towers;
   - Fire hydrants and fire hose cabinets;
   - Water spray and water fog spray.

Fire team personnel should don:
   - Full firefighting personal protective equipment including respiratory equipment;

and should ensure:
   - Their escape route is secure through the deployment of water sprays at the fire monitor tower and back along the jetty;
   - They are not working alone;
   - The alarm has in fact been raised and product transfer has in fact stopped.

Support should arrive in the form of:
   - The fire trailer with monitor;
   - Portable foam monitor;
   - The deployment of shipboard firefighting systems.

An incident team must be set up, allowing for relief of fire team members and provision of medical attention as required.

3) If the major gasoline fire occurs along the length of the jetty as opposed to the jetty head, then the fire water monitor towers will not be available, and the fire should be tackled with:
   - The fire trailer with monitor;
   - Portable foam monitor;
   - Fire hydrants and fire hose cabinets;

Bearing in mind that water may not be effective against gasoline fires, personnel should also ensure that:
   - The water spray is being successfully applied to the pipeway to effect skin cooling;
   - A possible spray fire or jet fire is not directed across the road;
   - A possible spray fire or jet fire does not impinge directly on neighbouring pipework;
   - A possible spray fire or jet fire does not impinge directly on the wall of the electrical switchgear room, the firewater pump house or the operator huts.

4) Recommendations: the following additional measures should be considered:
   - The possibility of inducing foam at the fire hydrants;
   - Strategic location of firefighting foam drums along the jetty;
   - Spare firefighting PPE at the jetty;
   - Passive fire protection of the firewater pump house walls and roof;
   - Passive fire protection of emergency shut-off valves at the jetty.

Gas Oil Fires
1) Large gas oil fires can occur along the length of the new Jetty and should be tackled with the utmost caution and only by qualified and trained members of the fire team using the appropriate equipment and PPE.

In the first instance large gas oil releases must be prevented through:
- Cleaning up the spill quickly using rapid dilution if necessary;
- Maintaining the integrity of pipework and fittings;
- Flange management;
- Careful driving of tanker trucks and strict adherence of the speed limit;
- Maintenance of crash barriers to protect piping and firewater pump house.

Secondly, the leak must be detected through:
- Alert new Jetty operations personnel raising the alarm and acting;
- The possible use of coupling position indicating alarms;
- The detection of gas oil vapours.

Thirdly, should a leak occur it must be controlled immediately through:
- Shutting down the pumped import of product;
- Effecting quick and effective segmentation and isolation of the source of the leak.

Then the leak must be mitigated by:
- Attempting to contain it;
- Diluting it with firewater.

In order to prevent ignition, the following measures must be in place:
- The strict control of the hazardous area classification on the new Jetty, through carefully controlled modifications to design that might occur on the jetty;
- The strict control of permitted work on the new Jetty, allowing no work to occur without the correct permit;
- Strict controls on the suitability of mobile plant, vehicles, hand tools and power tools on the jetty in relation to the hazardous areas;
- Ensuring that ship shutdown and new jetty shutdown systems and communications are connected;
- Ensuring that good bonding and earthing is applied to a discharging ship.
- A strictly observed no smoking policy;
- The condition of personnel’s PPE is in good order and of the appropriate type, particularly boots.

The effect of a fire is mitigated by ensuring redundancy and fire proofing of communication and fire and gas cables.

Gas oil vapour may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions. When mixed with air and exposed to ignition source, flammable vapours can burn in the open or explode in confined spaces. Vapours may travel long distance to an ignition source and flash back.

2) For a major gas oil fire on a berthed ship or at the jetty head, the following equipment should be started automatically and should be checked as being operational by trained personnel:
- Firewater pumps and salt water fire main and fire main distribution system;
- Foam generation tank and header.

As a result, the following fire fighting equipment will be available for use:
- Fire water foam monitor towers;
- Fire hydrants and fire hose cabinets;
• Water spray and water fog spray.

Fire team personnel should don:
  • Full firefighting personal protective equipment including respiratory equipment;
and should ensure:
  • Their escape route is secure through the deployment of water sprays at the fire monitor tower and back along the jetty;
  • And they are not working alone;
  • The alarm has in fact been raised and product transfer has in fact stopped.

Support should arrive in the form of:
  • The fire trailer with monitor;
  • portable foam monitor;
  • The deployment of shipboard firefighting systems.

An incident team must be set up, allowing for relief of fire team members and provision of medical attention as required.

3) If the major gas oil fire occurs along the length of the jetty as opposed to the jetty head, then the fire water monitor towers will not be available, and the fire should be tackled with:
  • The fire trailer with monitor;
  • portable foam monitor;
  • Fire hydrants and fire hose cabinets;

Bearing in mind that water may not be effective against gas oil fires, personnel should also ensure that:
  • The water spray is being successfully applied to the pipeway to effect skin cooling;
  • A possible spray fire or jet fire is not directed across road;
  • A possible spray fire or jet fire does not impinge directly on neighbouring pipework;
  • A possible spray fire or jet fire does not impinge directly on the wall of the electrical switchgear room, the firewater pump house or the operator huts.

4) Recommendations: the following additional measures should be considered:
  • The possibility of inducing foam at the fire hydrants;
  • Strategic location of firefighting foam drums along the jetty;
  • Spare firefighting PPE at the jetty;
  • Passive fire protection of the firewater pump house walls and roof;
  • Passive fire protection of emergency shut-off valves at the jetty.

Kerosene Fires

1) Large kerosene fires can occur along the length of the new Jetty and should be tackled with the utmost caution and only by qualified and trained members of the fire team using the appropriate equipment and PPE.

In the first instance large kerosene releases must be prevented through:
  • Cleaning up the spill quickly using rapid dilution if necessary;
  • Maintaining the integrity of pipework and fittings;
  • Flange management;
  • Careful driving of tanker trucks and strict adherence of the speed limit;
  • Maintenance of crash barriers to protect piping and firewater pump house.

Secondly, the leak must be detected through:
  • Alert new Jetty operations personnel raising the alarm and acting;
• The possible use of coupling position indicating alarms;
• The detection of kerosene vapours.

Thirdly, should a leak occur it must be controlled immediately through:
• Shutting down the pumped import of product;
• Effecting quick and effective segmentation and isolation of the source of the leak.

Then the leak must be mitigated by:
• Attempting to contain it;
• Diluting it with firewater.

In order to prevent ignition, the following measures must be in place:
• The strict control of the hazardous area classification on the new Jetty, through carefully controlled modifications to design that might occur on the jetty;
• The strict control of permitted work on the new Jetty, allowing no work to occur without the correct permit;
• Strict controls on the suitability of mobile plant, vehicles, hand tools and power tools on the jetty in relation to the hazardous areas;
• Ensuring that ship shutdown and new jetty shutdown systems and communications are connected;
• Ensuring that good bonding and earthing is applied to a discharging ship.
• A strictly observed no smoking policy;
• The condition of personnel’s PPE is in good order and of the appropriate type, particularly boots.

The effect of a fire is mitigated by ensuring redundancy and fire proofing of communication and fire and gas cables.

Kerosene vapour may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions. When mixed with air and exposed to ignition source, flammable vapours can burn in the open or explode in confined spaces. Vapours may travel long distance to an ignition source and flash back.

2) For a major kerosene fire on a berthed ship or at the jetty head, the following equipment should be started automatically and should be checked as being operational by trained personnel:
• Firewater pumps and salt water fire main and fire main distribution system;
• Foam generation tank and header.

As a result, the following fire fighting equipment will be available for use:
• Fire water foam monitor towers;

Fire team personnel should don:
• Full firefighting personal protective equipment including respiratory equipment; and should ensure:
• Their escape route is secure through the deployment of water sprays at the fire monitor tower and back along the jetty;
• And they are not working alone;
• The alarm has in fact been raised and product transfer has in fact stopped.

Support should arrive in the form of:
• The fire trailer with monitor;
• portable foam monitor;
• The deployment of shipboard firefighting systems.

An incident team must be set up, allowing for relief of fire team members and provision of medical attention as required.
3) If the major kerosene fire occurs along the length of the jetty as opposed to the jetty head, then the fire water monitor towers will not be available, and the fire should be tackled with:
   - The fire trailer with monitor;
   - portable foam monitor;

Bearing in mind that water may not be effective against kerosene fires, personnel should also ensure that:
   - The water spray is being successfully applied to the pipeway to effect skin cooling;
   - A possible spray fire or jet fire is not directed across road;
   - A possible spray fire or jet fire does not impinge directly on neighbouring pipework;
   - A possible spray fire or jet fire does not impinge directly on the wall of the electrical switchgear room, the firewater pump house or the operator huts.

4) Recommendations: the following additional measures should be considered:
   - The possibility of inducing foam at the fire hydrants;
   - Strategic location of firefighting foam drums along the jetty;
   - Spare firefighting PPE at the jetty;
   - Passive fire protection of the firewater pump house walls and roof;
   - Passive fire protection of emergency shut-off valves at the jetty.

Jet-A1 Fires

1) Large Jet-A1 fires can occur along the length of the new Jetty and should be tackled with the utmost caution and only by qualified and trained members of the fire team using the appropriate equipment and PPE.

   In the first instance large Jet-A1 releases must be prevented through:
   - Cleaning up the spill quickly using rapid dilution if necessary;
   - Maintaining the integrity of pipework and fittings;
   - Flange management;
   - Careful driving of tanker trucks and strict adherence of the speed limit;
   - Maintenance of crash barriers to protect piping and firewater pump house.

Secondly, the leak must be detected through:
   - Alert new Jetty operations personnel raising the alarm and acting;
   - The possible use of coupling position indicating alarms;
   - The detection of Jet-A1 vapours.

Thirdly, should a leak occur it must be controlled immediately through:
   - Shutting down the pumped import of product;
   - Effecting quick and effective segmentation and isolation of the source of the leak.

Then the leak must be mitigated by:
   - Attempting to contain it;
   - Diluting it with firewater.

In order to prevent ignition, the following measures must be in place:
   - The strict control of the hazardous area classification on the new Jetty, through carefully controlled modifications to design that might occur on the jetty;
   - The strict control of permitted work on the new Jetty, allowing no work to occur without the correct permit;
   - Strict controls on the suitability of mobile plant, vehicles, hand tools and power tools on the jetty in relation to the hazardous areas;
• Ensuring that ship shutdown and new jetty shutdown systems and communications are connected;
• Ensuring that good bonding and earthing is applied to a discharging ship.
• A strictly observed no smoking policy;
• The condition of personnel’s PPE is in good order and of the appropriate type, particularly boots.

The effect of a fire is mitigated by ensuring redundancy and fire proofing of communication and fire and gas cables.

Jet-A1 vapour may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions. When mixed with air and exposed to ignition source, flammable vapours can burn in the open or explode in confined spaces. Vapours may travel long distance to an ignition source and flash back.

2) For a major Jet-A1 fire on a berthed ship or at the jetty head, the following equipment should be started automatically and should be checked as being operational by trained personnel:
• Firewater pumps and salt water fire main and fire main distribution system;
• Foam generation tank and header.

As a result, the following fire fighting equipment will be available for use:
• Fire water foam monitor towers;
• Fire hydrants and fire hose cabinets;
• Water spray and water fog spray.

Fire team personnel should don:
• Full firefighting personal protective equipment including respiratory equipment;

and should ensure:
• Their escape route is secure through the deployment of water sprays at the fire monitor tower and back along the jetty;
• And they are not working alone;
• The alarm has in fact been raised and product transfer has in fact stopped.

Support should arrive in the form of:
• The fire trailer with monitor;
• portable foam monitor;
• The deployment of shipboard firefighting systems.

An incident team must be set up, allowing for relief of fire team members and provision of medical attention as required.

3) If the major Jet-A1 fire occurs along the length of the jetty as opposed to the jetty head, then the fire water monitor towers will not be available, and the fire should be tackled with:
• The fire trailer with monitor;
• portable foam monitor;
• Fire hydrants and fire hose cabinets;

Bearing in mind that water may not be effective against Jet-A1 fires, personnel should also ensure that:
• The water spray is being successfully applied to the pipeway to effect skin cooling;
• A possible spray fire or jet fire is not directed across road;
• A possible spray fire or jet fire does not impinge directly on neighbouring pipework;
• A possible spray fire or jet fire does not impinge directly on the wall of the electrical switchgear room, the firewater pump house or the operator huts.
4) Recommendations: the following additional measures should be considered:

- The possibility of inducing foam at the fire hydrants;
- Strategic location of firefighting foam drums along the jetty;
- Spare firefighting PPE at the jetty;
- Passive fire protection of the firewater pump house walls and roof;
- Passive fire protection of emergency shut-off valves at the jetty.

Gas Oil Fires

1) Large gas oil fires can occur along the length of the new Jetty and should be tackled with the utmost caution and only by qualified and trained members of the fire team using the appropriate equipment and PPE.

In the first instance large gas oil releases must be prevented through:

- Cleaning up the spill quickly using rapid dilution if necessary;
- Maintaining the integrity of pipework and fittings;
- Flange management;
- Careful driving of tanker trucks and strict adherence of the speed limit;
- Maintenance of crash barriers to protect piping and firewater pump house.

Secondly, the leak must be detected through:

- Alert new Jetty operations personnel raising the alarm and acting;
- The possible use of coupling position indicating alarms;
- The detection of gas oil vapours.

Thirdly, should a leak occur it must be controlled immediately through:

- Shutting down the pumped import of product;
- Effecting quick and effective segmentation and isolation of the source of the leak.

Then the leak must be mitigated by:

- Attempting to contain it;
- Diluting it with firewater.

In order to prevent ignition, the following measures must be in place:

- The strict control of the hazardous area classification on the new Jetty, through carefully controlled modifications to design that might occur on the jetty;
- The strict control of permitted work on the new Jetty, allowing no work to occur without the correct permit;
- Strict controls on the suitability of mobile plant, vehicles, hand tools and power tools on the jetty in relation to the hazardous areas;
- Ensuring that ship shutdown and new jetty shutdown systems and communications are connected;
- Ensuring that good bonding and earthing is applied to a discharging ship.
- A strictly observed no smoking policy;
- The condition of personnel’s PPE is in good order and of the appropriate type, particularly boots.

The effect of a fire is mitigated by ensuring redundancy and fire proofing of communication and fire and gas cables.

Gas oil vapour may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions. When mixed with air and exposed to ignition source, flammable vapours can burn in the
open or explode in confined spaces. Vapours may travel long distance to an ignition source and flash back.

2) For a major gas oil fire on a berthed ship or at the jetty head, the following equipment should be started automatically and should be checked as being operational by trained personnel:

- Firewater pumps and salt water fire main and fire main distribution system;
- Foam generation tank and header.

As a result, the following fire fighting equipment will be available for use:

- Fire water foam monitor towers;
- Fire hydrants and fire hose cabinets;
- Water spray and water fog spray

Fire team personnel should don:

- Full firefighting personal protective equipment including respiratory equipment;

and should ensure:

- Their escape route is secure through the deployment of water sprays at the fire monitor tower and back along the jetty;
- And they are not working alone;
- The alarm has in fact been raised and product transfer has in fact stopped.

Support should arrive in the form of:

- The fire trailer with monitor;
- Portable foam monitor;
- The deployment of shipboard firefighting systems.

An incident team must be set up, allowing for relief of fire team members and provision of medical attention as required.

3) If the major gas oil fire occurs along the length of the jetty as opposed to the jetty head, then the fire water monitor towers will not be available, and the fire should be tackled with:

- The fire trailer with monitor;
- Portable foam monitor;
- Fire hydrants and fire hose cabinets;

Bearing in mind that water may not be effective against gas oil fires, personnel should also ensure that:

- The water spray is being successfully applied to the pipeway to effect skin cooling;
- A possible spray fire or jet fire is not directed across road;
- A possible spray fire or jet fire does not impinge directly on neighbouring pipework;
- A possible spray fire or jet fire does not impinge directly on the wall of the electrical switchgear room, the firewater pump house or the operator huts.

4) Recommendations: the following additional measures should be considered:

- The possibility of inducing foam at the fire hydrants;
- Strategic location of firefighting foam drums along the jetty;
- Spare firefighting PPE at the jetty;
- Passive fire protection of the firewater pump house walls and roof;
- Passive fire protection of emergency shut-off valves at the jetty.

**Fuel Oil Fires**

1) Large fuel oil fires can occur along the length of the new Jetty and should be tackled with the utmost caution and only by qualified and trained members of the fire team using the appropriate equipment and PPE.
In the first instance large fuel oil releases must be prevented through:

- Cleaning up the spill quickly using rapid dilution if necessary;
- Maintaining the integrity of pipework and fittings;
- Flange management;
- Careful driving of tanker trucks and strict adherence of the speed limit;
- Maintenance of crash barriers to protect piping and firewater pump house.

Secondly, the leak must be detected through:

- Alert new Jetty operations personnel raising the alarm and acting;
- The possible use of coupling position indicating alarms;
- The detection of fuel oil vapours.

Thirdly, should a leak occur it must be controlled immediately through:

- Shutting down the pumped import of product;
- Effecting quick and effective segmentation and isolation of the source of the leak.

Then the leak must be mitigated by:

- Attempting to contain it;
- Diluting it with firewater.

In order to prevent ignition, the following measures must be in place:

- The strict control of the hazardous area classification on the new Jetty, through carefully controlled modifications to design that might occur on the jetty;
- The strict control of permitted work on the new Jetty, allowing no work to occur without the correct permit;
- Strict controls on the suitability of mobile plant, vehicles, hand tools and power tools on the jetty in relation to the hazardous areas;
- Ensuring that ship shutdown and new jetty shutdown systems and communications are connected;
- Ensuring that good bonding and earthing is applied to a discharging ship.
- A strictly observed no smoking policy;
- The condition of personnel's PPE is in good order and of the appropriate type, particularly boots.

The effect of a fire is mitigated by ensuring redundancy and fire proofing of communication and fire and gas cables.

Fuel oil vapour may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions. When mixed with air and exposed to ignition source, flammable vapours can burn in the open or explode in confined spaces. Vapours may travel long distance to an ignition source and flash back.

2) For a major fuel oil fire on a berthed ship or at the jetty head, the following equipment should be started automatically and should be checked as being operational by trained personnel:

- Firewater pumps and salt water fire main and fire main distribution system;
- Foam generation tank and header.

As a result, the following fire fighting equipment will be available for use:

- Fire water foam monitor towers;
- Fire hydrants and fire hose cabinets;
- Water spray and water fog spray.

Fire team personnel should don:

- Full firefighting personal protective equipment including respiratory equipment;
and should ensure:
  • Their escape route is secure through the deployment of water sprays at the fire monitor tower and back along the jetty;
  • And they are not working alone;
  • The alarm has in fact been raised and product transfer has in fact stopped.

Support should arrive in the form of:
  • The fire trailer with monitor;
  • portable foam monitor;
  • The deployment of shipboard firefighting systems.

An incident team must be set up, allowing for relief of fire team members and provision of medical attention as required.

3) If the major fuel oil fire occurs along the length of the jetty as opposed to the jetty head, then the fire water monitor towers will not be available, and the fire should be tackled with:
  • The fire trailer with monitor;
  • portable foam monitor;
  • Fire hydrants and fire hose cabinets;

Bearing in mind that water may not be effective against fuel oil fires, personnel should also ensure that:
  • The water spray is being successfully applied to the pipeway to effect skin cooling;
  • A possible spray fire or jet fire is not directed across road;
  • A possible spray fire or jet fire does not impinge directly on neighbouring pipework;
  • A possible spray fire or jet fire does not impinge directly on the wall of the electrical switchgear room, the firewater pump house or the operator huts.

4) Recommendations: the following additional measures should be considered:
  • The possibility of inducing foam at the fire hydrants;
  • Strategic location of firefighting foam drums along the jetty;
  • Spare firefighting PPE at the jetty;
  • Passive fire protection of the firewater pump house walls and roof;
  • Passive fire protection of emergency shut-off valves at the jetty.

Electrical Fires
It is not expected that large electrical fires can take hold at the new Jetty. Electrical switchgear rooms are fitted with fixed CO₂ systems, with manual release at the outside of the entrance.

More recently, Innogen or equivalent systems have been used, due to the concentrations and harmful effect of a CO₂ release on personnel.

A fixed Innogen or equivalent system should be considered for the electrical switchgear room.

Cellulosic Fires
Large cellulosic fires are to be tackled using hose reels connected to the fire hydrants. These types of fires should not occur on the jetty, as all matches, cigarette lighters and other sources of ignition will not be permitted on the new Jetty, which will also be a non-smoking area.

6.5 Training Requirements for Fighting Huge Fires
Huge fires are associated with storage tank fires, both at Massawa and on the vessel itself. Storage Tank fires at Massawa are outside the scope of this document, but could involve retreating and
leaving the storage tank fire to burn itself out. Emergency services from the municipality would be called in as would federal assistance. It would also be important to pass advice to inhabitants in the local area to stay in doors until further notice to minimize the ingestion of smoke and harmful products of combustion.

A huge fire could occur on the tanker vessel due to fire in the storage compartments. There would be little the new Jetty could do in this situation apart to bring the fire monitor towers to bear if the vessel was within reach, but it is expected that the heat radiation would overcome the operators even with the water spray providing protection to personnel; thus the approach would be to retreat and to generally act in a support role.

Thus the new Jetty fire response effort should not be designed to tackle these huge fires.
7 References


2. Material Safety Data Sheets as given in Appendix B.


4. EPConsult: Petroleum Jetty in Massawa ESIA Oil Spill Risk Assessment and Contingency Plan, MES-POY-OS&CP-002, 31.01.08.
Appendix A
Base Data
A.1 General

This section gives the study basis, the data gathering and assumptions that have been made to produce the firefighting training plan.

The new Jetty is designed and constructed the standards given in Table A-1.

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</tbody>
</table>

The following design loadings are used for the design of the structures. These figures supplement the loadings specified in the applicable standards.

