Appendix O

Preliminary Risk Assessment

Rutherford Waste Recovery Facility - Preliminary Risk Assessment

January 2006

Transpacific Industries Pty Ltd

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Excellence Award 2003
Category: Project Management

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Engineering
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2118506A-RPT00x7aj

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Date: 25 November 2005

Distribution:

Contents

Page Number

Contents (continued)

Page Number

List of tables

List of figures

Appendices

Executive summary

Transpacific Industries Pty Ltd proposes to develop a resource recovery and recycling facility at Rutherford, NSW. The purpose of the facility will be to store, treat, recycle, recover and transport most industrial wastes generated within the region in order to reduce impacts on the environment. As a result of the activities undertaken, and the nature of materials used and stored as part of the operation, the proposed development would constitute a potentially hazardous industry, and a preliminary hazard analysis (PHA) of the operation has therefore been undertaken in accordance with the requirements of NSW State Environmental Planning Policy No 33 – Hazardous and Offensive Development (SEPP 33).

The methodology used in the preliminary hazard analysis has generally followed the guidelines issued by the NSW Department of Urban Affairs and Planning (now the Department of Planning), in particular the publication Multi-Level Risk Assessment Guidelines. It has also been undertaken in accordance with relevant titles in the series of Hazardous Industry Planning Advisory Papers issued by the Department, and with the Australian Standard AS/NZS 4360:2004 Risk Management.

Activities occurring or undertaken as a result of the proposed Rutherford resource recovery operations that could lead to off-site risk include:

- transport of waste and other materials to and from the site
- storage of waste and other materials on site
- processing of waste and recyclable materials on site

Materials that could lead to significant risk have been identified as follows.

Wastes in dangerous goods classes 3 (flammable liquids), 5 (oxidising substances), 6 (toxic substances), 8 (corrosive substances) and 9 (miscellaneous) will be accepted, stored, processed or consolidated and dispatched from the site. In addition, a significant volume of lubricating oil, classed as a combustible liquid, will be accepted for treatment in a hydrogenation unit. Hydrogen will be generated from natural gas by a high pressure and temperature steam reforming process, and used in the oil hydrogenation unit, which also operates at high temperature and pressure. A by-product of this process will be a liquid stream of light, flammable hydrocarbons that will be sent off-site for use as a fuel or feedstock at other sites. All activities and transport operations associated with the site are consistent with existing uses of land in the surrounding industrial estate.

The most significant hazards arising from the materials and activities involved that could potentially affect areas off-site are seen to be the potential for fire or explosion and the release of toxic material to the atmosphere, either directly or as the result of fire or unintended chemical reaction. Other hazards could arise, but are not likely to result in any risk outside the site boundaries. It is not expected that the transport of goods to or from the facility would result in any significant increase in risk to the public along the routes taken. However, the transport of any Class 6.1 toxic materials needs to be specifically considered based on SEPP 33 screening criteria (discussed in Section 3.3).

A screening process has been undertaken in accordance with SEPP 33 based on the maximum quantities of dangerous goods that would be present on the site.

In most cases, the quantities of dangerous substances handled on the site are below the individual SEPP 33 screening quantities, although aggregate figures are likely to exceed the criterion. The maximum quantities of Class 2.1, 5, 6.1 and 8 materials that might be present exceed the screening thresholds for storage (although no Class 2.1 material is actually stored). The movement of Class 6.1 material also exceeds the (zero) screening threshold for movements, so the development is considered potentially hazardous, and must be subjected to a preliminary hazard analysis, under the provisions of SEPP 33.

An assessment using the IAEA method recommended by the DUAP guidelines for multi-level risk assessment has been undertaken. It shows that the most significant estimated societal risk items are all of relatively low consequence although in some cases they may be relatively frequent. They generally fall outside the societal risk guidelines, being either in the negligible risk area or having consequences not likely to cause a fatality during any one event. The risk of toxic combustion products from Class 6.1 toxic materials in the event of a fire is the most significant societal risk.

Events with consequences extending beyond the boundary and a frequency of more than once in 10^7 years are possible, so the risks can not be assumed to be negligible. Further risk assessment was therefore considered appropriate. However, the events with higher frequencies are seen to have relatively limited consequences in terms of the number of potential fatalities that might result. The significant risk items are seen to be material in storage and not the process plants. The most significant risk area was found to be the toxic combustion of products from a fire involving Class 6.1 toxic substances (for example agro-chemicals such as pesticides). The historical frequency of warehouse fires and the low exposure limits for some Class 6.1 materials and their combustion products, could result in levels of individual risk outside the facility boundary that exceed planning guidelines. Surrounding land uses and the distance of the facility from residential areas means that it is unlikely that a fatality would result from such an event. These risks must be managed by appropriate procedures and good engineering design. Facilities storing similar materials are not uncommon, and the Rutherford facility will be designed and operated to meet the best practice for such facilities.

Risk management systems including relevant Australian Standards, design codes and company procedures are available and will be implemented as part of the design and operation of the facility to ensure that its operation will not expose persons living or working in the area to unacceptable levels of risk.

1. Introduction

Transpacific Industries Pty Ltd proposes to develop a resource recovery and recycling facility at Rutherford, NSW. The purpose of the facility will be to store, treat, recycle, recover and transport most industrial wastes generated within the region in order to reduce impacts on the environment. As a result of the activities undertaken and the nature of materials used and stored as part of the operation, the proposed development would constitute a potentially hazardous industry (and also possibly a potentially offensive industry), and a preliminary hazard analysis (PHA) of the operation has therefore been undertaken in accordance with the requirements of NSW State Environmental Planning Policy No 33 – Hazardous and Offensive Development (SEPP 33).

1.1 Applicable legislation

SEPP 33 - Hazardous and Offensive Development (subsidiary legislation No 129 of 1992) includes in its objectives (clause 2):

"(a) to amend the definitions of hazardous and offensive industries where used in environmental planning instruments

(d) to ensure that in determining whether a development is a hazardous or offensive industry, any measures proposed to be employed to reduce the impact of the development are taken into account

(e) to ensure that in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impact

(f) to require the advertising of applications to carry out any such development".