<table>
<thead>
<tr>
<th>Element</th>
<th>Direction</th>
<th>Loading</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jetty/Dolphins</td>
<td>Vertical</td>
<td>10KN/m²</td>
<td></td>
</tr>
<tr>
<td>Jetty</td>
<td>Vertical</td>
<td>965KN/m²</td>
<td>Liebherr HS845 HD Litronic Crane or similar, crane weight + 12 ton concrete beam</td>
</tr>
<tr>
<td>Access walkways</td>
<td>Vertical</td>
<td>1.5KN/m²</td>
<td></td>
</tr>
<tr>
<td>All elements</td>
<td>Horizontal &amp; Vertical</td>
<td>2.5KN/m²</td>
<td>Seismic loading</td>
</tr>
</tbody>
</table>

A.2 Key Assumptions

The new Jetty design is based on the following premises for the unloading of product:

- Parcel sizes for white product (Gas oil, Kerosene & Gasoline) are based on a maximum vessel size of 50,000 tonne vessel (DWT).
- White product will be delivered in a single vessel (70% Gas oil, 20% Kerosene & 10% Gasoline).
- Parcel sizes for fuel oil are based on a maximum vessel size of 30,000 tonne vessel (DWT)
- Delivery pressure at the vessel manifold will be a minimum of 7 bar for white product, 10 bar for fuel oil and 16 bar for LPG.
- Minimum required inlet pressure at the storage tank is 1.5bar for white product and fuel oil and 7.5 bar for LPG.
• Elevation difference between the Jetty head and the storage tank inlet will not exceed 2m.
• Lay time should not exceed 36 hours.
• Product discharge time should not exceed 31 hours, excluding connection, sampling, paperwork and unberthing.
• All the tanks in the Tamoil tank farm are bounded sufficiently to contain the oil product in the event of catastrophic rupture of the tanks.
• Any small oil spills onshore should be contained by a team using a dike made of sand. Drip trays should be covered with a non-porous medium and have a dike around them. Cleanup should be with a sorbent such as ‘Speedy Dry’, sorbent pads or boom.

A.3 Gathered Data

A.3.1 Climate Conditions

The climate conditions are based on the wind and wave data for Red Sea, Gulf of Aden Pilot and the data purchased from BMT.

For the operational conditions in these waters, the one minute mean wind speed with a return period of 10 years was estimated to be 25m/s. Rarely does the wind speed exceed 25m/s, and in this case, the vessel will not be at berth and will ride out the storm at anchor.

The relevant wave directions for the project site are East and Southeast. The operational conditions of a three hours storm with return periods of 10 years and 100 years were used for the design conditions.

<table>
<thead>
<tr>
<th>Wave Direction</th>
<th>$H_{s10}$</th>
<th>$T_{p10}$</th>
<th>$H_{s100}$</th>
<th>$T_{p100}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>1.9</td>
<td>5.2</td>
<td>2.2</td>
<td>5.5</td>
</tr>
<tr>
<td>Southeast</td>
<td>0.9</td>
<td>3.3</td>
<td>1.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wave Direction</th>
<th>$H_{s10}$</th>
<th>$T_{p10}$</th>
<th>$H_{s100}$</th>
<th>$T_{p100}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>1.1</td>
<td>5.2</td>
<td>1.3</td>
<td>5.5</td>
</tr>
<tr>
<td>Southeast</td>
<td>0.9</td>
<td>3.3</td>
<td>1.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Table A-5: Tidal Statistics for Massawa

<table>
<thead>
<tr>
<th>Tide</th>
<th>Level above CD (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Astronomical Tide</td>
<td>1.5</td>
</tr>
<tr>
<td>Mean High Water Spring</td>
<td>1.2</td>
</tr>
<tr>
<td>Mean high water Neaps</td>
<td>0.9</td>
</tr>
</tbody>
</table>
Tide | Level above CD (m)
--- | ---
Mean sea Level | 0.75
Mean Low Water Neaps | 0.5
Mean Low water Springs | 0.3
Lowest Astronomical Tide | 0.0

A design current of 0.5knot (0.25m/s) is proposed for the detailed design.

### Table A-6: Design Level Underside Jetty

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Design criteria</th>
<th>Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tide</td>
<td>H A T</td>
<td>CD + 1.50</td>
</tr>
<tr>
<td>Waves</td>
<td>$0.5 \times H_{\text{max100}}$</td>
<td>1.10</td>
</tr>
<tr>
<td>Wind setup</td>
<td>100 years, SE storm</td>
<td>0.05</td>
</tr>
<tr>
<td>Storm surge</td>
<td>Assumed</td>
<td>0.30</td>
</tr>
<tr>
<td>Minimum level underside deck</td>
<td></td>
<td>CD + 3.0</td>
</tr>
</tbody>
</table>

### A.3.2 Design Vessel and Sizing of Pipeline

The existing facility is limited by water depth and storage capacity at the oil terminal. These considerations restrict the vessel size to a length of 176m and a draught of 8.7m. This corresponds to a fully laden 16,000 DWT vessel or vessels with DWT of slightly over 25,000 tonne which are partially laden. The smallest vessel using the terminal is the LPG tanker (2,266 tonne and 71.2m length) Mereb Gas with a cargo of pressurised LPG sailing under the Eritrean flag.

In the Red Sea there are two routing transport systems used for the transport of oil products:

- Direct supply via shuttle tankers that have a direct service between the port of export and the port of import. There are two shuttle routes: one from the port export to Massawa; and the other from port to Djibouti with a weighted average of 817 nautical miles (817x 1852m).
- Multi port routing where a vessel sails a route from the port of export, calling at a number of import terminals and finally sailing back to the export terminal. The vessels will sail a route from the export terminal via Djibouti and Massawa back to the export terminal. The total length of this route is 1635 nautical miles.

### Table A-7: Distance and Market Share

<table>
<thead>
<tr>
<th>Export Terminal</th>
<th>Trade Share (%)</th>
<th>Distance to Massawa (nm)</th>
<th>Weighted Distance (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandar Abbas</td>
<td>9.1</td>
<td>1847</td>
<td>168</td>
</tr>
<tr>
<td>Qatar</td>
<td>5.6</td>
<td>1500</td>
<td>84</td>
</tr>
<tr>
<td>Yanbu</td>
<td>58.2</td>
<td>514</td>
<td>298</td>
</tr>
<tr>
<td>Abu Dhabi</td>
<td>14.4</td>
<td>1500</td>
<td>216</td>
</tr>
</tbody>
</table>
Massawa is currently served by both routing scenarios. It is proposed that a 50,000DWT tanker would be the maximum design vessel; and the existing LPG carrier will be used as the minimum design vessel unloading product at Massawa.

Table A-8: Principal Particulars for the Design Vessel

<table>
<thead>
<tr>
<th>Design Vessel</th>
<th>Smallest</th>
<th>Largest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of vessel</td>
<td>LPG</td>
<td>Product Tanker</td>
</tr>
<tr>
<td>Dead weight [tonne]</td>
<td>2266</td>
<td>50000</td>
</tr>
<tr>
<td>Gross tonnage [tonne]</td>
<td>1403</td>
<td>31000</td>
</tr>
<tr>
<td>LOA [m]</td>
<td>71.2</td>
<td>200</td>
</tr>
<tr>
<td>Draught (laden) [m]</td>
<td>5.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Beam [m]</td>
<td>11.5</td>
<td>32.5</td>
</tr>
</tbody>
</table>

Table A-9: Sizing of Pipelines

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Gas oil</th>
<th>Gasoline</th>
<th>Jet/Kero</th>
<th>Fuel oil</th>
<th>LPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parcel size [tonne]</td>
<td>35000</td>
<td>5000</td>
<td>10000</td>
<td>30000</td>
<td>2300</td>
</tr>
<tr>
<td>Lay time [hr]</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Discharge time ['hr]</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Pipe diameter [m]</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Manifold pressure [bar]</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Minimum flow rate to avoid</td>
<td>1313</td>
<td>222</td>
<td>403</td>
<td>1019</td>
<td>127</td>
</tr>
<tr>
<td>demurrage [m³/hr]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe pressure loss at minimum</td>
<td>5.5</td>
<td>0.5</td>
<td>2.2</td>
<td>7.5</td>
<td>1.1</td>
</tr>
<tr>
<td>flow rate to avoid demurrage [bar]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Modifications will be made to the existing tanks (Tamoil, Erigas and the power station) to accommodate the increase in the line pipe sizes.

The pipe, valve and equipment options as proposed for various alternatives. Alternative 3 has been selected as the development option.

Table A-10: Pipeline and Equipment Options

<table>
<thead>
<tr>
<th>#</th>
<th>Size &amp; Type</th>
<th>Product</th>
<th>Alt 1-3</th>
<th>Alt 4</th>
<th>Alt 5</th>
<th>Alt 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16” schedule 40 pipe</td>
<td>Fuel oil</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>16” schedule 40 pipe</td>
<td>White products –Gasoline/Gas oil/Kero/JetA1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8” schedule 40 pipe</td>
<td>LPG</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>16” schedule 40 submarine pipe</td>
<td>Fuel oil</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>16” schedule 40 submarine pipe</td>
<td>White products –Gasoline/Gas oil/Kero/JetA1</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8” schedule 40 submarine pipe</td>
<td>LPG</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>16” ANSI 150</td>
<td>Marine loading arm+ Coupler + Emergency</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Size &amp; Type</td>
<td>Product</td>
<td>Alt 1-3</td>
<td>Alt 4</td>
<td>Alt 5</td>
<td>Alt 6</td>
</tr>
<tr>
<td>----</td>
<td>------------</td>
<td>-------------------------------------------------------------------------</td>
<td>---------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>1</td>
<td>8” ANSI 300</td>
<td>Marine loading arm+ Coupler + Emergency Release system</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>Ship to shore transfer hose and spreader beam+ Manual coupler</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>Hose rack</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>Up to 12” schedule 40</td>
<td>Future Provision- dedicated gasoline &amp; Kero/ Jet A1</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Up to 16”</td>
<td>Future provision-bitumen</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>Future provision- marine loading arm+ Coupler + Emergency release system</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>Future provision- Ship to shore transfer hose and spreader beam+ Manual coupler</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Table A-11: Valve Options

<table>
<thead>
<tr>
<th>#</th>
<th>Size &amp; Type</th>
<th>Product</th>
<th>Alt 1-3</th>
<th>Alt 4</th>
<th>Alt 5</th>
<th>Alt 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple</td>
<td>16” ANSI 150</td>
<td>Isolation valves</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Multiple</td>
<td>16” ANSI 150</td>
<td>Emergency shutdown valves</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Multiple</td>
<td>16” ANSI 150</td>
<td>Metering valves</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple</td>
<td>16” ANSI 150</td>
<td>Non-return valves</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Multiple</td>
<td>8” ANSI 300</td>
<td>Isolation valves</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Multiple</td>
<td>8” ANSI 300</td>
<td>Emergency shutdown valves</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple</td>
<td>8” ANSI 300</td>
<td>Metering valves</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple</td>
<td>8” ANSI 300</td>
<td>Non-return valves</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Multiple</td>
<td>16” ANSI 150</td>
<td>Bypass pipe work &amp; valves</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The pollution control equipment and utilities/services equipment options proposed for various alternatives.

Table A-12: Pollution control equipment

<table>
<thead>
<tr>
<th>#</th>
<th>Size &amp; Type</th>
<th>Product</th>
<th>Alt 1-3</th>
<th>Alt 4</th>
<th>Alt 5</th>
<th>Alt 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48” x 100ft</td>
<td>Floating boom containment system and storage reel</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1</td>
<td>Mobile skimmer</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Slop tank and pump</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table A-13: Utility/service equipment

<table>
<thead>
<tr>
<th>#</th>
<th>Size &amp; Type</th>
<th>Product</th>
<th>Alt 1-3</th>
<th>Alt 4</th>
<th>Alt 5</th>
<th>Alt 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4” schedule 40</td>
<td>Potable water pipe work</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Bunkering hose and reel and isolation &amp; metering valves</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A.3.3 Product Storage Capacity

The oil products are currently distributed by ExxonMobil, Total and Tamoil. Total is in the process of acquiring the ExxonMobil assets and business, which will give Total a 70% share of the overall market. Tamoil will have the remaining 30% of the market share. Shell sold their local assets and business to Tamoil. Shell still has an oil depot in Assab.

The following bulk oil products are currently imported in Eritrea:

- Regular (i.e. leaded) gasoline;
- Jet-A1;
- Kerosene;
- Gas oil;
- Fuel oil;
- LPG.

The total annual import ranges from 20,000 tonnes to 250,000 tonnes. The import volumes are based on monthly forecasts which depend on the following factors:

- Oil demand;
- Daily stock reports;
- Oil purchase price;
- Economic development;
- Availability of foreign currency.

Figure A-1 shows the historic throughput of oil product. Gas oil is the oil product most in demand.

![Figure A-1: Historic oil Product (tonne) throughput in Eritrea](image)

The existing Jetty has four storage facilities at Massawa as follows:

- Tamoil depot (7 tanks);
• Total/Mobil storage facility (9 tanks);
• Erigas LPG depot (2 spherical tanks);
• Hirgigo Power plant storage facility 9.

The future storage capacity is proposed to not be less than 1.5 to 2 times the tanker ship parcel size.

Table A-14: Tamoil Tank Farm

<table>
<thead>
<tr>
<th>Storage Tank #</th>
<th>Product</th>
<th>Average loading flow rate (m³/hr)</th>
<th>Safe operational Maximum capacity (m³)</th>
<th>Manifold Pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gasoline</td>
<td>330</td>
<td>3810</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Gas oil</td>
<td>330</td>
<td>4360</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Gas oil</td>
<td>330</td>
<td>3910</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>Kerosene</td>
<td>330</td>
<td>1170</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Gas oil</td>
<td>330</td>
<td>4300</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>Fuel oil</td>
<td>320</td>
<td>3910</td>
<td>7</td>
</tr>
<tr>
<td>12</td>
<td>Kerosene</td>
<td>330</td>
<td>1170</td>
<td>5</td>
</tr>
</tbody>
</table>

The Hirgigo Power plant 15,000 m³ fuel oil storage capacity is adjacent to the Tamoil tank farm. It is also reported that sometimes the vessels discharge more than the available storage capacity. In such cases road tankers are loaded simultaneously as the vessel is discharging. These are taken to contain on average 20 tonnes of product (i.e. non-articulated bowsers).

Table A-15: Total/ExxonMobil Storage Facility

<table>
<thead>
<tr>
<th>Storage Tank #</th>
<th>Product</th>
<th>Average Flow rate (m³/hr)</th>
<th>Safe operational Maximum capacity (m³)</th>
<th>Manifold Pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1T</td>
<td>Gasoline</td>
<td>N/A</td>
<td>5000</td>
<td>N/A</td>
</tr>
<tr>
<td>2T</td>
<td>Fuel oil</td>
<td>N/A</td>
<td>5000</td>
<td>N/A</td>
</tr>
<tr>
<td>4T</td>
<td>Gasoline</td>
<td>N/A</td>
<td>1200</td>
<td>N/A</td>
</tr>
<tr>
<td>6T</td>
<td>Gas oil</td>
<td>N/A</td>
<td>5000</td>
<td>N/A</td>
</tr>
<tr>
<td>F401</td>
<td>Jet A-1</td>
<td>N/A</td>
<td>6500</td>
<td>N/A</td>
</tr>
<tr>
<td>F402</td>
<td>Jet A-1</td>
<td>N/A</td>
<td>2000</td>
<td>N/A</td>
</tr>
<tr>
<td>F403</td>
<td>Kerosene</td>
<td>N/A</td>
<td>1000</td>
<td>N/A</td>
</tr>
<tr>
<td>F404</td>
<td>Gasoline</td>
<td>N/A</td>
<td>1000</td>
<td>N/A</td>
</tr>
<tr>
<td>F405</td>
<td>Gasoline</td>
<td>N/A</td>
<td>1000</td>
<td>N/A</td>
</tr>
</tbody>
</table>

The Erigas LPG depot is connected to the Tamoil Jetty with a single pipeline with a storage capacity of 1000 m³ for both two spherical tanks.
Table A-16: Combined Storage Capacity of All Depots

<table>
<thead>
<tr>
<th>Product</th>
<th>Storage capacity (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular gasoline</td>
<td>7,010</td>
</tr>
<tr>
<td>Jet A-1</td>
<td>8,500</td>
</tr>
<tr>
<td>Kerosene</td>
<td>3,340</td>
</tr>
<tr>
<td>Gas oil</td>
<td>22,470</td>
</tr>
<tr>
<td>Fuel oil (Hirgigo Power plant)</td>
<td>23,910</td>
</tr>
<tr>
<td>LPG</td>
<td>2,000</td>
</tr>
</tbody>
</table>

Table A-17: Storage Capacity vs. Throughput of Oil

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas oil</td>
<td>22,180</td>
<td>12,674</td>
<td>388,150</td>
<td>345,454</td>
</tr>
<tr>
<td>Gasoline</td>
<td>7,010</td>
<td>4,006</td>
<td>122,675</td>
<td>89,553</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>23,910</td>
<td>13,663</td>
<td>418,425</td>
<td>397,504</td>
</tr>
<tr>
<td>Kerosene</td>
<td>3,340</td>
<td>1,909</td>
<td>58,450</td>
<td>47,345</td>
</tr>
<tr>
<td>Jet A-1</td>
<td>8,500</td>
<td>4,857</td>
<td>148,750</td>
<td>119,595</td>
</tr>
<tr>
<td>LPG</td>
<td>2,000</td>
<td>1,143</td>
<td>35,000</td>
<td>19,250</td>
</tr>
</tbody>
</table>

Table A-18: Forecast for Individual Oil Product [tonnes]

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel oil</td>
<td>45,792</td>
<td>56,702</td>
<td>74,635</td>
<td>96,982</td>
<td>124,831</td>
<td>159,536</td>
</tr>
<tr>
<td>Regular Gasoline</td>
<td>18,570</td>
<td>22,364</td>
<td>28,599</td>
<td>36,370</td>
<td>46,053</td>
<td>58,120</td>
</tr>
<tr>
<td>Kerosene</td>
<td>23,132</td>
<td>28,193</td>
<td>36,511</td>
<td>46,876</td>
<td>59,793</td>
<td>75,891</td>
</tr>
<tr>
<td>LPG</td>
<td>4,544</td>
<td>5,800</td>
<td>7,402</td>
<td>9,447</td>
<td>12,058</td>
<td>15,389</td>
</tr>
<tr>
<td>Gas oil</td>
<td>12,0141</td>
<td>153,334</td>
<td>195,697</td>
<td>249,764</td>
<td>318,769</td>
<td>406,840</td>
</tr>
<tr>
<td>Total</td>
<td>222,865</td>
<td>280,545</td>
<td>362,698</td>
<td>466,398</td>
<td>597,317</td>
<td>762,621</td>
</tr>
</tbody>
</table>

The following reference documents will be used as guideline for safety area around oil and gas terminal including handling and safety zoning:

- Area Classification code for Installations Handling Flammable Fluid, the Institute of Petroleum (British), Model of Code of state Practice, 2002. (this has since been revised).
- International Safety Guide for Oil Tanker & terminals, 3rd edition, IMO.
- The loading and unloading of bulk flammable liquids and gases at harbours and inland waterways, Health and safety executive (British), 1986.
The Institute for Petroleum area classification code for discharge facilities is as follows:

- Jetty with only discharge operation without loading facilities including ballasting other than to vapour-free segregated ballast tanks, then the vent of flammable vapours will not take place during discharging operations. It is recommended that Zone 2 classification should be an area extending from the hull horizontal distance of 20m in the landward direction up to 10m height above the Jetty deck and down to water. Where berths are restricted to barges, coaster or other Vessels with discharge rates that do not exceed 10m³/min then the above distance may be reduced to 5m horizontally.

- If ballasting is carried out during discharge into un-segregated vessel’s tanks which could contain vapours or if vent of tanks is carried out along side the Jetty then the Jetty should be classified in accordance with discharging and loading facilities.

Guidance note GS40 of the HSE recommends the following for separation distance:

- Adequate separation should be maintained between cargo transfer facilities and boundaries, occupied buildings (exception with small shelters), storage tanks and fixed sources of ignition. This is significant for liquefied gases such as LPG and liquids with flash point below 21°C. Where it is practicable at least 20m separation and it could be increased to 30m for boundary and distances between ships. For passenger ferries and their associated assembly areas, a distance of 75m is recommended.
### Table A-20: Physical Properties for Oil Products

<table>
<thead>
<tr>
<th>Oil</th>
<th>Boiling Range [°C]</th>
<th>Vapour Pressure [psia]</th>
<th>Vapour Density (air = 1)</th>
<th>Specific Gravity (H₂O = 1)</th>
<th>% Volatile</th>
<th>Evaporation Rate</th>
<th>Solubility (H₂O)</th>
<th>Pour Point [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Oil</td>
<td>171-371</td>
<td>0.009@21°C</td>
<td>&gt;1</td>
<td>0.87</td>
<td>100</td>
<td>Slow</td>
<td>Negligible</td>
<td>N/A</td>
</tr>
<tr>
<td>Gas Oil</td>
<td>180-390</td>
<td>0.044@20°C</td>
<td>&lt;1</td>
<td>0.82</td>
<td>N/A</td>
<td>N/A</td>
<td>Negligible</td>
<td>-24</td>
</tr>
<tr>
<td>Kerosene</td>
<td>150-300</td>
<td>0.435@20°C</td>
<td>&lt;1</td>
<td>0.775-0.82</td>
<td>N/A</td>
<td>N/A</td>
<td>Negligible</td>
<td>-24</td>
</tr>
<tr>
<td>Jet A-1</td>
<td>140-300</td>
<td>0.029@38°C</td>
<td>4.5</td>
<td>0.75-0.80</td>
<td>100</td>
<td>Slow</td>
<td>Negligible</td>
<td>N/A</td>
</tr>
<tr>
<td>Gasoline (All grades)</td>
<td>39-200</td>
<td>6.4-15 RVP @38°C</td>
<td>3-4</td>
<td>0.70-0.78</td>
<td>100</td>
<td>10-11(n-butyl acetate =1)</td>
<td>&lt; 0.1%</td>
<td>N/A</td>
</tr>
<tr>
<td>Bitumen</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>LPG (Autogas)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propane + Propene &gt;90% C4 &amp; others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPG (Propane)</td>
<td>-48 to -42</td>
<td>124@20°C</td>
<td>1.56</td>
<td>0.5-0.53</td>
<td>N/A</td>
<td>N/A</td>
<td>6.5v/v@17.8°C</td>
<td>-24</td>
</tr>
<tr>
<td>LPG (Butane)</td>
<td>-12 to 0</td>
<td>30.015@20°C</td>
<td>2</td>
<td>0.56-0.59</td>
<td>N/A</td>
<td>N/A</td>
<td>Sparingly Soluble</td>
<td>N/A</td>
</tr>
<tr>
<td>Oil</td>
<td>Flash Point [°C]</td>
<td>Auto Ignition Point [°C]</td>
<td>LEL [%]</td>
<td>UEL [%]</td>
<td>Fire Fighting Procedure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------------------</td>
<td>--------------------------</td>
<td>---------</td>
<td>---------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Fuel Oil    | 38               | 257                      | 0.6     | 7.5     | Vapours may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions. When mixed with air and exposed to ignition source, flammable vapours can burn in the open or explode in confined spaces.  
Vapours may travel long distance to an ignition source and flash back.  
Runoff to sewer may cause fire or explosion hazard.  
Small fires: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam or Halon.  
Large fires: Water spray, fog or fire fighting foam. Water may be ineffective for fire fighting, but may be used to cool fire-exposed containers.  
Fire fighting foam is suitable for polar solvents with > 10% oxygenate concentration (MTBE)  
Isolate area around a container involved in fire.  
Cool tanks, shells and containers exposed to fire and excessive heat with water.  
For huge fires the use of unmanned hose or monitor nozzles may be advantageous to minimize personnel exposure.  
Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires require specially trained personnel and equipment to extinguish the fire with the need for properly applied fire fighting foam. |
| Gas Oil     | 56               | 250                      | 0.5     | 5       | Leak can release vapours that readily form flammable mixtures at or above flash point  
Static discharge; material can accumulate static charges which may cause an incendiary electric discharge.  
Small fires: Foam, dry chemical powder and carbon dioxide.  
Large fires: Water fog or spray to cool fire exposed surfaces (e.g. containers) and to protect personnel.  
Only use personnel trained for fire fighting and cut off fuel supply if it is possible to do so.  
Respiratory and eye protection equipment are required for fire fighting personnel exposed to fumes or smoke. |
| Kerosene    | 38               | 250                      | 0.5     | 6       | Leak can release vapours that readily form flammable mixtures at or above flash point  
Static discharge; material can accumulate static charges which may cause an incendiary electric discharge.  
Small fires: Foam, dry chemical powder and carbon dioxide.  
Large fires: Water fog or spray to cool fire exposed surfaces (e.g. containers) and to protect personnel.  
Only use personnel trained for fire fighting and cut off fuel supply if it is possible to do so.  
Respiratory and eye protection equipment are required for fire fighting personnel exposed to fumes or smoke. |
## Fire Fighting Procedure

**Jet A-1**

- **Flash Point**: 38°C
- **Auto Ignition Point**: 210°C
- **LEL [%]**: 0.7
- **UEL [%]**: 5

Vapours may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions.
When mixed with air and exposed to ignition source, flammable vapours can burn in the open or explode in confined spaces.
Vapours may travel long distance to an ignition source and flash back.
Runoff to sewer may cause fire or explosion hazard.
Small fires: Any extinguisher suitable for Class B fires, dry chemical, CO₂, water spray, fire fighting foam or Halon.
Large fires: Water spray, fog or fire fighting foam. Water may be ineffective for fire fighting, but may be used to cool fire-exposed containers.
Fire fighting foam is suitable for polar solvents with > 10% oxygenate concentration (MTBE)
Isolate area around a container involved in fire.
Cool tanks, shells and containers exposed to fire and excessive heat with water.
For huge fires the use of unmanned hose or monitor nozzles may be advantageous to minimize personnel exposure.
Major fires may require withdrawal, allowing the tank to burn.
Large storage tank fires require specially trained personnel and equipment to extinguish the fire with the need for properly applied fire fighting foam.

**Gasoline (All grades)**

- **Flash Point**: -43°C
- **Auto Ignition Point**: >280°C
- **LEL [%]**: 1.4
- **UEL [%]**: 7.6

Vapours may be ignited rapidly when exposed to heat, spark, open flame or other source of ignitions.
When mixed with air and exposed to ignition source, flammable vapours can burn in the open or explode in confined spaces.
Vapours may travel long distance to an ignition source and flash back.
Runoff to sewer may cause fire or explosion hazard.
Small fires: Any extinguisher suitable for Class B fires, dry chemical, CO₂, water spray, fire fighting foam or Halon.
Large fires: Water spray, fog or fire fighting foam. Water may be ineffective for fire fighting, but may be used to cool fire-exposed containers.
Fire fighting foam is suitable for polar solvents with > 10% oxygenate concentration (MTBE)
Isolate area around a container involved in fire.
Cool tanks, shells and containers exposed to fire and excessive heat with water.
For huge fires the use of unmanned hose or monitor nozzles may be advantageous to minimize personnel exposure.
Major fires may require withdrawal, allowing the tank to burn.
Large storage tank fires require specially trained personnel and equipment to extinguish the fire with the need for properly applied fire fighting foam.
<table>
<thead>
<tr>
<th>Oil</th>
<th>Flash Point [°C]</th>
<th>Auto Ignition Point [°C]</th>
<th>LEL [%]</th>
<th>UEL [%]</th>
<th>Fire Fighting Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td>250</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Fire should not be extinguished until the source is shut off. Liquid spills readily form flammable mixture at temperature below ambient. Risk of fire or explosion by mechanical impact, friction, sparks, flames or others sources of ignition. Vapours settle to ground level and may reach ignition sources remote from the point of escape via drains and other underground passages. Static discharge; material can accumulate static charges which may cause an incendiary electric discharge. To avoid uncontrolled explosive re-ignition, do not extinguish flame at leak. Cut off fuel if safe to do so, and allow fire to burn out under controlled conditions. Extinguish small residual fires with foam or dry chemical powder. Respiratory and eye protection required for fire fighting personnel exposed to fumes or smoke. Water spray should be used to cool equipment.</td>
</tr>
<tr>
<td>LPG Autogas (Propane +Propene)&gt;90%+ C4 &amp; others</td>
<td>-104</td>
<td>468</td>
<td>2.2</td>
<td>9.5</td>
<td>To avoid uncontrolled explosive re-ignition, do not extinguish flame at leak. Cut of fuel if safe to do so, and allow fire to burn out under controlled conditions. Extinguish small residual fires with foam or dry chemical powder. Respiratory and eye protection required for fire fighting personnel exposed to fumes or smoke. Water spray should be used to cool equipment.</td>
</tr>
<tr>
<td>LPG (Propene Propene) &gt;90%</td>
<td>-60</td>
<td>450</td>
<td>1.9</td>
<td>8.5</td>
<td>To avoid uncontrolled explosive re-ignition, do not extinguish flame at leak. Cut off fuel if safe to do so, and allow fire to burn out under controlled conditions. Extinguish small residual fires with foam or dry chemical powder. Respiratory and eye protection required for fire fighting personnel exposed to fumes or smoke. Water spray should be used to cool equipment.</td>
</tr>
</tbody>
</table>
Appendix B
Material Safety Data Sheets
### No. 2 Fuel Oil

**MATERIAL SAFETY DATA SHEET**

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Exposure Limits</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2 Fuel Oil</td>
<td>OSHA PEL-TWA</td>
<td>10 mg/m³ air</td>
</tr>
<tr>
<td>CAS Number: 6547-35-2</td>
<td>ACGIH-TLV-TWA:</td>
<td>997 mg/m³ air, A2</td>
</tr>
<tr>
<td>Naphthenic</td>
<td>OSHA PEL-TWA</td>
<td>15 ppm</td>
</tr>
<tr>
<td>CAS Number: 61-207</td>
<td>ACGIH-TLV/TWA/TWA:</td>
<td>12/15 ppm, A4</td>
</tr>
</tbody>
</table>

A complex combination of hydrocarbons with carbon numbers in the range C8 and higher produced from the distillation of petroleum crude oil.

### HAZARDS IDENTIFICATION

**EMERGENCY OVERVIEW CAUTION!**

OSHA/NSF PA COMBUSTIBLE LIQUID - SLIGHT TO MODERATE IRITANT - EFFECTS CENTRAL NERVOUS SYSTEM - HARMFUL IF SWALLOWED

Moderate fire hazard. Avoid breathing vapors or mists. May cause dizziness and drowsiness. May cause moderate eye irritation and skin irritation. Long-term, repeated exposure may cause skin cancer.

Ingestion: Do NOT induce vomiting, as this may cause chemical pneumonitis (inflammation of the lungs).

**EYES**

Contact with eyes may cause mild irritation.

**SKIN**

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid can be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

**INHALATION**

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonitis (inflammation of the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

Inhalation: Excessive exposure may cause irritation to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

**Revision Date:** 02/28/01
AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

No. 2 Fuel Oil  MSDS No. 0088

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY

Stirrul products have produced skin cancer and systemic toxicity in laboratory animals following repeated applications. The significance of these results to human exposures has not been determined - see Section 11Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis ( rash).

4. FIRST AID MEASURES (rev. Jan-96, Tox-96)

EYES
In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN
Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or with waterless hand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION
DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION
Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored or trained to do so. Seek medical attention immediately.

5. FIRE FIGHTING MEASURES (rev. Sep-94)

FLAMMABLE PROPERTIES:
FLASH POINT: 100 °F (38 °C), minimum PMCC
AUTOIGNITION POINT: 494 °F (257 °C)
LOWER EXPLOSIVE LIMIT (%): 0.6
UPPER EXPLOSIVE LIMIT (%): 7.5

FIRE AND EXPLOSION HAZARDS
OSHA and NIPA Class 2 COMBUSTIBLE LIQUID (see Section 14 for transportation classification). Vapors may be ignited readily when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA
SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or Halon.
LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

FIRE FIGHTING INSTRUCTIONS
Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.
AMERICAN HESS CORPORATION
No. 2 Fuel Oil MATERIAL SAFETY DATA SHEET MSDS No. 0088

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 10 for the NFPA 704 Hazard Rating

6. ACCIDENTAL RELEASE MEASURES (rev. Jan-98)

ACTIVATE FACILITY’S SPILL CONTINGENCY OR EMERGENCY RESPONSE PLAN

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Response and clean-up areas must be properly trained and must utilize proper protective equipment (see Section 9).

7. HANDLING and STORAGE (rev. Jan-98)

HANDLING PRECAUTIONS

Handle as a combustible liquid. Keep away from heat, sparks, excessive temperatures and open flame.

No smoking or open flame in storage, use or handling areas. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special spill/leak procedures for "slow loading" must be followed to avoid the static ignition hazard that can exist when this product is loaded into tanks previously containing low flash point products (such as gasoline). - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

STORAGE PRECAUTIONS

Keep containers closed and clearly labeled. Use approved vented storage containers. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Codes". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks."

WORK/HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using latrine facilities. Do not use as a cleaning solvent or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse.
AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

No. 2 Fuel Oil

Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

<table>
<thead>
<tr>
<th>8. EXPOSURE CONTROLS and PERSONAL PROTECTION</th>
<th>(rev. Jan-90)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENGINEERING CONTROLS</strong></td>
<td></td>
</tr>
<tr>
<td>Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.</td>
<td></td>
</tr>
<tr>
<td><strong>EY/EYE PROTECTION</strong></td>
<td></td>
</tr>
<tr>
<td>Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.</td>
<td></td>
</tr>
<tr>
<td><strong>SKIN PROTECTION</strong></td>
<td></td>
</tr>
<tr>
<td>Gloves constructed of nitrile, neoprene, or PVC are recommended. Chemical protective clothing such as E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.</td>
<td></td>
</tr>
<tr>
<td><strong>RESPIRATORY PROTECTION</strong></td>
<td></td>
</tr>
<tr>
<td>A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, ANSI Z88.2-1992, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection.</td>
<td></td>
</tr>
<tr>
<td>Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9. PHYSICAL and CHEMICAL PROPERTIES</th>
<th>(rev. Jul-98)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APPEARANCE</strong></td>
<td></td>
</tr>
<tr>
<td>Red or reddish/orange colored (dyed) liquid</td>
<td></td>
</tr>
<tr>
<td><strong>ODOR</strong></td>
<td></td>
</tr>
<tr>
<td>Mild, petroleum distillate odor</td>
<td></td>
</tr>
<tr>
<td><strong>BASIC PHYSICAL PROPERTIES</strong></td>
<td></td>
</tr>
<tr>
<td>BOILING RANGE: 340 to 700 °F (171 to 371 °C)</td>
<td></td>
</tr>
<tr>
<td>VAPOR PRESSURE: 0.309 psia @ 70 °F (21 °C)</td>
<td></td>
</tr>
<tr>
<td>VAPOR DENSITY (air = 1): &gt; 1.0</td>
<td></td>
</tr>
<tr>
<td>SPECIFIC GRAVITY (H₂O = 1): AP 0.87</td>
<td></td>
</tr>
<tr>
<td>PERCENT VOLATILES: 100 %</td>
<td></td>
</tr>
<tr>
<td>EVAPORATION RATE: Slow varies with conditions</td>
<td></td>
</tr>
<tr>
<td>SOLUBILITY (H₂O): Negligible</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10. STABILITY and REACTIVITY</th>
<th>(rev. Sep-94)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STABILITY:</strong> Stable. Hazardous polymerization will not occur</td>
<td></td>
</tr>
<tr>
<td><strong>CONDITIONS TO AVOID and INCOMPATIBLE MATERIALS</strong></td>
<td></td>
</tr>
<tr>
<td>Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources. Keep away from strong oxidizers: Viton®, Fluorel®</td>
<td></td>
</tr>
<tr>
<td><strong>HAZARDOUS DECOMPOSITION PRODUCTS</strong></td>
<td></td>
</tr>
<tr>
<td>Carbon mon oxide, carbon dioxide and non-combusted hydrocarbons (smoke).</td>
<td></td>
</tr>
</tbody>
</table>

Revision Date: 02/28/01 Page 4 of 7
\textbf{AMERADA HESS CORPORATION}  

\textbf{MATERIAL SAFETY DATA SHEET}  

\begin{tabular}{|p{0.7\textwidth}|p{0.2\textwidth}|}
\hline
\textbf{No. 2 Fuel Oil} & \textbf{MSDS No. 0088} \\
\hline
\textbf{11. TOXICOLOGICAL PROPERTIES} & \textbf{(rev. Jan-06; Tox-06)} \\
\hline
\textbf{ACUTE TOXICITY} &  \\
Acute Oral LD50 (rat): 14.8 ml/kg &  \\
Acute Dermal LD50 (rabbit): > 5 ml/kg &  \\
Guinea Pig Sensitization: negative &  \\
Primary dermal irritation: moderately irritating (Draize mean irritation score - 3.08 rabbits) &  \\
Draize eye irritation: mildly irritating (Draize score, 48 hours, unwashed - 2.2 rabbits) &  \\
\hline
\textbf{CHRONIC EFFECTS AND CARCINOGENICITY} &  \\
Dermal carcinogenicity: positive - mice &  \\
Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation. &  \\
This product is similar to Diesel Fuel. IARC classifies whole diesel fuel exhaust particulates as probably carcinogenic to humans (Group 2A) and NICSH regards it as a potential cause of occupational lung cancer based on animal studies and limited evidence in humans. &  \\
\hline
\textbf{MUTAGENICITY (genetic effects)} &  \\
Material of similar composition has been positive in a mutagenicity study. &  \\
\hline
\end{tabular}

\textbf{12. ECOLOGICAL INFORMATION} \textbf{(rev. Jan-06)}  

Keep out of sewers, drainage areas and waterways. Report splits and releases, as applicable, under Federal and State regulations.  

\textbf{13. DISPOSAL CONSIDERATIONS} \textbf{(rev. Jan-06)}  

Consult federal, state and local waste regulations to determine appropriate disposal options.  

\textbf{14. TRANSPORTATION INFORMATION} \textbf{(rev. Jan-06)}  

\begin{tabular}{|p{0.7\textwidth}|}
\hline
PROPER SHIPPING NAME & FUEL OIL, NO. 2 \\
HAZARD CLASS & 8 \\
SHIPPING GROUP & 3, PG III \\
DOT IDENTIFICATION NUMBER: & NA 1993 \\
DOT SHIPPING LABEL: & FLAMMABLE LIQUID \\
May be reclassified for transportation as a COMBUSTIBLE LIQUID under conditions of DOT 49 CFR 173.120(b)(2). &  \\
\hline
\end{tabular}

\textbf{15. REGULATORY INFORMATION} \textbf{(rev. Feb-01)}  

\begin{tabular}{|p{0.7\textwidth}|}
\hline
U.S. FEDERAL, STATE and LOCAL REGULATORY INFORMATION &  \\
This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other regulations at the state and/or local level. Consult those regulations applicable to your facility/operation. &  \\
CLEAN WATER ACT (OIL SPILLS) &  \\
Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required. &  \\
\hline
\end{tabular}

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AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

No. 2 Fuel Oil

MSDS No. 0680

CERCLA SECTION 103 and SARA SECTION 304 [RELEASE TO THE ENVIRONMENT]
The CERCLA definition of hazardous substances contains a "petroleum exclusion" clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

ACUTE HEALTH: X
CHRONIC HEALTH: X
FIRE: X
SUDDEN RELEASE OF PRESSURE: --
REACTIVE: --

SARA SECTION 313 - SUPPLIER NOTIFICATION
This product may contain listed chemicals below the de minimis levels which therefore are not subject to the supplier notification requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372. If you may be required to report releases of chemicals listed in 40 CFR 372.28, you may contact Amerada Hess Corporate Safety if you require additional information regarding this product.

CANADIAN REGULATORY INFORMATION (WHMIS)
Class B, Division 3 (Combustible Liquid); Class D, Division 2, Subdivision B (Toxic by other means)

16. OTHER INFORMATION (rev. Feb-01)

NFPA® HAZARD RATING

HEALTH: 0 Negligible
FIRE: 2 Moderate
REACTIVITY: 0 Negligible

HMIS® HAZARD RATING

HEALTH: 1 * Slight
FIRE: 2 Moderate
REACTIVITY: 0 Negligible

SUPERSEDES MSDS DATED: 09/03/98

ABBREVIATIONS:
AF = Approximately
< = Less than
> = Greater than
N/A = Not Applicable
ND = Not Determined
ppm = parts per million

ACRONYMS:
ACGIH American Conference of Governmental Industrial Hygienists
AIHA American Industrial Hygiene Association
ANSI American National Standards Institute (21/2)
API American Petroleum Institute (202) 682-3000
CERCLA Comprehensive Emergency Response, Compensation, and Liability Act
DOT U.S. Department of Transportation [General info: (800) 497-4922]
EPA U.S. Environmental Protection Agency
HMS Hazardous Materials Information System
IARC International Agency For Research On Cancer
MSHA Mine Safety and Health Administration

NFPA National Fire Protection Association (617) 770-3000
NIOSH National Institute of Occupational Safety and Health
NOIC Notice of Intended Change (proposed change to ACGIH TLV)
NTP National Toxonomy Program
OSHA U.S. Occupational Safety & Health Administration
OEA Oil Pollution Act of 1990
RCRA Resource Conservation and Recovery Act
REL Recommended Exposure Limit (NIOSH)
SARA Superfund Amendments and Reauthorization Act of 1986 Title III
SCBA Self-Contained Breathing Apparatus

Revision Date: 02/29/01
### AMERADA HESS CORPORATION

#### MATERIAL SAFETY DATA SHEET

<table>
<thead>
<tr>
<th>No. 2 Fuel Oil</th>
<th>MSDS No. 0088</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SFCC</th>
<th>Spill Prevention, Control, and Countermeasures</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEL</td>
<td>Short-Term Exposure Limit (generally 15 minutes)</td>
</tr>
<tr>
<td>TLV</td>
<td>Threshold Limit Value (ACGIH)</td>
</tr>
<tr>
<td>TSCA</td>
<td>Toxic Substances Control Act</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TWA</th>
<th>Time Weighted Average (8 hr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEEL</td>
<td>Workplace Environmental Exposure Level (ALHA)</td>
</tr>
<tr>
<td>WHMIS</td>
<td>Canadian Workplace Hazardous Materials Information System</td>
</tr>
</tbody>
</table>

**DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES**

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of this material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.
MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY

PRODUCT NAME

GAS OIL

NAME AND ADDRESS OF MANUFACTURER/SUPPLIER

ConocoPhillips Ltd, Humber Refinery, South Killingholme, North Lincolnshire DN40 3DW
Telephone No. 01469 571571
Facsimile No. 01469 555143

EMERGENCY CONTACT

ConocoPhillips Ltd, Humber Refinery, South Killingholme, Immingham, North Lincolnshire DN40 3DW.
Health and Safety Emergency Telephone No. 01469 555348 (24 hours)

APPLICATION

Heating and fuel oil for industrial applications.

2. COMPOSITION / INFORMATION ON INGREDIENTS

Petroleum Hydrocarbons >99%
Saturated olefinic and aromatic - C₁₀ to C₂₆ - may contain Polycyclic Aromatic Hydrocarbons - PAHs.
CAS No. 093334-30-5 EINECS No. 269-922-7 R40

Additives
1. Middle distillate flow improvers (various) up to 500ppm. (Dispersion of Ethylene vinyl acetate in an organic solvent).
2. Cetane improvers (Alkyl Nitrates) - up to 500ppm. CAS No. 27247-96-7, EINECS No. 248-383-8
3. Dye and Chemical Marker - Gas Oil Marker Concentrate. CAS No. 083334-30-5.
GAS OIL

3. HAZARDS IDENTIFICATION

Health Hazards:
This product contains amounts of Polycyclic Aromatic Hydrocarbons (PAH's) some of which are known from experimental animal studies to be skin carcinogens. Prolonged and repeated exposure may therefore cause dermatitis and there is a risk of skin cancer. The risk of skin cancer will be very low, providing the handling precautions are such that prolonged and repeated skin contact is avoided and good personal hygiene is observed. Aspiration of liquid into the lungs directly or as a result of vomiting following ingestion of the liquid can cause severe lung damage and death.