Part 3 of SEPP 33 applies to:

(a) development for the purposes of a potentially hazardous industry

(b) development for the purposes of a potentially offensive industry

(c) development notified, for the purposes of this Part, by the Director in the Gazette as being a potentially hazardous or potentially offensive development.

In SEPP 33:

"potentially hazardous industry" means a development which, if it were to operate without employing appropriate measures to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality to either human health, life or property or to the biophysical environment. It includes a hazardous industry and a hazardous storage establishment;

"potentially offensive industry" means a development which, if it were to operate without employing appropriate measures to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would emit a polluting discharge (including for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land, and includes an offensive industry and an offensive storage establishment.

Part 3 requires that a person who proposes to make a development application to carry out development for the purposes of a potentially hazardous industry must prepare a preliminary hazard analysis (PHA) in accordance with current guidelines published by the relevant Department.

In making a determination regarding any such development application the consent authority is required to consider the PHA; any feasible alternatives to carrying out the development and its location, and the reasons for choosing the development and its location as proposed; and any likely future use of the surrounding land.

1.2 Applicability of SEPP 33

The Director General's requirements for the preparation of an EIS for the facility (30 January 2004), included a requirement for a screening of potential hazards on site to determine the potential for off-site impact and the need for a preliminary hazard analysis, in accordance with the Department's guideline *Applying SEPP 33*.

As a result of the activities undertaken and the nature of materials used and stored as part of the recovery operation, the proposed development could constitute a potentially hazardous industry. This preliminary hazard analysis has therefore been prepared to satisfy the requirements of SEPP 33 for the Transpacific development application for the proposed resource recovery facility.

Notwithstanding the fact that the development may constitute a potentially hazardous industry under SEPP 33, the proposed development, including the measures that are proposed to mitigate all risks and potentially offensive activities associated with the development, are considered adequate to ensure that there would be no significant risk to or impact on human health, life or property, or to the biophysical environment in the locality as a result of the presence of hazardous materials. The development would therefore not fall under the definition of either hazardous or offensive industry according to SEPP 33. This conclusion is supported by the preliminary analysis undertaken, involving preliminary screening and risk classification and prioritisation steps.

1.3 Objective

The objective of the PHA is to:

- qualitatively assess the risks posed to the human, social and biophysical environment in the locality by all activities associated with the proposed facility
- to determine whether any significant risk remains after the project design (including all appropriate risk mitigation measures) are considered
- provide the consent authority and any concurrence agencies with sufficient information regarding the risks involved in the proposal to enable them to make an informed decision when determining the development application.

1.4 Scope

This PHA considers only the risks to the human, social and biophysical environment arising from sudden and unexpected events such as accidents and the results of equipment failure, operator error and the results of external events involving (but not under the direct control of) the proponent. Therefore the assessment does not consider risks that are unrelated to a single event such as may result from discharges to the environment as a normal part of operation approved under an operating licence. Any such longer term risks are generally treated in other sections of the EA.

The results of the PHA should be read in conjunction with other sections of the EA including:

- Groundwater – EA Section 7.2, Appendix D
- Surface Water – EA Section 7.3, Appendix E
- Contamination Assessment – EA Section 7.4. Appendix F
- Air Quality – EA Section 6.4, Appendix J
- Noise – EA Section 6.5, Appendix K
- Traffic and Transportation – EA Section 6.7 Appendix M

1.5 Methodology

The methodology employed in this PHA is generally in accordance with AS/NZS 4360:2004 Risk Management, and relevant Department of Planning guidelines:

- Hazardous Industry Planning Advisory Paper: No 4 (HIPAP No 4) Risk Criteria for Land Use Planning (DUAP 1997a)
- Hazardous Industry Planning Advisory Paper: No 6 (HIPAP No 6) Guidelines for Hazard Analysis (DUAP 1997b)
- Multi-Level Risk Assessment Guidelines (DUAP 1999)
- Applying SEPP 33 (DUAP, 1997c)

In accordance with the recommendations of the guideline Multi-Level Risk Assessment (DUAP 1999), a screening process comparing the quantities of hazardous materials against screening thresholds was applied to determine whether further assessment was required.

In accordance with HIPAP No 6 (DUAP 1997b), the PHA process followed was generally as follows:

- identify all possible sources and causes of hazardous incidents
- detail all operational and organisational safety controls
- identify the likely consequences and frequency of incidents and quantify the risks for the most relevant hazards identified
- assess likely cumulative risks
- compare expected risks against risk criteria detailed in HIPAP No 4
- assess the adequacy of proposed mitigation measures and controls.

However, for the purpose of the preliminary hazard analysis, the level of assessment has been limited in accordance with the results of the screening process recommended in the multilevel risk assessment guidelines (DUAP 1999). No quantitative risk analysis has been attempted where it is clear from the screening process, or from the preliminary consequence analysis or the qualitative assessment that no significant risk is likely to exist.

The qualitative assessment has generally followed principles outlined in the companion to AS/NZS 4360:2004, handbook HB436:2004 Risk Management Guidelines.

2. Hazard identification

Hazard identification followed a systematic process to identify all credible hazards for the Rutherford facility. This has involved identifying all activities undertaken as part of the resource recovery operation, the materials associated with each activity, and the hazard that might arise from these activities and materials within each of a series of classes of hazardous incidents. Hazards were identified through discussions with Transpacific Industries staff, use of relevant checklists, experience with similar operations and assessment of proposed piping and instrument diagrams (P&IDs) and manufacturers' specifications. A HAZOP completed by FFS for Transpacific Industries has identified specific hazards in the hydrogenation plant. A copy is provided in Appendix A.