Safety Hazards:
Product is combustible. Keep away from flames, sparks and other sources of ignition. Electrostatic charges may be generated during liquid transfer.

Environmental Hazard:
Dangerous for the environment. Studies on gas oils indicate toxicity to invertebrates (LL50 typically 1 – 10 mg/l), and slight toxicity to fish (LL50 10 - >100 mg/l).

4. FIRST AID MEASURES

Eyes:
Rinse immediately with plenty of water until irritation subsides. If irritation persists, obtain medical attention.

Skin:
Immediate flush with large amounts of water, using soap if available. Remove contaminated clothing, including shoes, after flushing has begun. If irritation persists, get medical attention.

Inhalation:
In emergency situations use suitable respiratory protection to immediately remove the affected victim from exposure. Administer artificial respiration if breathing has stopped. Keep at rest. Call for prompt medical attention.

Ingestion:
DO NOT INDUCE VOMITING, since it is important that no amount of the material should enter the lungs (aspiration). Keep at rest. Get prompt medical attention.

Pressure Injection:
ALWAYS OBTAIN IMMEDIATE MEDICAL ATTENTION EVEN THOUGH THE INJURY MAY APPEAR MINOR.

5. FIRE-FIGHTING MEASURES

Extinguishing Media:
Foam, dry chemical powder, carbon dioxide.

Fire and Explosion Hazards:
Flammable liquid, moderate hazard. Liquid can release vapours that readily form flammable mixtures at or above the flash point. Static discharge; material can accumulate static charges which may cause an incendiary electrical discharge.

Special Fire-Fighting Procedures:
Water fog or spray to cool fire exposed surfaces (e.g. containers) and to protect personnel, should only be used by personnel trained in firefighting. Cut off "fuel"; depending on circumstances, either allow the fire to burn out under controlled conditions or use foam or dry chemical powder to extinguish the fire. Respiratory and eye protection required for fire-fighting personnel exposed to fumes or smoke.

Hazardous Combustion Products:
Smoke, sulphur oxides and carbon monoxide in the event of incomplete combustion.

6. ACCIDENTAL RELEASE MEASURES
GAS OIL

Personal Precautions: See Section 8.

Environmental Precautions:

Land Spill: Eliminate sources of ignition. Shut off source taking normal safety precautions. Prevent liquid from entering sewers, watercourses or low lying areas; advise the relevant authorities if it has, or if it contaminates soil/vegetation. Take measures to minimise the effects of groundwater.

Water Spill: Eliminate the spill immediately with booms. Warn shipping. Notify port and other relevant authorities.

Decontamination Procedures:

Recover by skimming or pumping using explosion-proof equipment, or contain spilled liquid with booms, sand or other suitable absorbent and remove mechanically into containers. If necessary, dispose of absorbed residues as directed in Section 13.

7. HANDLING AND STORAGE

Store product in cool, well ventilated surroundings, well away from sources of ignition. Provide suitable mechanical equipment for the safe handling of drums and heavy packages. Electrical equipment and fittings must comply with local regulations regarding fire prevention with this class of product.

Load/unload temperature: Ambient to 40°C Storage temperature: Ambient to 40°C

Special Precautions

Use the correct grounding procedure. Store and handle in closed or properly vented containers. Ensure compliance with statutory requirements for storage and handling. Check for and prevent potential leaks from containers.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

<table>
<thead>
<tr>
<th>Occupational Exposure Standard</th>
<th>Substance</th>
<th>8-hour TWA</th>
<th>STEL</th>
<th>Source / Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oil Mist, Mineral</td>
<td>6 mg/m³</td>
<td>10 mg/m³</td>
<td>HSE Guidance: not listed in EH 40</td>
</tr>
</tbody>
</table>

Personal Protection: In open systems where contact is likely, wear safety goggles (standard EN 166), chemical-resistant overalls, and chemically impervious gloves (EN 374). Where only incidental contact is likely, wear safety glasses with side shields. No other special precautions are necessary provided skin/eye contact is avoided. Where concentrations in air may exceed OES approved respirators may be required (EN 405).

9. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear red coloured liquid</td>
</tr>
<tr>
<td>Odour</td>
<td>Pungent petroleum</td>
</tr>
<tr>
<td>Density at 15°C</td>
<td>0.82 g/ml</td>
</tr>
<tr>
<td>pH</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Vapour Pressure at 20°C</td>
<td>&lt; 0.3 Kpa</td>
</tr>
<tr>
<td>Vapour Density (air=1)</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Boiling point, °C</td>
<td>180 - 190</td>
</tr>
<tr>
<td>Pour Point, °C</td>
<td>-24°C</td>
</tr>
<tr>
<td>Flash Point (Closed Cup), °C</td>
<td>&gt; 55</td>
</tr>
<tr>
<td>Auto-ignition Temperature, °C</td>
<td>250</td>
</tr>
</tbody>
</table>

Flammability Limit, in Air, % by Volume:
- LEL: 0.0%
- UEL: 5.0%

Kinematic Viscosity at 26°C, mm²/s: 4.8
Kinematic Viscosity at 40°C, mm²/s: 3.0

Solubility: Negligible

PLEASE NOTE THAT THESE PROPERTIES DO NOT CONSTITUTE A SPECIFICATION.

10. STABILITY AND REACTIVITY

- Stability: The product is stable and not subject to polymerisation.
- Conditions to avoid: Avoid exposure to extreme heat.
- Materials to avoid: Avoid contact with strong oxidising agents such as liquid chlorine.
- Hazardous Decomposition Products: Product does not decompose at ambient temperature.
11. TOXICOLOGICAL INFORMATION

The following toxicological assessment is based on a knowledge of the toxicity of the product's components.

HEALTH EFFECTS

On eyes: Slightly irritating but does not damage eye tissue.

On skin: Low order of acute toxicity. Irritating. Prolonged or repeated contact may also lead to more serious skin disorders, including skin cancer. Certain components present in this material may be absorbed through the skin, possibly in toxic quantities.

By inhalation: In high concentrations and/or at elevated temperatures, vapour or mist is irritating to mucous membranes, may cause headaches and dizziness, may be anaesthetic and may cause other central nervous system effects. Elevated temperatures or mechanical action may form vapours, mists or fumes which may be irritating to the eyes, nose, throat and lungs. Avoid breathing vapours, mists or fumes.

By ingestion: Low order of acute/systemic toxicity. Minute amounts of aspirated Gas Oil into the lungs during ingestion or vomiting may cause severe pulmonary injury and death.

Chronic: Contains Polycyclic Aromatic Hydrocarbons (PAH's). Prolonged and/or repeated skin contact with certain PAH's has been shown to cause skin cancer. Prolonged and/or repeated exposures by inhalation of certain PAH's may also cause cancer of the lung and of other sites of the body.

Acute: Based upon animal test data from similar materials and products, the acute toxicity of this product is expected to be:

<table>
<thead>
<tr>
<th>Route</th>
<th>LD50</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td>&gt; 5000 mg/kg</td>
<td>Slightly toxic</td>
</tr>
<tr>
<td>Dermal</td>
<td>&gt; 2000 mg/kg</td>
<td>Moderately toxic</td>
</tr>
</tbody>
</table>

12. ECOLOGICAL INFORMATION

This assessment is based on information developed with various other crude oils and in experimental studies on gas oils. Product will form films of hydrocarbons on release to water, which float and spread on the surface. On release to soil adsorption is the predominant process.

Biotoxocity: Dangerous for the environment. Toxic to most invertebrates and slightly toxic to fish.

Mobility: Some mobility in soils.

Persistence and Degradability: Inherently biodegradable with hydrocarbon components degraded by microorganisms. Lighter components volatilise, and in air undergo photolysis to give half lives of less than a day. Photooxidation of liquid hydrocarbons on water surfaces also contributes to the loss process. Adsorbed hydrocarbons from gas oils will slowly degrade, both in water and soil.

Bioaccumulation Potential: Gas oils have the potential to bioaccumulate, but metabolic processes may reduce this tendency.

13. DISPOSAL CONSIDERATIONS

The product contains hazardous ingredients listed in Section 2. Collects and dispose of it at an authorised disposal facility, in conformance with national and local regulations and in accordance with EEC Directives on hazardous waste.

14. TRANSPORT INFORMATION
GAS OIL

Classification for Transport: Rail cars, tank trucks, tankers, barges, drums.
Shipping Name: Gas Oil or Heating Oil Light
UN Number: 1202
UN Class: Class 3
ADR/RID: Class 3
Emergency Action Code: 3Y

15. REGULATORY INFORMATION

Hazard Label Data: GAS OIL
Xn, Harmful. N, Dangerous for the environment

R & S Phrases:
R40 Limited evidence of carcinogenic effect
R51/53 Toxic to aquatic organisms, may cause long term adverse effects in the aquatic environment
S2 Keep out of reach of children
S36/37 Wear suitable protective clothing and gloves
S01 Avoid releases into the environment, see Section 0
S02 If swallowed, do not induce vomiting; seek medical advice immediately and show this container or label.

EC Directives:
EC Directive 91/155 / EEC
Waste Oil Directive 87 / 101/ EEC

Statutory Information:
The Health and Safety at Work Act 1974
Consumer Protection Act 1987
Environmental Protection Act 1990
Control of Substances Hazardous to Health Regulations 2002 (as amended)
Chemicals (Hazard Information and Packaging for Supply) Regulations 2002
Dangerous Substances and Explosive Atmospheres Regulations 2002

European Waste Catalogue No: 13 02 02

16. OTHER INFORMATION

The data and advice given apply when the product is sold for the stated application or applications. The product is not sold as suitable for any other application. Use of the product for applications other than as stated in this sheet may give rise to risks not mentioned in this Sheet. You should not use the product other than for the stated application or applications.

If you have purchased the product for supply to a third party for use at work, it is your duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet.

If you are an employer, it is your duty to tell your employees and others or may be affected of any hazards described in this sheet and of any precautions that should be taken.

This data sheet has been revised in sections 1, 8 & 15.
MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY

PRODUCT NAME

AVIATION KEROSENE

SYNONYMS: Regular Burning Oil (RBO), 25 second Heating Oil, Aviation Jet Fuel A-1 (civilian), Avtur, NATO F34, F35 (military)

NAME AND ADDRESS OF MANUFACTURER/SUPPLIER

ConocoPhillips Ltd, Humber Refinery, South Killingholme, North Lincolnshire DN40 3DW.
Telephone No.: 01469 571571
Fax No.: 01469 555143

EMERGENCY CONTACT

ConocoPhillips Ltd, Humber Refinery, South Killingholme, Immingham, North Lincolnshire DN40 3DW.
Health and Safety Emergency Telephone No.: 01469 555348 (24 hours)

APPLICATION

Aviation turbine fuel and heating oil. As an undosed petroleum distillate, kerosene is intended for use as a fuel only. Any other use implies a processing operation which may change its essential characteristics and liability for the safety of the product will transfer to the processor. When supplied as Avtur, it is intended for use as an aviation fuel only.

2. COMPOSITION / INFORMATION ON INGREDIENTS

Petroleum hydrocarbons (saturated olefinic and aromatics C₈ - C₄₅) >99%
CAS No. 64742-81-0 EINECS No. 685-194-9 RIO. 38. 85.

Additives:

1. Static dissipator additive: up to 3 mg/litre
2. Anti-oxidant (alkylated phenols): 17-34 mg/litre
3. May contain Fuel system icing inhibitor: 0.10-0.15 vol % Diethylene Glycol Monomethyl Ether (DME)
4. May also contain a marker (cocamid): 2 mg/litre

3. HAZARDS IDENTIFICATION

Health Hazards:
This product contains a distillate which when undiluted has been shown in experimental animal studies to be a weak skin carcinogen. The risk of skin cancer will be very low, providing the handling precautions are such that prolonged and repeated skin contact is avoided and good personal hygiene is observed.
PRODUCT NAME

AVIATION KEROSENE

3. HAZARDS IDENTIFICATION (CONT.)

Safety Hazards:
Product is flammable. Keep away from flames, sparks and other sources of ignition when not in use. Electrostatic charges may be generated during liquid transfer.

Environmental Hazards:
Dangerous for the environment. Expected to be toxic to fish and aquatic invertebrates (LL50 typically 1 – 10 mg/l).

4. FIRST AID MEASURES

Eyes: Rinse immediately with plenty of water until irritation subsides. If irritation persists, obtain medical attention.

Skin: Immediate flush with large amounts of water, using soap if available. Remove contaminated clothing, including shoes, after flushing has begun. If irritation persists, get medical attention.

Inhalation: In emergency situations use proper respiratory protection to immediately remove the affected victim from exposure. Administer artificial respiration if breathing has stopped. Keep at rest. Call for prompt medical attention.

Ingestion: DO NOT INDUCE VOMITING, since it is important that no amount of the material should enter the lungs (aspiration). Keep at rest. Get prompt medical attention.

Pressure Injection: ALWAYS OBTAIN IMMEDIATE MEDICAL ATTENTION EVEN THOUGH THE INJURY MAY APPEAR MINOR.

5. FIRE-FIGHTING MEASURES

Extinguishing Media: Foam, dry chemical powder, carbon dioxide.

Fire and Explosion Hazards: Flammable, moderate hazard. Liquid can release vapour, which forms flammable mixtures at or above the flash point. Static discharge; material can accumulate static charges which may cause an incendiary electrical discharge.

Special Fire-Fighting Procedures: Water fog or spray to cool fire exposed surfaces (e.g. containers) and to protect personnel. Should only be used by personnel trained in firefighting. Cut off "fuel"; depending on circumstances, either allow the fire to burn out under uncontrolled conditions or use foam or dry chemical powder to extinguish the fire. Respiratory and eye protection required for fire-fighting personnel exposed to flames or smoke.

Hazardous Combustion Products: Smoke and carbon monoxide in the event of incomplete combustion.
6  ACCIDENTAL RELEASE MEASURES

**Personal Precautions:** See Section 8.

**Environmental Precautions:**

- **Land Spill:** Eliminate sources of ignition. Shut off source taking normal safety precautions. Prevent liquid from entering sewers, water courses, or low lying areas. Advise the relevant authorities if it has, or if it contaminates soil/vegetation. Take measures to minimise the effects of groundwater.

- **Water Spill:** Eliminate sources of ignition and warn other shipping to stay clear. Notify port and other relevant authorities. Do not confine in area of leakage. Remove from the surface by skimming or with suitable absorbents. Disperse the residue in unconfined waters, if permitted by local authorities and environmental agencies.

**Decontamination Procedures:**

Recover by skimming or pumping using explosion-proof equipment, or contain spilled liquid with booms, sand or other suitable absorbent and remove mechanically into containers. If necessary, dispose of absorbed residues as directed in Section 13.

7.  HANDLING AND STORAGE

The design and operation of bulk storage and fuel systems must comply with national legislation and recognised codes of good practice. In similar quantities, containers such as drums should be stored in cool, well ventilated surroundings, away from all sources of ignition. Electrical equipment and fittings must comply with local fire prevention regulations for this class of flammable product.

**Load/unload temperature:** Ambient to 40°C  
**Storage temperature:** Ambient to 40°C

**Special Precautions:**

Ensure compliance with statutory requirements for storage and handling. Use the correct grounding procedure. Store and handle in closed or properly vented containers. Prevent small spills and leakages to avoid slip hazard.

8.  EXPOSURE CONTROLS / PERSONAL PROTECTION

**Workplace Exposure Limit:**

<table>
<thead>
<tr>
<th>Substance</th>
<th>8-hour TWA</th>
<th>STEL</th>
<th>Source / Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>No applicable UK standards</td>
<td>-</td>
<td>-</td>
<td>HSE Workplace Exposure Limits (EH40).</td>
</tr>
</tbody>
</table>

**Engineering measures:**

Use only explosion proof electrical equipment if ventilation is used to reduce atmospheric levels.

**Personal Protection:**

In open systems where contact is likely, wear safety goggles, chemical-resistant overalls, and nitrile chemically impervious gloves (EN374). Where only incidental contact is likely, wear safety glasses with side shields (EN165). No other special precautions are necessary provided skin/eye contact is avoided. Where concentrations in air may be excessive approved respirators fitted with appropriate cartridges suitable for organic vapours may be required (EN 405).
9. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear liquid</td>
</tr>
<tr>
<td>Odour</td>
<td>Mild paraffinic</td>
</tr>
<tr>
<td>Specific Gravity at 15°C</td>
<td>0.775-0.820</td>
</tr>
<tr>
<td>pH</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Vapour Pressure at 20°C kPa</td>
<td>3.0</td>
</tr>
<tr>
<td>Vapour Density (air=1)</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Boiling point, °C</td>
<td>160-200°C (typically)</td>
</tr>
<tr>
<td>Pour Point, °C</td>
<td>-24°C</td>
</tr>
<tr>
<td>Flash Point (ASTM D 56), °C</td>
<td>36min</td>
</tr>
<tr>
<td>Auto-ignition Temperature, °C</td>
<td>200°C</td>
</tr>
<tr>
<td>Flammability Limit, LEL (°C)</td>
<td>0.0</td>
</tr>
<tr>
<td>Flammability Limit, UEL (°C)</td>
<td>0.0</td>
</tr>
<tr>
<td>Kinematic Viscosity at 20°C mm²/s</td>
<td>2.0</td>
</tr>
<tr>
<td>Solubility</td>
<td>negligible at 20°C</td>
</tr>
</tbody>
</table>

PLEASE NOTE THAT THESE PROPERTIES DO NOT CONSTITUTE A SPECIFICATION.

10. STABILITY AND REACTIVITY

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>The product is stable and not subject to polymerisation.</td>
</tr>
<tr>
<td>Conditions to avoid</td>
<td>Avoid exposure to extreme heat, heat sources, open flames and other sources of ignition.</td>
</tr>
<tr>
<td>Materials to avoid</td>
<td>Avoid contact with strong oxidising agents such as liquid chlorine.</td>
</tr>
<tr>
<td>Hazardous Decomposition Products</td>
<td>Product does not decompose at ambient temperature.</td>
</tr>
</tbody>
</table>

11. TOXICOLOGICAL INFORMATION

HEALTH EFFECTS

<table>
<thead>
<tr>
<th>Route</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes</td>
<td>Slightly irritating but does not damage eye tissue.</td>
</tr>
<tr>
<td>Skin</td>
<td>Low order of acute toxicity. Irritating. Prolonged or repeated contact may also lead to dermatitis.</td>
</tr>
<tr>
<td>Inhalation</td>
<td>Negligible hazard at ambient/normal handling temperatures. In high concentrations and/or at elevated temperatures, vapour or mist is irritating to mucous membranes, may cause headaches and dizziness, may be anaesthetic and may cause other central nervous system effects. Elevated temperatures or mechanical action may form vapours, mists or fumes which may be irritating to the eyes, nose, throat and lungs. Avoid breathing vapours, mists or fumes.</td>
</tr>
<tr>
<td>Ingestion</td>
<td>Low order of acute/systemic toxicity.</td>
</tr>
<tr>
<td>Chronic</td>
<td>Lifetime skin painting tests indicate that materials of similar composition have produced skin cancer in experimental animals. The relationship of these results to humans has not been fully established.</td>
</tr>
</tbody>
</table>

Acute: Based upon animal test data from similar materials and products, the acute toxicity of this product is expected to be:

<table>
<thead>
<tr>
<th>Route</th>
<th>LC50/LD50 (mg/kg or mL)</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral (rat)</td>
<td>&gt;5000</td>
<td>Slightly toxic</td>
</tr>
<tr>
<td>Inhalation (rat)</td>
<td>&gt;2500</td>
<td>Slightly toxic</td>
</tr>
<tr>
<td>Dermal (rabbit)</td>
<td>&gt;2000</td>
<td>Moderately toxic</td>
</tr>
</tbody>
</table>
AVIATION KEROSENE

12. ECOLOGICAL INFORMATION

Kerosines released to water will form a film of hydrocarbons floating on the surface. Water solubility of kerosines is extremely low. Some evaporation will occur, and higher molecular weight hydrocarbons may be absorbed on sediment.

Ecotoxicity: Dangerous for the environment. Acutely toxic to fish and aquatic invertebrates.

Mobility: Some mobility in soils

Persistence and Degradability: Inherently bio-degradable by micro-organisms. Biodegradation in water is a minor loss process. Hydrocarbon constituents of kerosine react with hydroxyl radicals in the atmosphere to give half lives of less than a day.

Bioaccumulation Potential: Kerosines have the potential to bioaccumulate, although metabolic processes may reduce the level of bioconcentration achieved.

13. DISPOSAL CONSIDERATIONS

The product contains hazardous ingredients listed in Section 2. Collect and dispose of it at an authorised disposal facility, in accordance with national and local, regulations and in accordance with EEC Directives on hazardous waste.

14. TRANSPORT INFORMATION

Classification for Transport: Railcars, tank trucks, cylinders (Special storage equipment)

Shipping Name: Kerosene

UN Number: 1223

UN Class: Class 3

IMO/IMDG: Class 3

ADR/RID: Class 3

ICAO/IATA: Class 3

Emergency Action Code: 3Y
15. **REGULATORY INFORMATION**

**Hazard Label Data:**
- F: Xn - Harmful
- Xi - Imitant
- N - Dangerous for the environment

**R & S Phrases:**
- R10 - Flammable
- R51/53 - Toxic to aquatic organisms, may cause long term adverse effects in the aquatic environment
- R45 - Harmful: May cause lung damage if swallowed
- S2 - Keep out of reach of children
- S23 - Do not breathe vapours
- S24 - Avoid contact with skin
- S61 - Avoid releases to the environment (see Sections 12 & 13)
- S62 - If swallowed DO NOT INDUCE VOMITING, seek medical attention showing label or container

**EC Directives:**
- EC Directive 91/155/EEC
- Waste Oil Directive 97/101/EEC

**Statutory Information:**
- The Health and Safety at Work Act 1974
- Consumer Protection Act 1987
- Environmental Protection Act 1990
- Control of Substances Hazardous to Health Regulations 2002 (as amended)
- Chemicals (Hazard Information and Packaging for Supply) Regulations 2002
- Dangerous Substances and Explosive Atmospheres Regulations 2002

16. **OTHER INFORMATION**

The data and advice given apply when the product is sold for the stated application or applications. The product is not sold as suitable for any other application. Use of the product for applications other than as stated in this Sheet may give rise to risks not mentioned in this Sheet. You should not use the product other than for the stated application or applications.