2.1 Site activities

Activities that will be undertaken as part of the resource recovery operation are:

- transport of equipment and materials to site
- equipment maintenance
- storage of materials on-site
- oily water treatment and waste oil recovery
- manufacture of re-refined base lube oils by hydrogenation (including a methane reforming plant for hydrogen production)
- treatment of non-sewerable aqueous wastes by neutralisation, chemical fixation, stabilisation and solidification (CFS)
- waste decanting, consolidation, repackaging and storage
- waste disposal, recovery and reuse
- loadout and transport of wastes and recovered resources, including re-refined oil, off-site

2.2 Sources of hazard

Classes of materials that might give rise to or be involved in hazardous incidents and that will or might be present on the site are:

- waste and re-refined lubricating oil
- natural gas and hydrogen
- light ends (volatile organic fraction)
- other flammable or combustible substances such as solvents
- oxidising, toxic, corrosive or miscellaneous wastes
- other wastes

The types of hazardous incidents considered in this PHA are:

- loss of containment (typically resulting mainly in health or environmental impacts)
- fire

- explosion
- inappropriate waste treatment or disposal
- vehicle accidents

These classifications have been combined in Table 2-1, which details credible (but not necessarily likely) hazards relevant to each type of material present at the proposed Rutherford operation.

2.3 Site characteristics

The hazard assessment is based on the following broad characteristics of the plant and the surrounding area.

- The site is generally flat, with a number of existing buildings that will be converted for use in the waste recovery operation. It is proposed to locate the hydrogenation plant and tank farm in the south-west corner of the site. An existing pond and drainage easement on the western and southern sides of the property provide a buffer area between the plant and adjoining properties.
- It is proposed that the hydrogen and hydrogenation plants will be constructed outside without any confining structures and separated from the rest of the facility. This minimises the risk of any accumulation of flammable gases and maximises the opportunities for fire-fighting in the event of a fire.
- The area immediately surrounding the site is currently zoned for industrial activities, and the activities proposed are considered to be compatible with neighbouring businesses. To the west of Kyle Street the land is zoned rural. To the north of the New England Highway (at a distance of approximately 300 m) the land is zoned rural, special purpose (airport) and open space/recreation. The closest area zoned for residential use is over 1.5 km to the east.
- Existing activities in surrounding areas include transport depots and waste handling facilities. The occupancy is not expected to be high, and an average of 5 persons per hectare has been assumed for the purpose of the hazard assessment for the surrounding area (including the rural area to the west) within the maximum likely effect radius for the operations (typically not more than 100 m but up to 200 m, see summary in section 4.4).
- There are no sensitive locations or land uses in the vicinity (up to 500m) that would be expected to attract any significant assemblies of people.

Table 2-1: Credible hazards identified for Rutherford facility

Activities	Classes of hazardous materials involving risk					
	Fuel, light ends (incl. Class 3 PGII)	Waste and re-refined lubricating oils (C1 or C2)	Solvents (Class 3 PG I, II or III)	Oxidising, toxic, corrosive, miscellaneous (Classes 5, 6, 8, 9)	Other wastes	Hydrogen & natural gas (Class 2.1)
Transport to site	Vehicle accident Fire Loss of containment	Vehicle accident Loss of containment	Vehicle accident Fire Loss of containment	Vehicle accident Fire (if Class 5 contacts Class 3) Loss of containment Toxic emissions (contact between incompatible materials)	Vehicle accident Loss of containment Fire	Pipeline leak Fire Explosion
Storage, loading, unloading on-site	Fire Explosion Loss of containment	Loss of containment	Fire Loss of containment	Fire (if Class 5 contacts Class 3) Loss of containment Toxic emissions (contact between incompatible materials)	Loss of containment Fire (Spontaneous combustion possible but considered unlikely)	Leak Fire Explosion
Processing, decanting or consolidating on site	Fire Explosion (at elevated temperatures) Loss of containment	Loss of containment Fire (at elevated process temperatures)	Fire Loss of containment	Fire (if Class 5 contacts Class 3) Loss of containment Toxic emissions (contact between incompatible materials)	Loss of containment Fire (Spontaneous combustion possible but considered unlikely)	Leak Fire Explosion

Activities	Classes of hazardous materials involving risk					
	Fuel, light ends (incl. Class 3 PGII)	Waste and re-refined lubricating oils (C1 or C2)	Solvents (Class 3 PG I, II or III)	Oxidising, toxic, corrosive, miscellaneous (Classes 5, 6, 8, 9)	Other wastes	Hydrogen & natural gas (Class 2.1)
Equipment maintenance	Fire Loss of containment	Loss of containment Fire (at elevated process temperatures)	Fire Loss of containment	Fire (if Class 5 contacts Class 3) Loss of containment	n/a	Leak Fire Explosion
Waste disposal/discharges to land	n/a	n/a	n/a	n/a	Loss of containment Inappropriate waste disposal	n/a
Transport off-site	Vehicle accident Fire Loss of containment	Vehicle accident Loss of containment	Vehicle accident Fire Loss of containment	Vehicle accident Fire Toxic emissions Loss of containment	Loss of containment	n/a

The following table contains more detailed consideration of events, causes, consequences and proposed mitigation factors arising from the more significant hazards identified in the table above.

Table 2-2: Hazards potentially causing significant off-site consequences

Event	Causes	Consequences	Mitigation
Gas supply			
Pipeline failure and gas leak	Corrosion/ mechanical failure/ bad installation. Mechanical damage (collision etc). External fire/ explosion etc (domino effect).	May disperse without ignition before being isolated. May ignite early and form jet fire May form a gas cloud and ignite to form fireball May form gas cloud and detonate/explode	Site isolation at boundary. Remotely operated automatic isolation at process plant Pipeline mainly buried. Protect eg valve or metering stations Unconfined plant limits risk of explosion, increases rate of dispersion. Follow ExP standards for all electrical equipment to minimise risk of ignition
Hydrogen plant			
Piping or vessel failure and gas/ hydrogen leak (including reformer tubes)	Corrosion/ erosion/ mechanical failure Hydrogen embrittlement Mechanical damage	May disperse without ignition before being isolated (except in reformer). May ignite early and form jet fire May form a gas cloud and ignite to form fireball May form gas cloud and detonate/explode (unlikely)	Design standards and correct selection of materials of construction Site isolation at boundary. Remotely operated automatic isolation at process plant Pipeline mainly buried Unconfined plant limits risk of explosion, increases rate of dispersion. Follow ExP standards for all electrical equipment to minimise risk of ignition Operating and maintenance procedures and practices Regular inspection and testing according to pressure vessel standards Limited inventory: <200 Nm^3 on site.