If you have purchased the product for supply to a third party for use at work, it is your duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet.

If you are an employer, it is your duty to tell your employees and others or may be affected of any hazards described in this sheet and of any precautions which should be taken.

This data sheet has been revised in sections 1, 8 and 15.
Jet Fuel A / A-1

1. CHEMICAL PRODUCT AND COMPANY INFORMATION (rev. Feb-00)

Amerada Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0951

EMERGENCY TELEPHONE NUMBER (24 hrs): CHEMTREC (800) 424-9300
COMPANY CONTACT (business hours): Corporate Safety (732) 750-6000


See Section 16 for abbreviations and acronyms.

2. COMPOSITION AND INFORMATION ON INGREDIENTS (rev. Sep-00)

<table>
<thead>
<tr>
<th>INGREDIENT NAME</th>
<th>EXPOSURE LIMIT</th>
<th>CONCENTRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerosene</td>
<td>CSHA REL-TWA: 5 mg/m³ as mineral oil misc. 100</td>
<td></td>
</tr>
<tr>
<td>CAS NUMBER: 8136-23-6</td>
<td>ACGIH TLV-TWA: 100 ppm</td>
<td>100</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>CSHA REL: 10 ppm</td>
<td>Typically 0.04</td>
</tr>
<tr>
<td>CAS NUMBER: 91-20-3</td>
<td>ACGIH TLV-TWA: 100 ppm</td>
<td>100</td>
</tr>
</tbody>
</table>

A complex combination of hydrocarbons including naphthenes, paraffins, and aromatics.

3. HAZARDS IDENTIFICATION (rev. Feb-00; Tox-89)

EMERGENCY OVERVIEW

CAUTION!

OSHA/NFPA COMBUSTIBLE LIQUID - SLIGHT TO MODERATE IRRITANT - EFFECTS CENTRAL NERVOUS SYSTEM - HARMFUL OR FATAL IF SWALLOWED

Moderate fire hazard. Avoid breathing vapors or mists. May cause dizziness and drowsiness. May cause eye irritation and skin irritation (tach). Long-term, repeated exposure may cause skin cancer.

If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs).

EYES

Contact with liquid or vapor may cause mild irritation.

SKIN

May cause skin irritation with prolonged or repeated contact. Practically non-toxic if absorbed following acute (single) exposure. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

INGESTION

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid droplets into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION

Excessive exposure may cause irritation to the nose, throat, lungs, and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

Revision Date: 09/03/99
## Material Safety Data Sheet

### Jet Fuel A / A-1

**MSDS No. 0325**

**WARNING:** The burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

**CHRONIC EFFECTS and CARCINOGENICITY**
Similar products produced skin cancer and systemic toxicity in laboratory animals following repeated applications. The significance of these results to human exposures has not been determined - see Section 11 Toxicological Information.

**MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE**
Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash).

### 4. FIRST AID MEASURES

- **EYES**
  
  In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

- **SKIN**
  
  Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops.

- **INGESTION**
  
  DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

- **INHALATION**
  
  Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

### 5. FIRE FIGHTING MEASURES

**FLAMMABLE PROPERTIES**

- **FLASH POINT:** > 100 °F (38 °C) TCC
- **AUTOIGNITION POINT:** 410 °F (210 °C)
- **OSHA/NPA FLAMMABILITY CLASS:** 2 (COMBUSTIBLE) (see Section 14 for transportation classification)
- **LOWER EXPLOSIVE LIMIT (%):** 0.7
- **UPPER EXPLOSIVE LIMIT (%):** 6.2

**FIRE AND EXPLOSION HAZARDS**

Vapors may be ignited readily when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

**EXTINGUISHING MEDIA**

- **SMALL FIRES:** Any extinguisher suitable for Class B fires, dry chemical, CO₂, water spray, fire fighting foam, or Halon.

- **LARGE FIRES:** Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire but may be used to cool fire-exposed containers.

**FIRE FIGHTING INSTRUCTIONS**

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.
AMERADA HESS CORPORATION
MATERIAL SAFETY DATA SHEET

Jet Fuel A / A-1

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 10 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES (rev. Feb-08)

ACTIVATE FACILITY'S SPILL CONTINGENCY OR EMERGENCY RESPONSE PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, ditching sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by digging, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Caution: flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE (rev. Feb-08)

HANDLING PRECAUTIONS

Handle as a combustible liquid. Keep away from heat, sparks, and open flame. Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when high flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product). See API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents.

STORAGE PRECAUTIONS

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and cleanily labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) RP 2012 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product.
from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION (rev. Feb-98)

ENGINEERING CONTROLS
Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

EYE/FACE PROTECTION
Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION
Gloves constructed of nitrile, neoprene, or PVC are recommended. Chemical protective clothing such as of E I DuPONT Tychem®, Saramax® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION
A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, ANSI Z88.2-1992, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES (rev. Feb-98)

APPEARANCE
Pale yellow to water-white liquid.

ODOR
Characteristic petroleum distillate odor.

BASIC PHYSICAL PROPERTIES

BOILING RANGE: 260 to 572°F (140 to 300°C)
VAPOR PRESSURE: 0.020 psia @ 100°F (38°C)
VAPOR DENSITY (air = 1): 2.6
SPECIFIC GRAVITY (H2O = 1): 0.75 - 0.80
PERCENT VOLATILES: 100%
EVAPORATION RATE: Slow, varies with conditions
SOLUBILITY (H2O): Negligible

10. STABILITY and REACTIVITY (rev. Jan-94)

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID
Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources.

INCOMPATIBLE MATERIALS
Keep away from strong oxidizers such as nitric and sulfuric acids.

HAZARDOUS DECOMPOSITION PRODUCTS
Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

Revision Date: 09/03/95
# Material Safety Data Sheet

## Jet Fuel A / A-1

**AMERADA HESS CORPORATION**

### Material Safety Data Sheet

**MSDS No. 0325**

### 11. TOXICOLOGICAL PROPERTIES (rev. Feb-98; Tox-98)

#### ACUTE TOXICITY
- Acute dermal LD50 (rabbits): > 5 g/kg
- Acute oral LD50 (rats): > 25 g/kg
- Primary dermal irritation: mildly irritating (rabbits)
- Primary eye irritation: mildly irritating (rabbits)
- Guinea pig sensitization: negative

#### CHRONIC EFFECTS AND CARCINOGENICITY
- Dermal carcinogenicity: positive (mice)

Studies have shown that similar products produce skin cancer or skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation.

### 12. ECOLOGICAL INFORMATION (rev. Feb-98)

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

### 13. DISPOSAL CONSIDERATIONS (rev. Feb-98)

Consult federal, state and local waste regulations to determine appropriate disposal options.

### 14. TRANSPORTATION INFORMATION (rev. Feb-98)

#### PROPER SHIPPING NAME:
- Fuel, Aviation, Turbine Engine

#### HAZARD CLASS and PACKING GROUP:
- Class 3, PG III

#### DOT IDENTIFICATION NUMBER:
- UN 1965

#### DOT SHIPPING LABEL:
- FLAMMABLE LIQUID

May be reclassified for transportation as a COMBUSTIBLE LIQUID under conditions of DOT 49 CFR 173.120(b)(2).

### 15. REGULATORY INFORMATION (rev. Sep-98)

**U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION**

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other regulations at the state and/or local level. Consult those regulations applicable to your facility/operation.

**CLEAN WATER ACT (OIL SPILLS)**

Any spill or release of this product to "navigate waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

**CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)**

The CERCLA definition of hazardous substances contains a "petroleum exclusion" clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

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**Revision Date:** 09/03/98  
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### MATERIAL SAFETY DATA SHEET

**Jet Fuel A / A.1**  
MSDS No. 0325

#### SARA SECTION 311/312 - HAZARD CLASSES

<table>
<thead>
<tr>
<th>Acute Health</th>
<th>Chronic Health</th>
<th>Fire</th>
<th>Sudden Release of Pressure</th>
<th>Reactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>~</td>
</tr>
</tbody>
</table>

#### SARA SECTION 313 - SUPPLIER NOTIFICATION

This product does not contain toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372.

#### CANADIAN REGULATORY INFORMATION (WHMIS)

Class B, Division 3 (Combustible Liquid)  
Class D, Division 2, Subdivision B (Toxic by other means)

#### OTHER INFORMATION

**NFPA® HAZARD RATING**

<table>
<thead>
<tr>
<th>Health</th>
<th>Fire</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

**HMIS® HAZARD RATING**

<table>
<thead>
<tr>
<th>Health</th>
<th>Fire</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

**SUPERSEDES MSDS DATED:** 02/19/99

**ABBREVIATIONS:**

- AP = Approximately
- < = Less than
- >= Greater than
- N/A = Not Applicable
- ND = Not Determined
- ppm = parts per million

**ACRONYMS:**

- ACGIH: American Conference of Governmental Industrial Hygienists
- APA: Oil Pollution Act of 1990
- AIHA: American Industrial Hygiene Association
- AIHS: American National Standards Institute
- API: American Petroleum Institute (202) 862-8200
- ASG: American Society for Testing and Materials
- CLP: Common Label Program
- CERCLA: Comprehensive Emergency Response, Compensation, and Liability Act
- DOT: U.S. Department of Transportation
- EPA: U.S. Environmental Protection Agency
- GHS: Globally Harmonised System
- HEMI: Hazardous Materials Information System
- IARC: International Agency for Research on Cancer
- IEC: International Electrotechnical Commission
- ILCAA: Information and Laboratory Coordinating Agency
- ILSC: Information Laboratory and Systems Coordinating Agency
- ILSC: Information Laboratory and Systems Coordinating Authority
- MSHA: Mine Safety and Health Administration
- NFPA: National Fire Protection Association
- NIOSH: National Institute of Occupational Safety and Health
- NOIC: Notice of Intended Change
- OSHA: Occupational Safety and Health Administration
- PEL: Permissible Exposure Limit (OSHA)
- PPM: Parts per Million
- REL: Recommended Exposure Limit (NIOSH)
- SARA: Superfund Amendments and Reauthorization Act of 1986 Title III
- SCBA: Self-Contained Breathing Apparatus
- SPCC: Spill Prevention, Control, and Countermeasures
- STEL: Short-Term Exposure Limit (generally 15 minutes)
- TLV: Threshold Limit Value (ACGIH)
- TWA: Time Weighted Average (8 hr.)
- WEEL: Workplace Environmental Exposure Level (AIHA)
- WHMIS: Workplace Hazardous Materials Information System (Canada)
AMERADA HESS CORPORATION

Jet Fuel A / A.1

MATERIAL SAFETY DATA SHEET

DISCLAIMER OF EXPRESS AND IMPLIED WARRANTIES

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract or invoice or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.
AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 3950

EMERGENCY OVERVIEW

DANGER!
EXTREMELY FLAMMABLE - EYE AND MUCOUS MEMBRANE IRRITANT
- EFFECTS CENTRAL NERVOUS SYSTEM - HARMFUL OR FATAL IF
SWALLOWED - ASPIRATION HAZARD

High fire hazard. Keep away from heat, spark, open flame, and other ignition sources.

If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs). Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects.

Long-term exposure may cause effects to specific organs, such as to the liver, kidneys, blood, nervous system, and skin. Contains benzene, which can cause blood disease, including anemia and leukemia.

1. CHEMICAL PRODUCT AND COMPANY INFORMATION

   Amerada Hess Corporation
   1 Hess Plaza
   Woodbridge, NJ 07095-0991

   EMERGENCY TELEPHONE NUMBER (24 hrs): CHEMTREC (800)424-9300
   COMPANY CONTACT (business hours): Corporate Safety (732)750-5000
   MSDS Internet Website: www.hess.com/about/environ.html

SYNONYMS:
   Hess Conventional (Oxygenated and Non-oxygenated) Gasoline; Reformulated Gasoline (RFG); Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB); Unleaded Motor or Automotive Gasoline

See Section 16 for abbreviations and acronyms.

2. COMPOSITION AND INFORMATION ON INGREDIENTS *

   (rev. Jan-04)

   INGREDIENT NAME (CAS No)                  CONCENTRATION PERCENT BY WEIGHT

   Gasoline (86250-51-5)                        100
   Benzene (71-43-2)                            0.1 - 4.9 (0.1 - 1.3 reformulated gasoline)
   n-Butane (108-97-8)                          < 10
   Ethyl Alcohol (Ethanol) (64-17-5)           < 10
   Ethyl benzene (100-41-4)                     < 3
   n-Hexane (110-54-3)                          0.0 to 4
   Methyl-tertiary butyl ether (MTBE) (1334-04-4) 0 to 15.0
   Tertiary-amyl methyl ether (TAME) (904-05-6) 0 to 17.2
   Toluene (108-88-3)                           1 - 25
   1,2,4-Trimethylbenzene (95-83-8)            < 6
   Xylene, mixed isomers (1330-20-7)          1 - 15

A complex blend of petroleum-derived normal and branched-chain alkane, cyclicalkane, alkene, and aromatic hydrocarbons. May contain antioxidant and multifunctional additives. Non-oxygenated Conventional Gasoline and RBOB do not have oxygenates (Ethanol or MTBE and/or TAME).

Oxygenated Conventional and Reformulated Gasoline will have oxygenates for octane enhancement or as legally required.

Revision Date: 01/08/04
AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

3. HAZARDS IDENTIFICATION (rev. Dec-07)

EYES
Moderate irritant. Contact with liquid or vapor may cause irritation.

SKIN
Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

INGESTION
The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonitis (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION
Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS AND CARCINOGENICITY
Contains benzene, a regulated human carcinogen. Benzene has the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with systemic toxicity. See also Section 11 - Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE
Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash). Chronic respiratory disease, liver or kidney dysfunction, or pre-existing central nervous system disorders may be aggravated by exposure.

4. FIRST AID MEASURES (rev. Dec-07)

EYES
In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN
Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or rashiness develops.

INGESTION
DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION
Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.
AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9956

5. FIRE FIGHTING MEASURES (rev. Dec-97)

FLAMMABLE PROPERTIES:

FLASH POINT: 45 °F (-7 °C)

AUTOIGNITION TEMPERATURE: highly variable; > 530 °F (>280 °C)

OSHA/NFPA FLAMMABILITY CLASS: 1A (flammable liquid)

LOWER EXPLOSIVE LIMIT (%): 1.4%

UPPER EXPLOSIVE LIMIT (%): 7.0%

FIRE AND EXPLOSION HAZARDS:

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA:

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO₂, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

During certain times of the year and in certain geographical locations, gasoline may contain MTBE and/or TAME. Firefighting foam suitable for polar solvents is recommended for fuel with greater than 10% oxygenate concentration - refer to NFPA 11 "Low Expansion Foam - 1994 Edition."

FIRE FIGHTING INSTRUCTIONS:

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES (rev. Dec-97)

ACTIVATE FACILITY SPILL CONTINGENCY or EMERGENCY PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel; diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by dikeing, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product.

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Page 3 of 8
# Material Safety Data Sheet

**Gasoline, All Grades**  
**MSDS No. 9950**

Vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up areas must be properly trained and must utilize proper protective equipment (see Section 8).

### Handling and Storage

**Handling Precautions**

"USE ONLY AS A MOTOR FUEL"  
"DO NOT SIPHON BY MOUTH"

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

**Storage Precautions**

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

**Work/Hygiene Practices**

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

### Exposure Limits

**Exposure Controls and Personal Protection**  
(Rev. Jan-04)

<table>
<thead>
<tr>
<th>Component (CAS No.)</th>
<th>Source</th>
<th>TWA (ppm)</th>
<th>STEL (ppm)</th>
<th>Exposure Limits</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene (71-43-2)</td>
<td>AGCH</td>
<td>100</td>
<td>300</td>
<td>A3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>USCG</td>
<td>5.5</td>
<td>10.5</td>
<td>A1, skin</td>
<td></td>
</tr>
<tr>
<td>n-Undecane (112-47-9)</td>
<td>AGCH</td>
<td>1600</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>USCG</td>
<td>1000</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>n-Hexadecane (124-14-8)</td>
<td>AGCH</td>
<td>100</td>
<td>120</td>
<td>A3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>USCG</td>
<td>100</td>
<td>120</td>
<td>A3</td>
<td></td>
</tr>
</tbody>
</table>

Revision Date: 01/05/04
## AMERADA HESS CORPORATION

### MATERIAL SAFETY DATA SHEET

**Gasoline, All Grades**

<table>
<thead>
<tr>
<th>Component (CAS No.)</th>
<th>Source</th>
<th>TWA (ppm)</th>
<th>STEL (ppm)</th>
<th>Exposure Limits</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-Heptane (110-82-7)</td>
<td>OSHA</td>
<td>50</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methylene chloride (75-09-2)</td>
<td>OSHA</td>
<td>200</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toluene (108-88-3)</td>
<td>OSHA</td>
<td>200</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xylenes, mixed isomers (106-42-3)</td>
<td>OSHA</td>
<td>150</td>
<td>150</td>
<td></td>
<td>Ai</td>
</tr>
</tbody>
</table>

**ENGINEERING CONTROLS**

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

**EYE/FACE PROTECTION**

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

**SKIN PROTECTION**

Gloves constructed of nitrile or neoprene are recommended. Chemical protective clothing such as that made of of E.I DuPont Tycem® products or equivalent is recommended based on degree of exposure.

Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

**RESPIRATORY PROTECTION**

A NIOSH-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection and limitations.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

### 3. PHYSICAL and CHEMICAL PROPERTIES

**APPEARANCE**

A transparent, straw-colored or light yellow liquid

**ODOR**

A strong, characteristic aromatic hydrocarbon odor. Oxygenated gasoline with MTBE and/or TAME may have a sweet, ether-like odor and is detectable at a lower concentration than non-oxygenated gasoline.

**ODOR THRESHOLD**

<table>
<thead>
<tr>
<th></th>
<th>Odor Detection</th>
<th>Odor Recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-oxygenated gasoline</td>
<td>0.1 - 3.0 ppm</td>
<td>0.8 - 1.3 ppm</td>
</tr>
<tr>
<td>Gasoline with 15% MTBE</td>
<td>0.2 - 3.3 ppm</td>
<td>0.4 - 0.7 ppm</td>
</tr>
<tr>
<td>Gasoline with 15% TAME</td>
<td>0.1 ppm</td>
<td>0.2 ppm</td>
</tr>
</tbody>
</table>

**BASIC PHYSICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Range</td>
<td>85 to 407 °F (39 to 208 °C)</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>6.4 - 15.9 atm @ 100°F (38 °C) 275-475 mm Hg @ 65 °F (20 °C)</td>
</tr>
<tr>
<td>Vapor Density (air = 1)</td>
<td>3 to 4</td>
</tr>
<tr>
<td>Specific Gravity (H₂O = 1)</td>
<td>0.70 - 0.78</td>
</tr>
<tr>
<td>Evaporation Rate</td>
<td>10 - 11 (n-butyl acetate = 1)</td>
</tr>
<tr>
<td>Percent Volatiles</td>
<td>100 %</td>
</tr>
</tbody>
</table>
AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9556

SOLUBILITY (H2O): Non-oxygenated gasoline - negligible (< 0.1% @ 77 °F). Gasoline with 15% MTBE - slight (0.1 - 3%) @ 77 °F; ethanol is readily soluble in water.

10. STABILITY and REACTIVITY (rev. Dec-94)

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID
Avoid high temperatures, open flames, sparks, welding, and smoking and other ignition sources.

INCOMPATIBLE MATERIALS
Keep away from strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS
Carbon monoxide, carbon dioxide, and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitroresols that can decompose violently.

11. TOXICOLOGICAL PROPERTIES (rev. Dec-97)

ACUTE TOXICITY
Acute Dermal LD50 (rabbits): > 5 mL/kg
Primary dermal irritation (rabbits): slightly irritating
Guinea pig sensitization: negative

Acute Oral LD50 (rat): 18.75 mL/kg
Oral eye irritation (rabbits): non-irritating

CHRONIC EFFECTS AND CARCINOGENICITY
Carcinogenicity: OSHA: NO IARC: YES - 2B NTP: NO ACGIH: YES (A3)

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated with animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.

This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

This product may contain methyl tertiary butyl ether (MTBE); animal and human health effects studies indicate that MTBE may cause eye, skin, and respiratory tract irritation, central nervous system depression and neurotoxicity. MTBE is classified as an animal carcinogen (A3) by the ACGIH.

12. ECOLOGICAL INFORMATION (rev. Jan-04)

Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable, under Federal and State regulations. If released, oxygenates such as ethers and alcohols will be expected to exhibit fairly high mobility in soil, and therefore may leak into groundwater. The API (www.api.org) provides a number of useful references addressing petroleum and oxygenate contamination of groundwater.

13. DISPOSAL CONSIDERATIONS (rev. Dec-97)

Consult federal, state, and local waste regulations to determine appropriate disposal options.