Event	Causes	Consequences	Mitigation
Catastrophic vessel failure	Hydrogen embrittlement. Over-pressure/ over-temperature Fatigue from excessive pressure cycles	Vessel rupture, shrapnel, domino effect on other plant and equipment Gas leak, ignition likely: secondary jet fire, fireball or explosion possible	Design standards and correct selection of materials of construction Control systems Pressure relief systems Regular inspection and testing according to pressure vessel standards Limited inventory: <200 Nm^3 on site.
Internal explosion	Air left in system at startup Reaction of natural gas/hydrogen with other contaminants. Ingress of air during operation eg compressor suction/seals	Vessel rupture, shrapnel, domino effect on other plant and equipment Gas leak, ignition likely: secondary jet fire, fireball or explosion possible	System N_2 purged on startup, following maintenance etc. Maintenance procedures Cleaning and startup procedures System normally operates at (high) positive pressure at all points after natural gas compressor. Nitrogen purge of potential air ingress points Control and alarm systems on compressor suctions and other critical points
Hydrogenation plant			
Piping or vessel failure and hydrogen/ hydrocarbon gas leak	Corrosion/ erosion/ mechanical failure Hydrogen embrittlement Mechanical damage	May disperse without ignition before being isolated. May ignite early and form jet fire May form a gas cloud and ignite to form fireball May form gas cloud and detonate/explode	Design standards and correct selection of materials of construction Unconfined plant limits risk of explosion, increases rate of dispersion. Follow ExP standards for all electrical equipment to minimise risk of ignition Operating and maintenance procedures and practices Regular inspection and testing according to pressure vessel standards Limited inventory: <200 Nm^3 of hydrogen/ light hydrocarbons on site.

Event	Causes	Consequences	Mitigation
Piping or vessel failure and flammable liquid leak (including fired heater tubes)	Corrosion/ erosion/ mechanical failure Mechanical damage	May not ignite (except for leaks in fired heater) Jet or pool fire likely	Design standards and correct selection of materials of construction Follow ExP standards for all electrical equipment to minimise risk of ignition Operating and maintenance procedures and practices Control and alarm systems Regular inspection and testing according to pressure vessel standards Class 3 liquid inventory in plant and tank farm below threshold.
Catastrophic vessel failure	Hydrogen embrittlement. Over-pressure/ over-temperature Fatigue from excessive pressure cycles	Vessel rupture, shrapnel, domino effect on other plant and equipment Jet or pool fire likely	Design standards and correct selection of materials of construction Control systems Pressure relief systems Regular inspection and testing according to pressure vessel standards Class 3 liquid inventory in plant and tank farm below threshold.
Internal explosion	Air left in system at startup Reaction with other contaminants. Ingress of air during operation eg vacuum compressor suction/seals	Vessel rupture, shrapnel, domino effect on other plant and equipment Gas or liquid leak likely. Jet or pool fire likely, explosion possible (not likely).	System N_2 purged on startup, following maintenance etc, Maintenance procedures Cleaning and startup procedures System normally operates at positive pressure except in vacuum stripping circuit Nitrogen purge of potential air ingress points Control and alarm systems on vacuum compressor suctions and other critical low pressure points

Tank farm

Event	Causes	Consequences	Mitigation
Tank leak	Corrosion, poor maintenance, sucked in etc Mechanical damage	Fill bund. For light ends, may ignite	Fully bunded Nitrogen blanketed and vacuum break. Regular tank inspections
Tank overflow	Operator error, instrument failure.	Fill bund. For light ends, may ignite	Fully bunded Alarms and control systems Regular bund inspection and cleanout
Dangerous goods store			
Fire involving Class 3 flammable materials	Leaks, spills, poor containment, poor housekeeping. Static discharge during transfers, equipment malfunction, electrical equipment, other sources of ignition.	Loss of assets. Possible involvement of other DG classes (see below). Risk to site personnel and off-site personnel from radiation, toxic combustion products (mainly if other DG classes involved).	No packages that do not conform to DG code. Storage to AS1940-separation, segregation etc. Good housekeeping. Control of ignition sources (ExP methods, equipment maintenance, procedures). Fire detection and control systems, emergency procedures. Maximum inventory below threshold for Class 3 DGs. ~90 m to nearest site boundary.
Leaks, mixing of Class 5.1 and Class 3 or other combustibles, or contamination with sensitising substance plus initiating event	Poor inventory control, inadequate analysis, poor housekeeping Poor segregation of DGs. Poor control of consolidation or repackaging of DGs.	Fire Explosion	Accurate analysis of DGs Segregate Class 5 from all incompatible flammable/ combustible materials Maintain housekeeping standards Fire detection and control systems, emergency procedures. Limit inventory

Event	Causes	Consequences	Mitigation
Fire involving Class 5.1 ammonium nitrate plus initiating event	Class 3 or other flammable/ combustible warehouse fire in adjoining storage areas	Explosion (not likely)	Limited inventory, small stockpile, unconfined. No Class 1 accepted. Segregation of flammables/ combustibles according to standards Fire detection and control systems, emergency procedures. Maintain good housekeeping standards.
Leaks, mixing of Class 5.1 and Class 8 (acids)	Poor inventory control, inadequate analysis, poor housekeeping Poor segregation of DGs. Poor control of consolidation or repackaging of DGs.	Reaction and emission of toxic gases possible (large emissions considered unlikely)	Accurate analysis of DGs to identify hazards. Segregate Class 5 from all incompatible Class 8 materials Maintain housekeeping standards Limit inventory
Fire involving Class 6.1 toxic chemicals (e.g. agrochemicals)	Class 3 or other flammable/ combustible warehouse fire	Emission of toxic combustion products Emission of parent material that survives fire	Segregate Class 6.1 from high fire risk materials (Class 3) in accordance with standards Identify keep high toxicity materials separate. Maintain housekeeping standards Fire detection and control systems, emergency procedures. Limit inventory of high toxicity materials Surrounding land use is not sensitive. Occupants likely to be able to avoid toxic emissions

The significant consequences outlined above that might result in off-site impacts, together with the most likely causes and mitigation measures, are considered further in the following sections.

3. Screening assessment

The following sections provide a description of the hazards identified in the preceding section, likely scenarios, quantities of materials involved (where relevant), typical controls that would be applied, and the results of a preliminary screening against the criteria provided in the guideline Applying SEPP 33 (DUAP 1997).

3.1 Hazardous and other materials

3.1.1 Waste and re-refined lubricating oil

Waste oils collected by road tankers from regional generators such as mine sites, automotive and truck workshops, shipping industries, defence forces, railway workshops, engineering firms, etc, will be transferred to storage tanks at Rutherford for consolidation. All the waste oil will then be transferred by road tankers to TPI's off-site oil recycling facilities (such as Nationwide Oil Wetherill Park in NSW or Nationwide Oil Narangba in Queensland). Any water which separates from the oil phase on standing in the storage tanks will be decanted and transferred to the on-site waste water treatment plant.

Oil processed at Wetherill Park undergoes re-refining to provide the base lube oil feedstock for the Hydrogenation Plant proposed for Rutherford. The Wetherill Park re-refinery is the only one of its type in Australia. The re-refining process involves solvent extraction of the oil (in liquid propane) from water and other impurities. The propane is recovered and the oil distilled in a column to give a number of hydrocarbon fractions including diesel, light gas oil, light neutral oil, heavy neutral oil and asphaltine residuum. The major fraction produced is light neutral oil which will be the feedstock for the Hydrogenation Plant.

3.1.2 Hydrogenation Plant

The feedstock for the Hydrogenation Plant will be the light neutral oil fraction from the re-refining process at Wetherill Park. The hydrogenation reaction will saturate the hydrocarbon chains by inserting hydrogen atoms into unsaturated carbon bonds in the presence of a catalyst at elevated temperature and pressure (maximum 380°C and 1500 kPa).. The final product will meet lubricant-grade specifications.

Waste oil will be transported to the site by road and stored in a tank farm, processed and returned to the tank farm for storage prior to dispatch. Up to 1600 kL would be stored in seven 100 kL tanks and initially two 450 kL tanks. Allowance has been made for a further 450 kL tank. The characteristics of the incoming and re-refined waste oil is variable and has been classified as combustible C1 (having a flash-point below 150°C) to be conservative; in some cases it might be C2 (flashpoint above 150°C). The tank farm would be constructed in accordance with the requirements of *AS 1940-2004: The storage and handling of flammable and combustible liquids*. This would include a bund around all storages capable of containing the contents of the largest tank. The storage would not be located in any catchment area that might allow uncontrolled discharge to a watercourse. This would limit the potential for spread of fire and any serious impacts on water quality, downstream water users and aquatic ecosystems.

Transport of waste oil to the site would conform to the requirements of the Australian Dangerous Goods Code (ADG Code), and is unlikely to measurably increase the quantities of combustible materials already being transported on public roads in the region generally, although it might increase the quantities significantly on local roads closer to the facility (principally the New England Highway and Racecourse Road/Kyle Street). It is therefore unlikely that there would be any noticeable effect on the risk to the public from waste oil transport.

Lubricating oil is not included in the SEPP 33 screening process as it does not have a dangerous goods classification. However, for the screening process it should be considered as Class 3 if stored with Class 3 materials. At the Rutherford facility the re-refined oil used as feedstock for the Hydrogenation Process (Class C1/2 Combustible Liquid) and the processed oil (Class C1/2 Combustible Liquid) and flammable light ends (Class 3 PG II Flammable Liquid) produced will be stored in separate bunds set apart by distances sufficient to minimise the risk in case of fire or other accident in accordance with Australian Standards and design codes.

Pumps, pipes and valves will be used to transfer the oil to and from the tank farms. Tankers will transfer incoming and outgoing oil in a dedicated, bunded area via manifolds, pumps and pipes. In all cases, the separation distances between tanks, bunds, other relevant aspects of the facility and the site boundaries will be sufficient to minimise the risk in case of fire or other accident in accordance with Australian Standards and design codes.

Similarly, waste oil (Class C2 Combustible Liquid) will be stored in a separate bund set apart by distances sufficient to minimise the risk in case of fire or other accident in accordance with Australian Standards and design codes.

3.1.3 Solvents and light ends

Used solvents of various classes will be collected from generators in drums (up to 205 litres) or small bulk tanks (typically 1000 litres) and transported to Rutherford for consolidation and storage prior to being transferred to licensed recycling facilities. All package and semi-bulk material would be stored within secondary containment within a package store designed in accordance with AS1940-2004. The package store will be roofed to prevent generation of contaminated stormwater and impacts on surface waters. A package store with a maximum capacity of 3000 drums of 200 L each is planned. There is potential for all material to be Class 3. Up to 10% of this might be Packaging Group I (PG I) at any time.

Recycled solvents will be returned to the Rutherford Facility and stored in a holding tank (60 kL) from which it will be decanted into drums and returned to customers. The Recycled Solvent Tank and bund will be constructed in accordance with the requirements of AS 1940-2004. The recycled solvents will be Class C1 Combustible Liquid only. (Class 3 solvents received at the Rutherford facility from generators and transferred to other licensed facilities will not be recycled through the Rutherford facility). Transfers and decanting of the recycled solvent will be conducted in a bunded area in accordance with AS 1940-2004. The Recycled Solvent tank will be segregated and located at the eastern side of the Facility.