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Page 8 of 6
11. TRANSPORTATION INFORMATION (rev. Jan-04)

DOT PROPER SHIPPING NAME: Gasoline
DOT HAZARD CLASS AND PACKING GROUP: 3, PG II
DOT IDENTIFICATION NUMBER: UN 1203
DOT SHIPPING LABEL: FLAMMABLE LIQUID

15. REGULATORY INFORMATION (rev. Jan-04)

U.S. FEDERAL, STATE, AND LOCAL REGULATORY INFORMATION

This product and its constituents listed herein are on the EPA TSCA inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other federal, state, or local regulations; consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a "petroleum exclusion" clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

ACUTE HEALTH HUMAN HEALTH FIRE SUDDEN RELEASE OF PRESSURE REACTIVE
X X X -- --

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372:

<table>
<thead>
<tr>
<th>INGREDIENT NAME (CAS NUMBER)</th>
<th>CONCENTRATION WT. PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene (71-43-2)</td>
<td>6.1 to 9.3 (5.1% to 13% for reformulated gasoline)</td>
</tr>
<tr>
<td>Ethyl benzene (100-41-4)</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>n-Hexane (110-54-3)</td>
<td>6.5 to 4</td>
</tr>
<tr>
<td>Methyl-tertiary butyl ether (MTBE) (109-04-4)</td>
<td>6 to 10</td>
</tr>
<tr>
<td>Toluene (108-88-3)</td>
<td>1 to 10</td>
</tr>
<tr>
<td>1,2,4-Trimethylbenzene (95-03-5)</td>
<td>&lt; 6</td>
</tr>
<tr>
<td>Xylene, mixed isomers (108-33-5)</td>
<td>1 to 16</td>
</tr>
</tbody>
</table>

US EPA guidance documents [www.epa.gov/tri](http://www.epa.gov/tri) for reporting Persistent Bioaccumulating Toxics (PBTs) indicate this product may contain the following denominations of toxic chemicals subject to Section 313 reporting:

<table>
<thead>
<tr>
<th>INGREDIENT NAME (CAS NUMBER)</th>
<th>CONCENTRATION - Parts per million (ppm) by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polycyclic aromatic compounds (PAEs)</td>
<td>17</td>
</tr>
<tr>
<td>Benzene (g,h,i) paralylene (101-34-2)</td>
<td>2.65</td>
</tr>
<tr>
<td>Lead (7431-02-1)</td>
<td>0.070</td>
</tr>
</tbody>
</table>

Revision Date: 01/05/04
**AMERADA HESS CORPORATION**

**MATERIAL SAFETY DATA SHEET**

| Gasoline, All Grades | MSDS No. 9550 |

**CANADIAN REGULATORY INFORMATION (WHMIS)**

Class B, Division 2 (Flammable Liquid)
Class D, Division 2A (Very toxic by other means) and Class D, Division 2B (Toxic by other means)

<table>
<thead>
<tr>
<th>NFPA HAZARD RATING</th>
<th>HEALTH: 1 Slight</th>
<th>FIRE: 3 Serious</th>
<th>REACTIVITY: 0 Minimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMIS HAZARD RATING</td>
<td>HEALTH: * 1 Slight</td>
<td>FIRE: 3 Serious</td>
<td>REACTIVITY: 0 Minimal</td>
</tr>
<tr>
<td></td>
<td>* CHRONIC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUPERSEDES MSDS DATED:** 12/30/97

**ABBREVIATIONS:**

AP = Approximately, < = Less than, > = Greater than, N/A = Not Applicable, N/D = Not Determined, ppm = parts per million

**ACRONYMS:**

ACGIH American Conference of Governmental Industrial Hygienists
AIHA American Industrial Hygiene Association
ANSI American National Standards Institute
API American Petroleum Institute
CERCLA Comprehensive Emergency Response, Compensation, and Liability Act
DOT U.S. Department of Transportation
EPA U.S. Environmental Protection Agency
IARC International Agency For Research On Cancer
MSHA Mine Safety and Health Administration
NFPA National Fire Protection Association
NIOSH National Institute of Occupational Safety and Health
NOIC Notice of Intended Change (proposed change to ACGIH TLV)

**DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES**

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief but are not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendor or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally vendor assumes no responsibility for injury to vendor or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendor assumes the risk in their use of the material.

Revision Date: 01/04/04
**SHELL BITUMEN CLASS 170**  
**PAVING GRADE BITUMEN**

**DESCRIPTION**  
Class 170 is a paving grade bitumen manufactured to a tighter specification than prescribed in AS 2020 and is suitable for standard sealing and lightly trafficked asphalt applications.

**PERFORMANCE FEATURES**  
- Dedicated feedstock supply  
- Tight manufacturing viscosity tolerance  
- Consistent properties

**SUMMARY OF BENEFITS**  
The Shell standards to which Class 170 bitumen is made result in a very consistent bitumen with predictable handling and performance characteristics.

**APPLICATIONS**  
Class 170 bitumen can be used for all standard spray sealing and lightly trafficked asphalt applications.

### Asphalt recommendations

<table>
<thead>
<tr>
<th>Mixing Temperature</th>
<th>Holding time at Mixing Temperature</th>
<th>Medium term storage temperature</th>
<th>Medium term storage time</th>
<th>Maximum safe handling temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>140-165°C</td>
<td>14 days</td>
<td>130-150°C</td>
<td>39 days</td>
<td>175°C</td>
</tr>
</tbody>
</table>

### Sealing recommendations

<table>
<thead>
<tr>
<th>Spraying Temperature</th>
<th>Holding time at spraying temperature</th>
<th>Medium term storage temperature</th>
<th>Medium term storage time</th>
<th>Minimum pavement temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>170-180°C</td>
<td>7 days</td>
<td>130-150°C</td>
<td>39 days</td>
<td>15°C</td>
</tr>
</tbody>
</table>

During spraying operations it is normal practice to add cutter oil to the bitumen to reduce binder viscosity to a level at which effective wetting and adhesion of the cover aggregate can take place. The quantity of cutter oil added to the bitumen depends upon the pavement temperature, the daily traffic and the nominal size of the cover aggregate. Basic cutting practice for Shell Class 170 bitumen should be as follows:
### SHELL BITUMEN CLASS 170

**PAVING GRADE BITUMEN**

<table>
<thead>
<tr>
<th>Pavement Temperature (°C)</th>
<th>Traffic (veh/vehicle/day)</th>
<th>Nominal Aggregate Size: 10mm or greater</th>
<th>Nominal Aggregate Size: 7mm or less</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 to 29</td>
<td>low (&lt;100)</td>
<td>7-8</td>
<td>7-10</td>
</tr>
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<td></td>
<td>med (100 - 1500)</td>
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<tr>
<td></td>
<td>high (&gt;1500)</td>
<td>4</td>
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<tr>
<td>20 to 23</td>
<td>low</td>
<td>7-4</td>
<td>7-10</td>
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<tr>
<td></td>
<td>med</td>
<td>5-6</td>
<td>6-6</td>
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<tr>
<td></td>
<td>high</td>
<td>4</td>
<td>5-6</td>
</tr>
<tr>
<td>26 to 35</td>
<td>low</td>
<td>4-6</td>
<td>6-8</td>
</tr>
<tr>
<td></td>
<td>med</td>
<td>2-4</td>
<td>5-7</td>
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<tr>
<td></td>
<td>high</td>
<td>2-3</td>
<td>4-6</td>
</tr>
<tr>
<td>&gt;36</td>
<td>all</td>
<td>0-2</td>
<td>0-3</td>
</tr>
</tbody>
</table>

**HEALTH & SAFETY**

Shell Bitumen C170 is unlikely to present any significant health or safety hazard when properly used in the recommended application where good standards of industrial practice are maintained.

Further guidance on Product Health and Safety is available on the relevant Material Safety Data Sheet.

**SPECIFICATIONS/APPROVALS**

<table>
<thead>
<tr>
<th>AS 2005</th>
<th>Class 170</th>
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**TYPICAL CHARACTERISTICS**

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<th>METHODS</th>
<th>TYPICAL</th>
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<tr>
<td>Viscosity at 60°C</td>
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<td>AS 2341.2</td>
<td>170</td>
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<tr>
<td>Viscosity at 135°C</td>
<td>Pa.s</td>
<td>AS 2341.2</td>
<td>0.35</td>
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<td>Pen at 25°C</td>
<td>mm</td>
<td>AS 2341.2</td>
<td>min 90</td>
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<tr>
<td>Flashpoint</td>
<td>°C</td>
<td>AS 2311.1.c</td>
<td>min 250</td>
</tr>
<tr>
<td>Viscosity of residue at 60°C</td>
<td>Pa.s</td>
<td>AS 2341.2</td>
<td>min 300</td>
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**Document Information**

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<td>Date Revised</td>
<td>2/11/09</td>
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MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY

PRODUCT NAME

LPG AUTOGAS

CAS No: 74-98-6
EINECS No:

NAME AND ADDRESS OF MANUFACTURER/SUPPLIER

ConocoPhillips Ltd, Humber Refinery, South Killingholme, North Lincolnshire, DN40 3DW.
Telephone No. 01469 577571
Facsimile No. 01469 555143

EMERGENCY CONTACT

ConocoPhillips Ltd, Humber Refinery, South Killingholme, Immingham, North Lincolnshire DN40 3DW.
Health and Safety Emergency Telephone No. 01469 305348 (24 hours)

APPLICATION

LPG Road Fuel

2. COMPOSITION / INFORMATION ON INGREDIENTS

General: Propane + Propene (Propylene) > 90%, C4 and higher Alkanes < 10%
Ethyl Mercaptan added as a stenching agent (< 50 ppm).

EINECS No: 270-990-0

3. HAZARDS IDENTIFICATION

HIGHLY FLAMMABLE – KEEP AWAY FROM SOURCES OF IGNITION

Under normal conditions of storage and use, liquefied petroleum gas will not constitute a health hazard. However, being heavier than air, if released the gas will collect in any confined space and may reach concentrations presenting an asphyxiating or safety hazard. Direct contact of the skin with liquid gas may cause frostbite or cold burns and containers may present a similar hazard when gas is being withdrawn due to the cooling effect. Handling precautions should be strictly observed.
PRODUCT NAME

LPG AUTOGAS

4. FIRST AID MEASURES

Eyes: In case of cold burns caused by rapidly expanding gas or vaporising liquid, obtain immediate medical attention.

Skin: In case of cold burns caused by rapidly expanding gas or vaporising liquid, obtain immediate medical attention.

Inhalation: In emergency situations use proper respiratory protection to immediately remove the affected victim from exposure. Administer artificial respiration if breathing has stopped. Keep at rest. Call for prompt medical attention.

Ingestion: Not applicable.

Pressure Injection: ALWAYS OBTAIN IMMEDIATE MEDICAL ATTENTION EVEN THOUGH THE INJURY MAY APPEAR MINOR.

5. FIRE-FIGHTING MEASURES

Flammability: Do not attempt to extinguish the fire until the source is shut off.

Fire and Explosion Hazards: Extreme hazard. Gas leaks or liquid spills readily form flammable mixtures at temperatures below ambient. Risk of fire or explosion by mechanical impact, friction, sparks, flames or other sources of ignition. Auto refrigeration; cranes can be plugged and valves made inoperable by the formation of ice when expanding vapours or vaporising liquid cause temperatures to fall below 0°C. Vapours settle to ground level and may reach ignition sources remote from the point of escape via drains and other underground passages. Static discharge, material can accumulate static charges which may cause an incendiary electrical discharge.

Special Fire-Fighting Procedures: To prevent uncontrolled explosive re-ignition, do not extinguish flame at leak. Cut off fuel and/or allow fire to burn out under controlled conditions. Extinguish small residual fires with foam or dry chemical powder. Respiratory and eye protection required for fire-fighting personnel exposed to fumes or smoke. Use water spray to cool equipment.

Hazardous Combustion Products: Smoke, carbon monoxide may be formed in the event of incomplete combustion.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: See Section 8.

Environmental Precautions:

Land Spill: Eliminate sources of ignition. Shut off source taking normal safety precautions. Warn occupants in downwind areas of fire and explosion hazard. Evacuate endangered people, if necessary. Allow the spill to evaporate; ventilate closed and confined spaces.

Water Spill: Eliminate sources of ignition. Advise occupants and shipping in downwind areas of fire and explosion hazard and warn them to stay clear. Notify port and other relevant authorities. Allow liquid to evaporate from the surface.
7. HANDLING AND STORAGE

Bulk LPG is stored under pressure at ambient temperatures or as a refrigerated liquid. The design of pressure vessels, fuel systems, safety devices and the operating procedures must comply with national legislation and with recognised codes of good practice.

Small containers e.g. cylinders of approved design, properly sealed and in good condition, should be stored outdoors or in well ventilated storerooms, at no lower than ground level and must be quickly removable in an emergency. Eliminate all sources of ignition from the storage area. Instruct personnel handling LPG about potential hazards and precautions, and train them in safe handling and emergency procedures. Always ensure eye and skin protection against a gas release. Avoid being in line of fire in the event of gas release under pressure.

Load/unload temperature: -15°C to +40°C  Storage temperature: Ambient to 40°C

Special Precautions
Take precautionary measures against static discharge. Keep all connections for filling/emptying securely closed when not in use. Ensure that only containers/equipment of suitable pressure rating are used. Ensure that the permissible filling ratio for the product is not exceeded.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational exposure limits: Classed as a simple asphyxiant under the Control of Substances Hazardous to Health (COSHH) Regulations. No exposure limit.

Engineering measures: Use only explosion proof electrical equipment at correct classification (approved by EC Notified Body).

Personal Protection: Frostbite hazard. Protect eyes, hands and skin from exposure. When concentrations in air are not adequately controlled by engineering, work practices or other means of exposure reduction, approved respirators (EN 405) fitted with AX low boiling gas/vapour filter cartridges may be required. Ensure LPG concentrations remain well below LEL. During emergency response to release of LPG or when concentrations may be immediately dangerous to life or health, wear self-contained breathing apparatus.

For eye, face, hand and body protection refer to the following hierarchy of controls: -

EYE AND FACE PROTECTION (to standard EN 160)
1 Full-face visor and chemical goggles
2 Full-face visor and safety glasses with side shields
3 Chemical goggles
4 Safety glasses with side shields

HAND PROTECTION (to standard EN 374)
1 Cryo gauntlets
2 Cryo gloves
3 Insulated PVC gauntlets
4 Insulated PVC gloves
5 PVC or Neoprene gauntlets with thermal liner glove
6 PVC or Neoprene gauntlets

BODY
For additional body protection use a waterproof, thermal Cryo-apron

The level of PPE selected should be appropriate for the task as identified in the risk assessment.
10. STABILITY AND REACTIVITY

Stability: The product is stable and not subject to polymerisation.
Conditions to avoid: Avoid exposure to extreme heat.
Materials to avoid: Avoid contact with strong oxidising agents such as liquid chlorine.
Hazardous Decomposition Products: Product does not decompose at ambient temperature.

11. TOXICOLOGICAL INFORMATION

The following toxicological assessment is based on a knowledge of the toxicity of the product's component(s).

HEALTH EFFECTS

On eyes: Exposure to rapidly expanding gas or liquid may cause frostbite (cold burn) and damage the eyes.
On skin: Exposure of skin to liquid or rapidly expanding gas may cause frostbite (cold burn).
By inhalation: Negligible hazard at ambient/normal temperatures. Breathing saturated vapours for a few minutes may be fatal. Saturated vapours can be encountered in confined spaces and/or under conditions of poor ventilation. May cause irritation, breathing failure, coma and death without any warning occur being sensed. Avoid breathing vapours, mists or fumes.
By ingestion: No hazard in normal industrial use.
Chronic: No chronic data available at this time.
Acute: At very high levels, propane has narcotic and asphyxiating properties and cases of "sudden death" have been documented in which propane and propylene were identified in blood, urine and cerebrospinal fluid. Animal inhalation studies indicate a gas concentration of 60% to be below the anaesthetic level, but to depress the blood pressure of cats. 1% propane causes hemodynamic changes in dogs; 3.5% decreased inotropic of the heart, decreases the mean aortic pressure, stroke volume and cardiac output, and increases pulmonary vascular resistance. In the primate, 10% propane induces some myocardial effects, and 20% aggravation of these parameters and respiratory depression. 10% propane in the mouse and 16% in the dog appear to produce no arrhythmia but weak cardiac sensitization. Ref. Patty's Industrial Hygiene and Toxicology, 3rd Ed. G. Clayton and F. Claytons (eds). A Wiley-Interscience Publication, Vol. 1/2, pp 3181 - 3182

12. ECOLOGICAL INFORMATION

Biodegradability: In the absence of specific environmental data for this product, this assessment is based on information for hydrocarbon components found in liquefied petroleum gas (LPG). These gases do not meet the criteria for classification as dangerous for the environment. LPG released into the environment will rapidly evaporate and be dispersed into the atmosphere as a gas. Based on chemical/physical data from the literature, no harmful effects to terrestrial or aquatic habitats would be expected from components in LPG. LPG components have been reported to have short atmospheric half-lives and therefore, would not be expected to persist.
### 13. **DISPOSAL CONSIDERATIONS**

The product contains hazardous ingredients listed in Section 2. Collect and dispose of it at an authorised disposal facility, in conformance with national and local regulations and in accordance with EU Directives on hazardous waste.

### 14. **TRANSPORT INFORMATION**

<table>
<thead>
<tr>
<th>Classification for Transport</th>
<th>Raila cars, tank trucks, cylinders (Special high pressure equipment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Name</td>
<td>Propane</td>
</tr>
<tr>
<td>Packaging Group</td>
<td>Not applicable</td>
</tr>
<tr>
<td>UN Number</td>
<td>1978</td>
</tr>
<tr>
<td>Marine Pollutant</td>
<td>No</td>
</tr>
<tr>
<td>UN Class</td>
<td>Class 2.1</td>
</tr>
<tr>
<td>ICAO/IATA</td>
<td>Class 2 (b)</td>
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<tr>
<td>ADR/RID</td>
<td>Class 2.1</td>
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<td>Emergency Action Code</td>
<td>2YE</td>
</tr>
<tr>
<td>IMO/IMDG</td>
<td>Class 2.1</td>
</tr>
</tbody>
</table>

### 15. **REGULATORY INFORMATION**

| Hazard Label Data            | Extremely flammable, F+                                             |
| R & S Phrases                | R12: Extremely flammable; S2: Keep out of reach of children; S6: Keep container in a well ventilated area; D18: Keep away from sources of ignition- NO SMOKING |
LPG AUTOGAS

16. OTHER INFORMATION

The data and advice given apply when the product is sold for the stated application or applications. The product is not sold as suitable for any other application. Use of the product for applications other than as stated in this sheet may give rise to risks not mentioned in this sheet. You should not use the product other than for the stated application or applications.

If you have purchased the product for supply to a third party for use at work, it is your duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet.

If you are an employer, it is your duty to tell your employees and others who may be affected by any of the hazards described in this sheet and of any precautions which should be taken.

This data sheet has been revised in sections 1, 9
MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY

PRODUCT NAME

PROPAONE

CAS No: 74-98-8
ENICe No: 270-990-9

NAME AND ADDRESS OF MANUFACTURER/SUPPLIER

ConocoPhillips Ltd, Humber Refinery, South Killingholme, North Lincolnshire, DN40 3DW.
Telephone No.: 01469 571571
Facsimile No.: 01469 555143

EMERGENCY CONTACT

ConocoPhillips Ltd, Humber Refinery, South Killingholme, Immingham, North Lincolnshire DN40 3DW.
Health and Safety Emergency Telephone No.: 01469 555548 (24 hours)

APPLICATION

Multi-purpose fuel

2. COMPOSITION / INFORMATION ON INGREDIENTS

General: Propane + Propene (Propylene) > 90%, C4 and higher Alkanes < 10%
Ethyl Mercaptan added as a stenching agent (< 50 ppm).

3. HAZARDS IDENTIFICATION

Under normal conditions of storage and use, liquefied petroleum gas will not constitute a health hazard. However if released, being heavier than air, the gas will collect in any confined space and may reach concentrations presenting an asphyxiation or safety hazard. Direct contact of the skin with liquid gas may cause frostbite or cold burns and containers may present a similar hazard when gas is being withdrawn, due to the cooling effect. Handling precautions should be strictly observed.
PRODUCT NAME

PROPANE

4. FIRST AID MEASURES

Eyes: In case of solid burns caused by rapidly expanding gas or vaporizing liquid, obtain immediate medical attention.

Skin: In case of solid burns caused by rapidly expanding gas or vaporizing liquid, obtain immediate medical attention.

Inhalation: In emergency situations use proper respiratory protection to immediately remove the affected victim from exposure. Administer artificial respiration if breathing has stopped. Keep at rest. Call for prompt medical attention.

Ingestion: Not applicable.

Pressure Injection: ALWAYS OBTAIN IMMEDIATE MEDICAL ATTENTION EVEN THOUGH THE INJURY MAY APPEAR MINOR.

5. FIRE-FIGHTING MEASURES

Flammability: Do not attempt to extinguish the fire until the source is shut off.

Fire and Explosion Hazards: Extreme hazard; gas leaks or liquid spills readily form flammable mixtures at temperatures below ambient. Risk of fire or explosion by mechanical impact, friction, sparks, flames or other sources of ignition. Auto refrigeration; drains can be plugged and valves made inoperable by the formation of ice when expanding vapours or vaporising liquid cause temperatures to fall below 0°C. Vapours settle to ground level and may reach ignition sources remote from the point of escape via drains and other underground passages. Static discharge; material can accumulate static charges which may cause an incendiary electrical discharge.

Special Fire-Fighting Procedures: To prevent uncontrolled explosive re-ignition, do not extinguish flame at leak. Cut off fuel if safe to do so and/or allow fire to burn out under controlled conditions. Extinguish small residual fires with foam or dry chemical powder. Respiratory and eye protection required for fire-fighting personnel exposed to fumes or smoke. Use water spray to cool equipment.

Hazardous Combustion Products: Smoke, carbon monoxide may be formed in the event of incomplete combustion.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: See Section 8.

Environmental Precautions:

Land Spill: Eliminate sources of ignition. Shut off source taking normal safety precautions. Warn occupants in downwind areas of fire and explosion hazard. Evacuate endangered people, if necessary. Allow the spill to evaporate; ventilate closed and confined spaces.

Water Spill: Eliminate sources of ignition. Advise occupants and shipping in downwind areas of fires and explosion hazard and warn them to stay clear. Notify port and other relevant authorities. Allow liquid to evaporate from the surface.
7. **HANDLING AND STORAGE**

Bulk LPG is stored under pressure at ambient temperatures or as a refrigerated liquid. The design of pressure vessels, fuel systems, safety devices and operating procedures must comply with national legislation and with recognised codes of good practice.

Small containers, e.g., cylinders of approved design, properly sealed and in good condition, should be stored outdoors or in well-ventilated storerooms, at no lower than ground level and must be quickly removable in an emergency. Eliminate all sources of ignition from the storage area. Instruct personnel handling LPG about potential hazards and precautions, and train them in safe handling and emergency procedures.

<table>
<thead>
<tr>
<th>Load/unload temperature</th>
<th>Storage temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>-15°C to -40°C</td>
<td>Ambient to 40°C</td>
</tr>
</tbody>
</table>

**Special Precautions**

Take precautionary measures against static discharge. Keep all connections for filling/emptying securely closed when not in use. Ensure that only containers/equipment of suitable pressure rating are used. Ensure that the permissible filling ratio for the product is not exceeded.

8. **EXPOSURE CONTROLS / PERSONAL PROTECTION**

**Occupational exposure limits**:

Classed as simple asphyxiant under the Control of Substances Hazardous to Health Regulations (COSHH). No exposure limit.

**Engineering measures**:

Use only explosion proof electrical equipment at correct classification (approved by EC Notified Body).

**Personal Protection**:

Frostbite hazard. Protect eyes, hands and skin from exposure. When concentrations in air are not adequately controlled by engineering, work practices, or other means of exposure reduction, approved respirators (EN 405) fitted with A1 low boiling gas/vapour filter cartridges may be required. Ensure propane concentrations remain well below LEL. During emergency response to a leak of propane or where exposure conditions may be immediately dangerous to life or health, wear self-contained breathing apparatus.

For eye, face, hand and body protection refer to the following hierarchy of controls:

- **EYE AND FACE PROTECTION** (to standard EN 166)
  1. Full-face visor and chemical goggles
  2. Full-face visor and safety glasses with side shields
  3. Chemical goggles
  4. Safety glasses with side shields

- **HAND PROTECTION** (to standard EN 374)
  1. Cryo gauntlets
  2. Cryo gloves
  3. Insulated PVC gauntlets
  4. Insulated PVC gloves
  5. PVC or Neoprene gauntlets with thermal liner glove
  6. PVC or Neoprene gauntlets

- **BODY**

  For additional body protection use a waterproof, thermal Cryo-apron

The level of PPE selected should be appropriate for the task as identified in the risk assessment.
Massawa Port Authority
Petroleum Jetty ESIA
Fire Risk Assessment and Fire Training Plan

PROPYR ENERGY LTD.
Date March 25, 2008
Page 96

PROPAINE

9. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Colourless gas (liq. under pressure)</td>
</tr>
<tr>
<td>Odour</td>
<td>Strong, sulphurous pungent odour due to stabilizing agent</td>
</tr>
<tr>
<td>Specific Gravity at 15.6°C</td>
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<tr>
<td>pH</td>
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<td>Vapour Pressure at 20°C</td>
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<tr>
<td>Vapour Density (air=1)</td>
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<tr>
<td>Boiling point, °C</td>
<td>-42°C to -43°C</td>
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<tr>
<td>Pour Point/Melting Point, °C</td>
<td>-24°C (sp)</td>
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<tr>
<td>Flash Point (Closed Cup), °C</td>
<td>-104°C</td>
</tr>
<tr>
<td>Auto-ignition Temperature, °C</td>
<td>493°C</td>
</tr>
<tr>
<td>Flammability Limit, % by Volume</td>
<td>LEL : 2.2 UEL : 0.5</td>
</tr>
<tr>
<td>Kinematic Viscosity at 15°C, mm²s⁻¹</td>
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</tr>
<tr>
<td>Solubility</td>
<td>in water (as gas) 6.5% by volume at 17.8°C (753 mm Hg)</td>
</tr>
</tbody>
</table>

PLEASE NOTE THAT THESE PROPERTIES DO NOT CONSTITUTE A SPECIFICATION.

10. STABILITY AND REACTIVITY

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Stability</td>
<td>The product is stable and not subject to polymerization.</td>
</tr>
<tr>
<td>Conditions to avoid</td>
<td>Avoid exposure to extreme heat.</td>
</tr>
<tr>
<td>Materials to avoid</td>
<td>Avoid contact with strong oxidizing agents such as liquid chlorine.</td>
</tr>
<tr>
<td>Hazardous</td>
<td>Product does not decompose at ambient temperature.</td>
</tr>
<tr>
<td>Decomposition Products</td>
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</tr>
</tbody>
</table>
11. TOXICOLOGICAL INFORMATION

The following toxicological assessment is based on a knowledge of the toxicity of the product’s components.

**HEALTH EFFECTS**

**On eyes:** Exposure to rapidly expanding gas or liquid may cause frostbite (cold burn) and damage the eyes.

**On skin:** Exposure of skin to liquid or rapidly expanding gas may cause frostbite (cold burn).

**By inhalation:** Negligible hazard at ambient/normal temperatures. Breathing saturated vapours for a few minutes may be fatal. Saturated vapours can be encountered in confined spaces and/or under conditions of poor ventilation. May cause irritation, breathing failure, coma and death without any warning odour being sensed. Avoid breathing vapours, mists or fumes.

**By ingestion:** No hazard in normal industrial use.

**Chronic:** No chronic data available at this time.

**Acute:** At very high levels, propane has narcotic and asphyxiating properties and cases of “sudden death” have been documented in which propane and propylene were identified in blood, urine and cerebrospinal fluid. Animal inhalation studies indicate a gas concentration of 50% to be below the anaesthetic level, but to depress the blood pressure of cats. 10% propane causes hemodynamic changes in dogs; 3.3% decreased inotropism of the heart; decreases the mean aortic pressure, stroke volume and cardiac output, and increases pulmonary vascular resistance. In the primate, 10% propane induces some myocardial effects, and 20% aggravation of these parameters and respiratory depression. 10% propane in the mouse and 15% in the dog appear to produce no arrhythmia but weak cardiac sensitization. Ref: Patty’s Industrial Hygiene and Toxicology, 3rd Ed, G. Clayton and F. Claytones (ed’s), A Wiley-Interscience Publication, Vol. II and III, Pp 3191 – 3192

12. ECOLOGICAL INFORMATION

**Biodegradability:**

In the absence of specific environmental data for this product, this assessment is based on information for hydrocarbon components found in liquefied petroleum gas (LPG). These gases do not meet the criteria for classification as dangerous for the environment. LPG released into the environment will evaporate and be dispersed into the atmosphere as a gas. Based on chemical/physical data from the literature, no harmful effects to terrestrial or aquatic habitats would be expected from components in LPG. LPG components have been reported to have short atmospheric halflives and therefore, would not be expected to persist.
PRODUCT NAME

PROPANE

13. DISPOSAL CONSIDERATIONS

The product contains hazardous ingredients listed in Section 2. Collect and dispose of it at an authorised disposal facility, in conformance with national and local regulations and in accordance with EU Directives on hazardous waste.

14. TRANSPORT INFORMATION

Classification for Transport: Rail cars, tank trucks, cylinders (Special high pressure equipment)

Shipping Name: Propane

UN Number: 1978

UN Class: Class 2.1

ADR/RID: Class 2.1

IMO/IMDG: Class 2.1

Packaging Group: Not applicable

Marine Pollutant: No

ICAO/MAPA: Class 2 (b)

Emergency Action Code: 2YE

15. REGULATORY INFORMATION

Hazard Label Data: Extremely flammable, F+

R & S Phrases:
- R12 Extremely flammable
- S2 Keep out of reach of children
- S9 Keep container in a well ventilated area
- S16 Keep away from sources of ignition- NO SMOKING

Statutory Information:
- The Health and Safety at Work Act 1974
- Consumer Protection Act 1987
- Environmental Protection Act 1990
- Control of Substances Hazardous to Health Regulations 2002 (as amended)
- Chemicals (Hazard Information and Packaging) Regulations 2002
- Dangerous Substances and Explosive Atmospheres Regulations 2002
16. **OTHER INFORMATION**

The data and advice given apply when the product is sold for the stated application or applications. The product is not sold as suitable for any other application. Use of the product for applications other than as stated in this sheet may give rise to risks not mentioned in this sheet. You should not use the product other than for the stated application or applications.

If you have purchased the product for supply to a third party for use at work, it is your duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet.

If you are an employer, it is your duty to tell your employees and others or may be affected of any hazards described in this sheet and of any precautions that should be taken.

This data sheet has been revised in sections 1, 8
# MATERIAL SAFETY DATA SHEET

## 1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY

<table>
<thead>
<tr>
<th>PRODUCT NAME</th>
<th>BUTANE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS No:</td>
<td>106-97-5</td>
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<tr>
<td>EINECS No:</td>
<td>270-690-9</td>
</tr>
</tbody>
</table>

**NAME AND ADDRESS OF MANUFACTURER/SUPPLIER**

ConocoPhillips Ltd, Humber Refinery, South Killingholme, North Lincolnshire, DN40 3DW.
Telephone No: 01469 571571
Facsimile No: 01469 555143

**EMERGENCY CONTACT**

ConocoPhillips Ltd, Humber Refinery, South Killingholme, Immingham, North Lincolnshire DN40 3DW.
Health and Safety Emergency Telephone No. 01469 555348 (24 hours)

**APPLICATION**

Multi-purpose fuel

## 2. COMPOSITION / INFORMATION ON INGREDIENTS

**General:** Mixture of normal and isobutane (approx. 90%) with butenes (< 8%), propane (< 2%) and pentane (< 1%).
Butadiene < 0.1%. Ethyl Mercaptan added as a stenching agent (< 50 ppm).

## 3. HAZARDS IDENTIFICATION

Under normal conditions of storage and use, liquefied petroleum gas will not constitute a health hazard. However, if released, being heavier than air, the gas will collect in any confined space and may reach concentrations presenting an asphyxiating or safety hazard. Direct contact of the skin with liquid gas may cause frostbite or cold burns, and containers may present a similar hazard when gas is being withdrawn, due to the cooling effect. Handling precautions should be strictly observed.
4. **FIRST AID MEASURES**

**Eyes**: In case of cold burns caused by rapidly expanding gas or vapourising liquid, obtain immediate medical attention.

**Skin**: In case of cold burns caused by rapidly expanding gas or vapourising liquid, obtain immediate medical attention.

**Inhalation**: In emergency situations use proper respiratory protection to remove the affected victim from exposure immediately. Administer artificial respiration if breathing has stopped. Keep at rest. Call for prompt medical attention.

**Ingestion**: Not applicable.

**Pressure injection**: ALWAYS OBTAIN IMMEDIATE MEDICAL ATTENTION EVEN THOUGH THE INJURY MAY APPEAR MINOR.

5. **FIRE-FIGHTING MEASURES**

**Flammability**: Do not attempt to extinguish the fire until the source is shut off.

**Fire and Explosion Hazards**: Extreme hazard. Gas leaks or liquid spills readily form flammable mixtures at temperatures below ambient. Risk of fire or explosion by mechanical impact, friction, sparks, flames or other sources of ignition. Auto re-ignition; drains can be plugged and valves made inoperable by the formation of ice when expanding vapours or vapourising liquid cause temperatures to fall below 0°C. Vapours settle to ground level and may reach ignition sources remote from the point of escape, via drains and other underground passages. Static discharge: material can accumulate static charges which may cause an incendiary electrical discharge.

**Special Fire-Fighting Procedures**: To prevent uncontrolled explosive re-ignition, do not extinguish flame at leak. Cut off fuel if safe to do so, and allow fire to burn out under controlled conditions. Extinguish small residual fires with foam or dry chemical powder. Respiratory and eye protection required for fire-fighting personnel exposed to fumes or smoke. Use water spray to cool equipment.

**Hazardous Combustion Products**: Smoke and carbon monoxide may be formed in the event of incomplete combustion.

6. **ACCIDENTAL RELEASE MEASURES**

**Personal Precautions**: See Section 8.

**Environmental Precautions**: 

**Land Spill**: Eliminate sources of ignition. Shut off source taking normal safety precautions. Warn occupants in downwind areas of fire and explosion hazard. Evacuate endangered people, if necessary. Allow the spill to evaporate; ventilate closed and confined spaces.

**Water Spill**: Eliminate sources of ignition. Advise occupants and shipping in downwind areas of fires and explosion hazard and warn them to stay clear. Notify port and other relevant authorities. Allow liquid to evaporate from the surface.
BUTANE

7. HANDLING AND STORAGE

Butane is stored under pressure at ambient temperatures or as a refrigerated liquid. The design of pressure vessels, fuel systems, safety devices and the operating procedures must comply with national legislation and with recognised codes of good practice.

Small containers e.g. cylinders of approved design, properly sealed and in good condition, should be stored outdoors or in well ventilated storerooms, at no lower than ground level and must be quickly removable in an emergency. Eliminate all sources of ignition from the storage area. Instruct personnel handling LPG about potential hazards and precautions, and train them in safe handling and emergency procedures.

Load/unload temperature: -15°C to +40°C
Storage temperature: Ambient to +40°C

Special Precautions
Take precautionary measures against static discharge. Keep all connections for filling/emptying securely closed when not in use. Ensure that only containers/equipment of suitable pressure rating are used. Ensure that the permissible filling ratio for the product is not exceeded.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

<table>
<thead>
<tr>
<th>Occupational exposure limits</th>
<th>Substance</th>
<th>8-hour TWA</th>
<th>STEL</th>
<th>Source / Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butane</td>
<td>600 ppm (1400 mg/m³)</td>
<td>750 ppm (1810 mg/m³)</td>
<td>WEL-HSE Workplace Exposure Limits (EH40)</td>
<td></td>
</tr>
</tbody>
</table>

Engineering measures:
Use only explosion proof electrical equipment at correct classification (approved by EC Notified Body).

Personal Protection:
Flammable hazard. Protect eyes, hands and skin from exposure. When concentrations in air may exceed the occupational exposure limit, and where engineering, work practices, or other means of exposure reduction are not adequate, approved respirators (EN 405) may be required, fitted with AX low boiling gas/vapour filter(s). Ensure concentrations remain below LEL. During emergency response to a release of butane or where exposure conditions may be immediately dangerous to life or health, self-contained breathing apparatus should be worn.

For eye, face, hand and body protection refer to the following hierarchy of controls:
- EYE AND FACE PROTECTION (to standard EN 166)
  1. Full-face visor and chemical goggles
  2. Full-face visor and safety glasses with side shields
  3. Chemical goggles
  4. Safety glasses with side shields

HAND PROTECTION (to standard EN 374)
- Cryo gauntlets
- Cryo gloves
- Insulated PVC gauntlets
- Insulated PVC gloves
- PVC or Neoprene gauntlets with thermal liner glove
- PVC or Neoprene gauntlets

BODY
For additional body protection use a waterproof, thermal Cryo-apron

The level of PPE selected should be appropriate for the task as identified in the risk assessment.
9. PHYSICAL AND CHEMICAL PROPERTIES

**Appearance:** Colourless liquid

**Odour:** Strong, sulphurous pungent odour due to stenching agent

**Specific Gravity at 15.6°C:** 0.56 - 0.59

**pH:** Not applicable

**Vapour Pressure at 20°C:** 2.07 bar

**Vapour Density (air=1):** 2.9

**Boiling point, °C:** -12 to 0°C

**Pour Point/Melting Point, °C:** Not applicable

**Flash Point (Closed Cup), °C:** -15°C

**Auto-Ignition Temperature, °C:** 450°C

**Flammability Limit, in Air, % by Volume:**

- **LEL:** 1.9
- **UEL:** 8.5

**Kinematic Viscosity at 15°C, mm² s⁻¹:** 0.3

**Solubility:** Sparingly soluble

PLEASE NOTE THAT THESE PROPERTIES DO NOT CONSTITUTE A SPECIFICATION.

10. STABILITY AND REACTIVITY

**Stability:** The product is stable and not subject to polymerisation.

**Conditions to avoid:** Avoid exposure to extreme heat.

**Materials to avoid:** Avoid contact with strong oxidising agents such as liquid chlorine.

**Hazardous Decomposition Products:** Product does not decompose at ambient temperature.
11. TOXICOLOGICAL INFORMATION

The following toxicological assessment is based on a knowledge of the toxicity of the product's components.

HEALTH EFFECTS

On eyes: Exposure to rapidly expanding gas or liquid may cause frostbite (cold burn) and damage the eyes.

On skin: Exposure of skin to liquid or rapidly expanding gas may cause frostbite (cold burn).

By inhalation: Negligible hazard at ambient/normal temperatures. Breathing saturated vapours for a few minutes may be fatal. Saturated vapours can be encountered in confined spaces and/or under conditions of poor ventilation. May cause irritation, breathing failure, coma and death without any warning odour being sensed. Avoid breathing vapours, mists or fumes.

By ingestion: No hazard in normal industrial use.

Chronic: No chronic data available at this time.

Acute: Butane has very similar properties to Propane, a summary of which follows. At very high levels, propane has narcotic and asphyxiating properties and cases of "sudden death" have been documented in which propane and propylene were identified in blood, urine and cerebrospinal fluid. Animal inhalation studies indicate a gas concentration of 56% to be below the anaesthetic level, but to depress the blood pressure of cats. 1% propane causes hemodynamic changes in dogs; 2.9% decreased inotropism of the heart, decreases the mean aortic pressure, stroke volume and cardiac output, and increases pulmonary vascular resistance. In the primate, 10% propane induces some myocardial effects, and 20% aggravation of these parameters and respiratory depression. 10% propane in the mouse and 15% in the dog appear to produce no arrhythmia but weak cardiac sensitization. Ref. Patty's Industrial Hygiene and Toxicology, 3rd Ed. G. Clayton and P. Claytons (ed's), A Wiley-Interscience Publication, Vol. 1B, Pp 3181 – 3182

12. ECOLOGICAL INFORMATION

Biodegradability: In the absence of specific environmental data for this product, this assessment is based on information for hydrocarbon components found in liquefied petroleum gas (LPG). These gases do not meet the criteria for classification as dangerous for the environment. LPG released into the environment will evaporate and be dispersed into the atmosphere as a gas. Based on chemical/physical data from the literature, no harmful effects to terrestrial or aquatic habitats would be expected from components in LPG. LPG components have been reported to have short atmospheric half-lives and therefore, would not be expected to persist.
13. DISPOSAL CONSIDERATIONS

The product contains hazardous ingredients listed in Section 2. Collect and dispose of it at an authorised disposal facility, in conformance with national and local regulations and in accordance with EU Directives on hazardous waste.

14. TRANSPORT INFORMATION

Classification for Transport: Ralis cars, tank trucks, cylinders (Special high pressure equipment)
Shipping Name: Butane
UN Number: 1011
UN Class: Class 2.1
ADR/RID: Class 2.1
IMO/IMDG: Class 2.1

Packaging Group: Not applicable
Marine Pollutant: No
ICAO/IATA: Class 2 (b)
Emergency Action Code: 2YE

15. REGULATORY INFORMATION

Hazard Label Data: Extremely flammable. F+
R & S Phrases:
R12 Extremely flammable
S2 Keep out of reach of children
S9 Keep container in a well ventilated area
S10 Keep away from sources of ignition - NO SMOKING

EC Directives:
EC Directive 91 / 155 / EEC
Waste Oil Directive 87 / 101/ EEC

Statutory Information:
The Health and Safety at Work Act 1974
Consumer Protection Act 1987
Environmental Protection Act 1990
Control of Substances Hazardous to Health Regulations 2002 (as amended)
Chemicals (Hazard Information and Packaging) Regulations 2002
Dangerous Substances and Explosive Atmospheres Regulations 2002

European Waste Catalogue No: Not applicable
16. OTHER INFORMATION

The data and advice given apply when the product is sold for the stated application or applications. The product is not sold as suitable for any other application. Use of the product for applications other than as stated in this sheet may give rise to risks not mentioned in this Sheet. You should not use the product other than for the stated application or applications.

If you have purchased the product for supply to a third party for use at work, it is your duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet.

If you are an employer, it is your duty to tell your employees and others or may be affected of any hazards described in this sheet and of any precautions that should be taken.

This data sheet has been revised in sections 1, 8.
Appendix C
Fire & Gas Response
C.1 General

This appendix provides details for key individuals and organizations required for effective and coordinated response to fire and gas incidents at the new Jetty at Massawa.

Note: at this stage, this is an outline document which will have to be completed accordingly (with the required information at the places highlighted [Hold] below) for establishing the applicable firefighting plan.

C.2 Qualified Individual and Alternate Qualified Individual

The names and 24-hour contact information for the Qualified Individual and Alternate Qualified Individuals meeting the requirements for this facility are documented here [Hold].

C.3 Firefighting Management Team Members

The names and 24-hour contact information for the members of the Firefighting Management Team are given below [Hold]. The members are grouped by their role in the Firefighting Plan.

C.4 Organizations to Contact to Activate Response Resources

The names and 24-hour contact details for the organizations to be contacted to activate the response resources are given below [Hold].

C.5 State and Local Agencies

The names and 24-hour contact details for the State/Regional and Local Agencies are given below [Hold].
Appendix D
Hazard Identification
D.1 Definitions

Flash Fire

Flash fires may occur due to a release of a flammable gas between its flammability limits. Generally speaking, the majority of clouds which are ignited do so at their edge as they disperse and meet a strong source of ignition such as naked flame, sparks, internal combustion engine etc. Then the combustion flame spreads back to the release point.

Vapour Cloud Explosion

This usually takes place in partially confined or congested areas, and it is also known as flash fire explosion or fuel air explosion. The flame spreads at subsonic velocity, so the overpressure damage is usually negligible and the bulk of the damage comes from thermal radiation, direct flame contact or secondary fires.

Pool Fire

A pool fire occurs when a spill of flammable liquid is ignited. A pool fire may also occur on the surface of flammable liquid spilled onto water or as a trench fire in a vessel tank containing flammable liquid.

Boiling Liquid Expanding Vapour Explosion (BLEVE)

BLEVE explosions are classed as extremely hazardous, and usually occur when a vessel containing a pressurized liquid is ruptured. An example of such kind of explosion will be a vessel containing LPG which is a gas at atmospheric pressure but liquid when pressurized.