Light ends will be generated as a by-product of the hydrogenation process and stored in the tank farm. It is a Class 3, PG II flammable liquid. Light ends will be exported from Rutherford for sale or use on another site as a fuel.

Transport of Class 3 dangerous goods to and from the site will be in accordance with the requirements of the ADG Code, and should not significantly increase the risk to the public (see section 3.3).

3.1.4 Natural gas

Natural gas will be supplied from either a 110 mm main or a 400 mm main, believed to be operating at pressures up to 100 kPa. The connection is expected to be a 50 mm diameter line. The maximum possible flow rate from this line in the event of a major failure is expected to be no more than 0.2 kg/s or 1100 Nm^3/h equivalent to 43,000 MJ/h. The maximum gas usage is expected to be approximately 560 Nm^3/h, equivalent to 22,000 MJ/h.

A leak of natural gas has the potential to form an explosive cloud, but it is generally held that the probability of this occurring in an unconfined space or for a small cloud is relatively small. The maximum rate of release of gas at the low supply pressure available is not sufficient to create a cloud large enough to be likely to cause an explosion within a credible period of undetected leakage, particularly as the leak would be effectively unconfined in the open plant layout proposed. Natural gas will be compressed to the pressures required for the hydrogen reforming process (typically 2.5 MPa), but the volumes of material within the process will be relatively small, and the potential for an explosive vapour cloud to form remains very small.

The potential for reaction of natural gas with any oxygen that might be left in the system following maintenance or catalyst replacement will be minimised by nitrogen purging of equipment prior to startup. Pressure relief systems will be incorporated to safely relieve any overpressure.

3.1.5 Hydrogen

Hydrogen will be generated by a methane reforming plant for use in the hydrogenation plant. Like the hydrogenation plant, the hydrogen plant operates at elevated temperature (typically 1000°C). The hydrogen plant production rate is matched closely to the hydrogenation plant's consumption rate, and no intermediate storage (other than the inventory of the connecting pipework) will be provided. Like natural gas, hydrogen is highly flammable and potentially explosive within a certain range concentrations in air. However, it is not considered likely that a (significant) explosion would occur in an unconfined area in an open air plant such as the Rutherford hydrogen plant and hydrogenation plant. Any excess hydrogen generation can be used in the boiler or safely flared. The volumes of hydrogen in the process will not be large enough to create a vapour cloud within the range likely to be explosive.

The potential for reaction of hydrogen with any oxygen that might be left in the system following maintenance or catalyst replacement will be minimised by nitrogen purging of equipment prior to startup. Pressure relief systems will be incorporated to safely relieve any overpressure.

3.1.6 Other process materials

In the hydrogenation plant there will be lubricating oil, hydrogen and a mix of light hydrocarbons circulating at high temperatures and pressures (up to 380°C and 2000 kPa) between the process heater and the hydrogenation reactor product coolers. This material will be above its flash point and a potential source of fire in the event of a leak, and needs to be treated as a flammable Class 3 material. However, the plant equipment items involved are not large, and maximum pipework diameter is 80 mm. The total volume of hot flammable oil in the system at high pressure is therefore relatively small, estimated to be less than 20 m^3. Oil that has been cooled to below its flash point will be present in other parts of the process, but will not present a major risk.

3.1.7 Other wastes

A wide range of other wastes could be accepted for treatment by the facility. Hazardous materials and those that might pose a risk to the environment and all recyclable materials will be processed, recycled or sent for treatment and disposal to licensed premises as appropriate. No significant hazards to the environment are likely from these activities because all waste will be stored, handled and treated strictly in accordance with relevant standards and codes of practice. All waste accepted by the facility will have been tested and assessed to determine its relevant characteristics including dangerous goods class. Incompatible classes of dangerous goods will be stored separately from each other. The greatest risks would be expected to arise if Class 3 flammable and Class 5 oxidising materials were allowed to come in contact, with fire likely to result; or if a fire involving Class 6 toxic materials occurred, which might result in toxic smoke and fumes, depending on the nature of the Class 6 material.

3.2 Assessment against screening thresholds

Hazardous materials that would or might be stored on the Rutherford site have been subjected to a screening process in accordance with the publication Applying SEPP 33 guidelines (DUAP 1997). The results are shown in Table 3-1 below.

Table 3-1: Results of hazard screening

Dangerous goods class	Dangerous goods potentially stored	Storage location	Maximum likely quantity in storage (aggregate)	Distance to nearest boundary/ external protected works	SEPP 33 Screening threshold
Class 2.1	Natural gas	Hydrogen plant and boiler. No storage-delivery by pipeline or in process only	estimate 10 m^3 at STP in process (not storage)	>25 m	5 m^3 at STP, up to 200 m^3 at 30 m or 2800 m^3 at 70 m
Class 2.1	Hydrogen	Hydrogen and hydrogenation plant. No storage-piped directly to hydrogenation plant	estimate <200 m^3 at STP in process (not storage)	>25 m	5 m^3 at STP, up to 200 m^3 at 30 m or 2800 m^3 at 70 m
Class 3 PG I	Solvents etc.	Package store	60 m^3	> 90 m	1 m^3, up to 60 m^3 at 20 m, ~4000 m^3 at 90 m