A BLEVE does not require a flammable substance, and therefore is not usually considered a type of chemical explosion. However, if the substance involved is flammable, it is likely that the resulting cloud of the substance will ignite after the BLEVE has occurred, forming a fireball and possibly a VCE.

Jet Fire

Jet fire results from the combustion of a material as it is being released from a pressurized process unit. The main concern is in thermal radiation effect and erosional action of the tip.

All the above fire types have the potential to exist during normal operation of the port facilities.

Other Fires

In addition the following fire types also can occur:

- Electrical fires in the switchgear room;
- Fires of combustible (i.e. cellulosic) materials in operator huts.

The following section gives more details regarding what fire types can occur during port operations.
D.2 Releases of Product

The following un-ignited releases were identified for the new Jetty.

Table G.1 Unignited Releases

<table>
<thead>
<tr>
<th>Product</th>
<th>Fluid</th>
<th>Release Types</th>
<th>Hazard Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kerosene</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gasoline</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bitumen (future)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ballast Water / Bilge</td>
<td>Sea water contaminated with petroleum products.</td>
<td>Discharge to the sea prior to taking on product</td>
<td>Environmental hazard to the sea</td>
</tr>
</tbody>
</table>

The following ignited releases were identified for the new jetty.

Table D.1.1 Ignited Source Release

<table>
<thead>
<tr>
<th>Product</th>
<th>Fluid</th>
<th>Fire Types</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gases</td>
<td>Flash fire, Explosion, Jet fire</td>
<td>Overpressure, High heat fluxes (radiation), Secondary fires, Vapour cloud, Smoke, Carbon Monoxide, BLEVE if trapped inventory subject to external fire.</td>
</tr>
<tr>
<td>White product</td>
<td>Gas Oil</td>
<td>Pool Fire on the sea, Pool Fire on land / jetty, Flash Fire, Jet Fire, Spray fire.</td>
<td>High heat fluxes (radiation), Secondary fires, Vapour cloud, Smoke, Carbon Monoxide, BLEVE if trapped inventory subject to external fire.</td>
</tr>
<tr>
<td></td>
<td>Kerosene</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gasoline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black product</td>
<td>Fuel Oil</td>
<td>Pool Fire on the sea, Pool Fire on land, Spray fire.</td>
<td>High heat fluxes (radiation), Smoke, Carbon Monoxide</td>
</tr>
<tr>
<td></td>
<td>Bitumen (future)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ballast Water</td>
<td>Sea water contaminated with petroleum products</td>
<td>Will not ignite</td>
<td>Environmental hazard to the sea, No fire risk</td>
</tr>
</tbody>
</table>

These hazards have been addressed for each location in the new jetty system in the Hazard Register, which is given in this appendix.
Figure D1.1: Location of Fires at Massawa
<table>
<thead>
<tr>
<th>#</th>
<th>Hazard</th>
<th>Cause</th>
<th>Consequences</th>
<th>C</th>
<th>P</th>
<th>Raw risk</th>
<th>Control / Safeguard</th>
<th>Residual Risk</th>
<th>Recommended Actions for new Jetty Fire Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Ignited Product Release</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1a</td>
<td>Small LPG fire</td>
<td>• Failure of shipboard equipment and systems</td>
<td>• Small vapour cloud</td>
<td>M</td>
<td>M</td>
<td>Medium</td>
<td>• Shipboard F&amp;G detection and ESD system.</td>
<td>Low</td>
<td>• Provide assistance as requested.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failure of shipboard procedures and practices.</td>
<td>• Small LPG pool which vaporizes</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard AFP and PFP.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Small jet/ spray fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Ship to shore comms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Small residual LPG fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard hazardous area classification.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard ESD system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b</td>
<td>Large LPG fire</td>
<td>• Failure of shipboard equipment and systems</td>
<td>• Large vapour cloud over the ship and jetty.</td>
<td>H</td>
<td>L</td>
<td>High</td>
<td>• Shipboard F&amp;G detection and ESD system.</td>
<td>Medium</td>
<td>• Isolate fuel source.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failure of shipboard procedures and practices.</td>
<td>• LPG spill to the deck, which vaporizes</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard AFP and PFP.</td>
<td></td>
<td>• Let jet/ spray fire burn in controlled fashion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Jet spray fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Ship to shore comms.</td>
<td></td>
<td>• Deflect jet if impinged on pipe, escape route.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Flash fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard structural safeguards.</td>
<td></td>
<td>• Skin cool pipework.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Wind sock on new Jetty.</td>
<td></td>
<td>• Water spray on escape route from jetty.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• New Jetty F&amp;G detection.</td>
<td></td>
<td>• Apply monitor to LPG pool fire.</td>
</tr>
<tr>
<td>2a</td>
<td>Small White Product fire</td>
<td>• Failure of shipboard equipment and systems</td>
<td>• Small vapour cloud</td>
<td>M</td>
<td>M</td>
<td>Medium</td>
<td>• Shipboard F&amp;G detection and ESD system...</td>
<td>Low</td>
<td>• Provide assistance as requested.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failure of shipboard procedures and practices.</td>
<td>• Small pool which vaporizes</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard AFP and PFP.</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Small jet/ spray fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Ship to shore comms.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard structural safeguards.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2b</td>
<td>Large White Product fire</td>
<td>• Failure of shipboard equipment and systems</td>
<td>• Vapour cloud over the release: drift to jetty.</td>
<td>M</td>
<td>L</td>
<td>Medium</td>
<td>• Shipboard F&amp;G detection and ESD system.</td>
<td>Low</td>
<td>• Isolate fuel source.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failure of shipboard procedures and practices.</td>
<td>• Spill to the deck, which vaporizes.</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard AFP and PFP.</td>
<td></td>
<td>• Let jet/ spray fire burn in controlled fashion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Jet spray fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Ship to shore comms.</td>
<td></td>
<td>• Deflect jet if impinged on pipe, escape route.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Flash fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard structural safeguards.</td>
<td></td>
<td>• Skin cool pipework.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Smoke clouds and toxic combustion products.</td>
<td></td>
<td></td>
<td></td>
<td>• Wind sock on new Jetty.</td>
<td></td>
<td>• Water spray on escape route from jetty.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• New Jetty F&amp;G detection.</td>
<td></td>
<td>• Apply monitor to pool fire.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Jetty shutdown.</td>
<td></td>
<td>• Jetty shutdown.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>• Don fire PPE and BA.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Hazard</td>
<td>Cause</td>
<td>Consequences</td>
<td>C</td>
<td>P</td>
<td>Raw risk</td>
<td>Control / Safeguard</td>
<td>Residual Risk</td>
<td>Recommended Actions for new Jetty Fire Team</td>
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<td>------------------------------------------</td>
</tr>
<tr>
<td>3a</td>
<td>Small Black Product fire</td>
<td>• Failure of shipboard equipment and systems</td>
<td>• Small vapour cloud</td>
<td>M</td>
<td>M</td>
<td>Medium</td>
<td>• Shipboard F&amp;G detection and ESD system.</td>
<td>Low</td>
<td>• Provide assistance as requested.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failure of shipboard procedures and practices.</td>
<td>• Small pool which vaporizes</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard AFP and PFP.</td>
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<td></td>
<td></td>
<td></td>
<td>• Small jet/ spray fire.</td>
<td></td>
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<td></td>
<td>• Ship to shore comms.</td>
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<td></td>
<td></td>
<td></td>
<td>• Structural failure.</td>
<td></td>
<td></td>
<td></td>
<td>• Shipboard structural safeguards.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Major mechanical failure.</td>
<td></td>
<td></td>
<td></td>
<td>• Wind sock on new Jetty.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• New Jetty F&amp;G detection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3b</td>
<td>Large Black Product fire</td>
<td>• Failure of shipboard equipment and systems</td>
<td>• Vapour cloud over the ship to drift towards jetty.</td>
<td>H</td>
<td>L</td>
<td>High</td>
<td>• Shipboard F&amp;G detection and ESD system.</td>
<td>Medium</td>
<td>• Isolate fuel source.</td>
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B. Fire on the surface of the sea, beneath or around the seaward end of the Jetty resulting from a spillage of petroleum products in a vessel moored.
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### Table D1.2: Hazard Register for Ignited Releases at Massawa

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D. Fire at any point of the connections during discharge
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<th>Residual Risk</th>
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### Table D1.2: Hazard Register for Ignited Releases at Massawa

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<td>E. Fire at the Slops Tanks</td>
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<td>• Let fire burn down in controlled fashion.</td>
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<td>• Residual LPG fire.</td>
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<td></td>
<td>• Consider PFP on slops tank.</td>
</tr>
</tbody>
</table>
### Table D1.2: Hazard Register for Ignited Releases at Massawa

<table>
<thead>
<tr>
<th>#</th>
<th>Hazard</th>
<th>Cause</th>
<th>Consequences</th>
<th>C</th>
<th>P</th>
<th>Raw risk</th>
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<th>Residual Risk</th>
<th>Recommended Actions for new Jetty Fire Team</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>3</td>
<td>Black Product fire</td>
<td>• Failure of Jetty equipment and systems.</td>
<td>• Vapour cloud</td>
<td>M</td>
<td>M</td>
<td>Medium</td>
<td>• Shipboard F&amp;G detection and ESD system.</td>
<td></td>
<td>• Isolate fuel source.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failure of Jetty procedures and practices.</td>
<td>• Small Black product pool with vapour</td>
<td></td>
<td></td>
<td></td>
<td>• Jetty AFP systems</td>
<td></td>
<td>• Deflect jet if impinged on slop tank, escape route.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failure of hoses and connections.</td>
<td>• Small jet/ spray fire.</td>
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<td></td>
<td></td>
<td>• Ship to shore comms.</td>
<td></td>
<td>• Let fire burn down in controlled fashion.</td>
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<td></td>
<td></td>
<td>• Poor clean up after release.</td>
<td>• Possibility of BLEVE.</td>
<td></td>
<td></td>
<td></td>
<td>• New jetty structural safeguards.</td>
<td></td>
<td>• Skin cool slops tank.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Toxic smoke and products of combustion.</td>
<td></td>
<td></td>
<td></td>
<td>• New Jetty F&amp;G detection and ESD system.</td>
<td></td>
<td>• Water spray on escape route from jetty.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Spill response plan.</td>
<td></td>
<td>• Apply monitor to pool fire.</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td>• PSVs on slop tank sized for fire case.</td>
<td></td>
<td>• Shut down loading.</td>
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<td>• Ensures spills are dealt with quickly.</td>
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<td></td>
<td>• Consider PFP on slops tank.</td>
</tr>
<tr>
<td>F.</td>
<td>Fires along the pipeline rack</td>
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</tr>
<tr>
<td>1a</td>
<td>Small LPG fire</td>
<td>• Leaking valves.</td>
<td>• Small vapour cloud</td>
<td>M</td>
<td>M</td>
<td>Medium</td>
<td>• New Jetty F&amp;G detection and ESD system.</td>
<td>Low</td>
<td>• Foam extinguisher for small residual fires.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flange or seal leaks</td>
<td>• Small LPG pool which vaporizes</td>
<td></td>
<td></td>
<td></td>
<td>• New Jetty AFP systems</td>
<td></td>
<td>• Isolate leak source and let jet fire burn down.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ignition of such leaks.</td>
<td>• Small jet/ spray fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Jetty hazardous area classification.</td>
<td></td>
<td>• Shutdown product loading.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Electrostatic discharges.</td>
<td>• Small residual LPG fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Maintenance of fittings.</td>
<td></td>
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</tr>
<tr>
<td>1b</td>
<td>Large LPG fire</td>
<td>• Ignition of leaks from pipe rupture</td>
<td>• Large vapour cloud around the piperrack.</td>
<td>H</td>
<td>L</td>
<td>High</td>
<td>• Jetty AFP systems</td>
<td>Medium</td>
<td>• Isolate fuel source.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Electrostatic discharges.</td>
<td>• LPG spill to around the piperrack which vaporizes</td>
<td></td>
<td></td>
<td></td>
<td>• Ship to shore comms.</td>
<td></td>
<td>• Let jet/ spray fire burn in controlled fashion.</td>
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<tr>
<td></td>
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<td></td>
<td>• Jet spray fire.</td>
<td></td>
<td></td>
<td></td>
<td>• Piperrack structural safeguards.</td>
<td></td>
<td>• Deflect jet if impinged on pipe, escape route.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Flash fire.</td>
<td></td>
<td></td>
<td></td>
<td>• New Jetty F&amp;G detection and ESD system.</td>
<td></td>
<td>• Skin cool pipework.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Possible detonation in piperrack.</td>
<td></td>
<td></td>
<td></td>
<td>• Flange management.</td>
<td></td>
<td>• Water spray on escape route from jetty.</td>
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<td></td>
<td></td>
<td>• Jetty hazardous area classification.</td>
<td></td>
<td>• Apply portable and mobile monitor to pool fire.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Crash barriers.</td>
<td></td>
<td>• Consider foam induction option at fire hydrants.</td>
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<td></td>
<td>• Consider foam drum locations along jetty.</td>
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<td></td>
<td></td>
<td></td>
<td>• Jetty shutdown.</td>
</tr>
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### Table D1.2: Hazard Register for Ignited Releases at Massawa

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<th>Recommended Actions for new Jetty Fire Team</th>
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</table>
| 2a | Small White Product fire| • Leaking valves.  
• Flange or seal leaks  
• Ignition of such leaks.  
• Electrostatic discharges.  | • Small vapour cloud  
• Small White product pool which vaporizes  
• Small jet/ spray fire.  | M | M | Medium | • New Jetty F&G detection and ESD system.  
• New Jetty AFP systems  
• Ship to shore comms.  
• Jetty hazardous area classification.  
• Maintenance of fittings.  | Low | • Foam extinguisher for small pool fires.  
• Use of foam monitors  
• Isolate leak source.  
• Hydrants and hosereels.  
• Shutdown loading. |
| 2b | Large White Product fire| • Ignition of leaks from pipe rupture.  
• Electrostatic discharges.  | • Vapour cloud around piperack.  
• White product around piperack which vapourises  
• Jet spray fire.  
• Flash fire.  | H | L | High    | • Jetty AFP systems  
• Ship to shore comms.  
• Piperack structural safeguards.  
• New Jetty F&G detection and ESD system.  
• Flange management.  
• Jetty hazardous area classification.  
• Crash barriers.  | Medium | • Isolate fuel source.  
• Let jet/ spray fire burn in controlled fashion.  
• Deflect jet if impinged on pipe, escape route.  
• Skin cool pipework.  
• Water spray on escape route from jetty.  
• Apply portable and mobile monitor to pool fire.  
• Consider foam induction option at fire hydrants.  
• Consider foam drum locations along jetty.  
• Jetty shutdown.  
• Don Fire PPE and BA. |
| 3a | Small Black Product fire| • Leaking valves.  
• Flange or seal leaks  
• Ignition of such leaks.  
• Electrostatic discharges.  | • Small vapour cloud  
• Small Black product pool with vapour  
• Small jet/ spray fire.  | M | M | Medium | • New Jetty F&G detection and ESD system.  
• New Jetty AFP systems  
• Ship to shore comms.  
• Jetty hazardous area classification.  
• Maintenance of fittings.  | Low | • Foam extinguisher for small pool fires.  
• Use of foam monitors  
• Isolate leak source.  
• Hydrants and hosereels.  
• Shutdown loading. |
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</table>
| 3b | Large Black Product fire | • Ignition of leaks from pipe rupture.  
• Electrostatic discharges. | • Large vapour cloud around the piperrick.  
• Black product spill around piperrick which vaporizes  
• Jet spray fire.  
• Flash fire.  
• Toxic smoke cloud and products of combustion. | H | L | High | • Jetty AFP systems  
• Ship to shore comms.  
• Piperrick structural safeguards.  
• New Jetty F&G detection and ESD system.  
• Flange management.  
• Jetty hazardous area classification.  
• Crash barriers. | Medium | • Isolate fuel source.  
• Let jet/spray fire burn in controlled fashion.  
• Deflect jet if impinged on pipe, escape route.  
• Skin cool pipework.  
• Water spray on escape route from jetty.  
• Apply portable and mobile monitor to pool fire.  
• Consider foam induction option at fire hydrants.  
• Consider foam drum locations along jetty.  
• Jetty shutdown.  
• Don Fire PPE and BA. |
| 1  | LPG fire | • Failure to observe speed limit.  
• Failure to clean up earlier spill.  
• Failure to ensure tankers suitable for jetty hazardous areas.  
• Failure to enforce no smoking.  
• Failure of crash barriers. | • Vapour cloud  
• Vaporising LPG pool jet/spray fire.  
• Residual LPG fire.  
• Possibility of BLEVE.  
• Impact on Pipework, FWPH & Switchgear. | M | L | Low | • Enforced speed limit.  
• Spill response plan.  
• Tankers suitable for hazardous area.  
• No smoking on jetty  
• Siting and maintenance of crash barriers. | Low | • Foam extinguisher in cab  
• Portable foam monitor.  
• Fire trailer and monitor.  
• If shell spray fire, leave to burn in controlled manner  
• Hydrants and hosereels.  
• Jetty shutdown.  
• Consider PFP for FWPH.  
• Consider 2 x FWPHs in different locations. |
| 2  | White Product fire | • Failure to observe speed limit.  
• Failure to clean up earlier spill.  
• Failure to ensure tankers suitable for jetty hazardous areas.  
• Failure to enforce no smoking.  
• Failure of crash barriers. | • Small vapour cloud  
• White product pool fire.  
• Small jet/spray fire.  
• Possibility of BLEVE.  
• Impact on Pipework, FWPH & Switchgear.  
• Drifting smoke. | M | M | Medium | • Enforced speed limit.  
• Spill response plan.  
• Tankers suitable for hazardous area.  
• No smoking on jetty  
• Siting and maintenance of crash barriers. | Low | • Foam extinguisher in cab  
• Portable foam monitor.  
• Fire trailer and monitor.  
• If shell spray fire, leave to burn in controlled manner  
• Hydrants and hosereels.  
• Jetty shutdown.  
• Consider PFP for FWPH.  
• Consider 2 x FWPHs in different locations. |
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<tr>
<td>3</td>
<td>Black Product fire</td>
<td>• Failure of Jetty equipment and systems.  • Failure of Jetty procedures and practices.  • Failure of hoses and connections.  • Poor clean up after release.</td>
<td>• Vapour cloud  • Small Black product pool with vapour  • Small jet/ spray fire.  • Possibility of BLEVE.  • Toxic smoke and products of combustion.</td>
<td>M</td>
<td>M</td>
<td>Medium</td>
<td>• Enforced speed limit.  • Spill response plan.  • Tankers suitable for hazardous area.  • No smoking on jetty  • Sitting and maintenance of crash barriers.</td>
<td>Low</td>
<td>• Foam extinguisher in cab  • Portable foam monitor.  • Fire trailer and monitor.  • If shell spray fire, leave to burn in controlled manner  • Hydrants and hose reels.  • Jetty shutdown.  • Consider PFP for FWPH.  • Consider 2 x FWPHs in different locations.</td>
</tr>
<tr>
<td>H.  Fire in the electrical switchgear room</td>
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</tr>
<tr>
<td>1. Electrical Fire.</td>
<td>• Overheating of bus bars.  • Insulator arcing due to salt deposits.  • Failure of maintenance procedures.  • Failure of electrical PTW system.  • Impact by road vehicles.  • Spray fire from ignited pipe leak.</td>
<td>• Loss of power and lighting.  • Loss of main firewater pump.  • Electric shock and possible fatality.</td>
<td>M</td>
<td>M</td>
<td>Medium</td>
<td>• Enforced speed limit.  • Sitting and maintenance of crash barriers.  • Manual start up of gas oil firewater pump.  • Electrical procedures and PTW System.</td>
<td>Medium</td>
<td>• Portable CO₂ extinguishers.  • Effect electrical isolations.  • Consult PPE before tackling fire.  • Don electrical PPE as well as fire PPE.  • Ensure transformer oil tank is cool and secure.  • Consider fixed inert gas extinguishing system.</td>
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<tr>
<td>I. Fire in the Operator Huts and Fire Water Pumphouse (FWPH).</td>
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<tr>
<td>1. Cellulosic Fire</td>
<td>• Impact by road vehicles.  • Poor housekeeping.  • Poor control of mobile plant and tools brought on to the Jetty.  • Impact by spray fire.</td>
<td>• Possibility of fatality in occupied building.  • Cellulosic fire and smoke.</td>
<td>M</td>
<td>M</td>
<td>Medium</td>
<td>• Design, construction and siting of operator huts.  • Design, construction and FWPH.  • Water extinguishers.  • Fire hydrants and hose reel cabinets.</td>
<td>Low</td>
<td>• Water extinguishers.  • Fire hydrants and hose reels.  • Enforce no smoking policy.</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Hazard</td>
<td>Cause</td>
<td>Consequences</td>
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<td>Raw risk</td>
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<td>Residual Risk</td>
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</tbody>
</table>
| 2 | Electrical Fire| • Impact by road vehicles.  
• Overheating of cables.  
• Deterioration of seals and JBs. | • Loss of power and lighting.  
• Loss of main firewater pump.  
• Electric shock and possible fatality. | M | L | Medium | • Maintenance of electrical systems.  
• Electrical PTW.  
• CO₂ extinguishers. | Medium | • Portable CO₂ extinguishers.  
• Effect electrical isolations.  
• Consult RPE before tackling fire.  
• Don electrical PPE as well as fire PPE.  
• Ensure transformer oil tank is cool and secure.  
• Consider fixed inert gas/fresh water spray extinguishing system. |
| 3 | Gas oil Fire   | • Spray release of gas oil in the FWPH on to hot surface. | • Impairment of FWPH during use.  
• Inability to fight large fires on the New Jetty. | H | L | Medium | • Hard piping of gas oil systems.  
• Weekly run up and checking of firewater pumps. | Medium | • Consider fixed inert gas/fresh water spray extinguishing system.  
• Consider 2 x FWPHs in different locations. |