Dangerous goods class	Dangerous goods potentially stored	Storage location	Maximum likely quantity in storage (aggregate)	Distance to nearest boundary/ external protected works	SEPP 33 Screening threshold
Class 3 PG II or III	Light ends, solvents etc.	Tank farm	100 m^3 (if stored separate from C1)	> 20 m	2 m^3, ~150 m^3 at 20 m, 700 m^3 at 35 m, ~10000 m^3 at 90 m
		Package store	Max 600 m^3	> 90 m	
Class 3	Process materials (oil and light hydrocarbon) at high temperature	Hydrogenation plant	estimate <20 m^3.	>50 m	1 m^3, up to 60 m^3 at 20 m, 1000 m^3 at 50 m (for PG I).
n/a	C1, C2 Combustible liquids – re-refined and processed lubricating oil	Tank farm- above ground tanks, fully bunded.	1350 m^3 (stored separate from Class 3)	>50 m	No threshold unless stored with Class 3, then as above.
Class 5.1	Oxidising substances	Package store	max 60 m^3 (assume 60 tonnes)	>90 m	5 tonnes
Class 6.1	Toxic substances	Package store	max 60 m^3 (assume 60 tonnes)	>90 m	0.5 m^3 (6.1(a)) or 2.5 m^3 (6.1(b))
Class 8	Corrosive substances	Package store	max 60 m^3 (assume 60 tonnes)	>90 m	PGIII- 50 tonnes. PGII- 25 tonnes
Class 9	Miscellaneous dangerous goods	Package store	max 60 m^3 (assume 60 tonnes)	>90 m	Not specified

The results of the screening process show that the maximum quantity of hydrogen (if considered to be stored), oxidising substances, toxic substances and corrosive substances could all exceed the basic screening thresholds. Therefore the conclusion from the basic screening process is that the risks associated with the development require further assessment of Class 2.1, 5, 6 and 8 materials under the provisions of SEPP 33.

The sum of the ratios of all Class 3 materials to their respective thresholds at the relevant distance of each storage from the nearest boundary is 0.76, and the screening threshold is therefore not exceeded in aggregate for Class 3, which is the principal source of fire risk.

3.3 Transportation risk

A development such as the Rutherford facility might also result in a transport-related risk. The SEPP 33 Guidelines provide screening thresholds for transport-generated risk. The estimated peak weekly movements for each class of dangerous goods that will be transported to or from the site are given in Table 3-2.

Table 3-2: Transport threshold screening

Dangerous goods class	Dangerous goods transported	Transport method	Peak weekly movements	SEPP 33 Screening threshold
Class 3 PG I	Solvents etc,	Packages	10	30
Class 3 PG II or III	Light ends, solvents etc,	Bulk	10	45 (PG II) 60 (PG III)
		Packages	40	
Class 5.1	Oxidising substances	Packages	10	30
Class 6.1	Toxic substances	Packages	10	all movements
Class 8	Corrosive substances	Packages	20	30
Class 9	Miscellaneous dangerous goods	Packages	20	60

No class of dangerous goods exceeds the weekly movements screening threshold except for Class 6.1 materials, for which the threshold is set to zero, so that any movement of Class 6.1 material is considered potentially hazardous. SEPP 33 Guidelines also provide lower limits for load size that are potentially hazardous, which for Class 6.1 are 1 tonne for bulk material and 3 tonnes for packages. It is possible that loads might exceed these limits. Therefore, there is the potential for transport-related risk arising from operation of the Rutherford facility based on the SEPP 33 screening criteria.

3.4 Conclusions

The maximum quantities of Class 2.1, 5, 6.1 and 8 materials that might be present on site exceed the screening thresholds for storage (although no Class 2.1 material is actually stored on site), and the movement of Class 6.1 material exceeds the (zero) screening threshold for movements. The development is therefore considered potentially hazardous, and must be subjected to a preliminary hazard analysis, under the provisions of SEPP 33.

4. Preliminary hazard analysis

A preliminary hazard analysis has been undertaken for those classes of material that exceed the screening thresholds specified in the SEPP 33 guidelines.

The Multi Level Risk Assessment guideline recommends that Classes 1, 2, 3 and 6.1 materials that exceed the screening thresholds should be subjected to the risk classification and prioritisation method of the IAEA as described in Appendix A of the guideline. Further risk assessment for these materials may not be necessary if:

- societal risk is in the negligible region
- no events would result in consequences extending beyond the site boundary with a frequency greater than 1 x 10^{-7} per annum
- the process is well understood and subject to recognised standards
- no off site consequences impact on sensitive land uses

For Class 5 hazardous materials, quantification of the consequences is recommended for all credible accident scenarios, taking into account toxic products of reactions such as combustion products. Qualitative analysis is only considered adequate where harmful consequences do not extend significantly beyond the site boundary. Based on the likely types of material that are expected to be received at Rutherford, explosion and toxic releases have been considered credible events and have been examined further.

For hazardous materials in Classes 6.2-8 the guideline advises that risks are generally adequately managed by compliance with relevant standards and codes of practice and the implementation of appropriate technical and management procedures, and that a qualitative approach demonstrating compliance is generally sufficient.

4.1 Risk classification and prioritisation

In order to determine which dangerous materials might give rise to significant external consequences, the IAEA method for classification and prioritisation of risks has been used where applicable.

For this assessment, a population density of 5 persons per hectare has been used. This is based on the large lots surrounding the Rutherford site, the amount of vacant or agricultural land, and the low intensity of the majority of activities adjoining the site. For example, the area to the west of the process area is used for truck parking, with land further west zoned as rural and effectively unpopulated. The area to the south is occupied by other waste processing operations, warehousing and similar industrial or commercial operations, generally located on large lots with significant open space around each building.

It is important to note that, with the exception of toxic combustion products for Class 6.1 materials, for all the potentially dangerous materials considered, the effect distances calculated in the following sections are similar to or in some cases lower than the buffer distances between the storage or plant area concerned and the nearest boundary. The conclusion is that it is most unlikely that any significant effect would impact a significant area outside the facility boundary. The populated fraction of each impact area is therefore 0% for a 25 m effect distance around the tank farms and process plants. The only boundary closer than 100 m to the dangerous goods store is the southern boundary (approximately 90 m from the store) and the populated fraction of the impact area is therefore approximately 5% for a 100 m effect distance around the dangerous goods store (based on 25% of the effect area between 90 and 100 m from the store). For the purpose of this assessment, ‘populated’ refers to areas where off-site people work. No residences fall within the estimated effect distances. For the larger, 200 m effect distance estimated for toxic combustion products from Class 6.1, areas outside the site boundary approximately 100 m to the north, west and south would potentially be impacted. For this case, the populated fraction of the impact area is therefore approximately 75% of the fraction of the area lying between 100 and 200 m from the store, or 56%.

4.1.1 Class 2.1 – Hydrogen and natural gas

No hydrogen will be stored in the plant. Hydrogen will be generated in the hydrogen plant and fed directly to the hydrogenation plant as required. In the event of a hydrogen plant shutdown, the hydrogenation plant would be shut down shortly after. Any excess hydrogen would be vented safely to the flare system. The total quantity of hydrogen present in the system would be unlikely to exceed 20 kg based on estimated plant operating volumes. The maximum quantity of natural gas (principally methane) plus other light hydrocarbon components that together would constitute Class 2.1 gases at the elevated process temperatures in the hydrogen and hydrogenation plants would be unlikely to exceed 200 kg. Using the IAEA method recommended, this is below the minimum effect category. The lowest category specified is CIII for 5-10 tonnes of material, for which there is a maximum effect distance of 50-100 m and an impact area of 0.3 ha. The number of people normally present within this distance of the plant outside the boundary would typically be quite small.

For light gases such as hydrogen, the formation of an explosive cloud with small quantities in an unconfined area is considered most unlikely. For other gases, quantities of less than 1 tonne are rarely involved in significant explosions in unconfined areas. Operating and maintenance procedures and nitrogen purging systems will minimise the risk of reactions with residual oxygen inside process equipment following maintenance, and pressure relief systems will protect process vessels. This is consistent with the lack of a rating for small quantities of Class 2.1 material under the IAEA method.

From this analysis, the conclusion is drawn that the risk of an accident involving hydrogen, natural gas or other light hydrocarbon gases having significant consequences external to the site are very low or negligible where their source is the process plant.

Natural gas is supplied by pipe from adjoining street mains for use in the hydrogen reforming unit and the steam boiler. The gas main would be expected to be buried at all points outside the fenced process plant area (except possibly for any required metering station, which would be a standard design that might be expected to exist in any industrial or commercial facility in the area). In addition to a site isolation valve, the supply will have remotely activated isolation valves for the reformer and boiler that will trip in the event of a site emergency or emergency shutdown of either unit. However, in the event of a major pipe or vessel failure, a failure of the isolation valve, and ignition of the resulting gas jet, a large radiant jet fire is possible.

It has previously been estimated that the maximum flow of gas from an open pipe end would be 1100 Nm^3/h, equivalent to 43,000 MJ/h or 11.9 MW. If 20% of this heat is radiated from a bright, turbulent flame, and it is assumed that the flame is effectively spherical and attenuation is small, then the radiation intensity at a distance of m metres from the flame would be:

$$I = (11.9 \times 10^6 \times 0.2)/(4 \times \pi \times m^2) \qquad (W/m^2)$$

At a distance of 25 m, the approximate distance of the hydrogen plant from the boundary, the intensity would be 300 W/m^2. (An alternative method using a more sophisticated calculation method (AIChE, 2000) gives a value of 190 W/m^2). This is well below the minimum level at which pain will be felt (about 1600 W/m^2). Pain would not be experienced at distances greater than approximately 25 m from the flame (or possibly as close as 7 m based on the AIChE method). There would be no risk to life and little risk of any injury outside the site boundary.

Hydrogen burns with a flame involving very little radiation, and no detectable impacts from a hydrogen fire would be likely outside the site boundary.

Based on the consequences estimated for this worst-case scenario of a jet fire involving the maximum likely gas flow, together with the IAEA consequence assessment, it is concluded that no Class 2.1 material present on the site would pose a significant risk to persons off site.

4.1.2 Class 3 – Flammable liquids

Class 3 materials likely to be present on the site will be stored separately from combustible materials to minimise the risk of a fire spreading to the larger quantity of that material being stored. The SEPP 33 threshold quantities are not exceeded for Class 3 materials.

The IAEA method shows an effect category of AI for 700 tonnes of mixed PGI and PGII flammable liquids in a bunded storage, giving a maximum effect distance of 25 m and an impact area of 0.2 ha (A). As all PGI and PG II storage will be further than 25 m from the site boundary and the IAEA method shows no likely offsite risk, no further analysis is needed.

4.1.3 Class 5 – Oxidising materials

Class 5 materials comprise Class 5.1: oxidising substances that are not necessarily combustible themselves but may cause or contribute to the combustion of other material by providing oxygen; and Class 5.2: organic peroxides, which are typically unstable and prone to undergoing spontaneous and self-accelerating decomposition, including explosive decomposition.

It is not likely that Class 5.2 materials would be sent to, and would not be knowingly accepted by, the Rutherford facility, because of the unstable nature of these compounds and the need for highly specialised treatment processes for their neutralisation.

Class 5.1 materials that might be accepted include substances such as ammonium nitrate (a fertiliser, but also a bulk explosive when it is mixed or contaminated with a fuel such as diesel) or calcium hypochlorite (solid pool chlorine, which can initiate a fire in contact with combustible material). A Class 5.1 material such as calcium hypochlorite could also generate toxic chlorine fumes if it was accidentally mixed with an acid due to a leak or a processing error. For these reasons, Class 5.1 materials will be carefully segregated from Class 3 and Class 8 materials.

There is a very small chance that waste material such as ammonium nitrate accepted by the facility could be contaminated with a source of fuel such as diesel in the appropriate proportions, or some other contaminant that would increase its sensitivity to heat or shock, either before or following receipt. Such material could subsequently explode as a result of some initiating event. The need for both a source of fuel or other contaminant and an initiating event makes an explosion unlikely given the testing and acceptance criteria for wastes and the segregation of incompatible dangerous goods classes. (The Australian Dangerous Goods Code classifies ammonium nitrate with more than 0.2% combustible material as Class 1.1D explosive, but all other forms as Class 5.1 or 9. *Note that Class 1.1D – Explosive will not be accepted or stored at the site).*

Class 5 – Oxidising Materials - Explosion

The hazard identification for Class 5 materials and the potential for explosion from section 2 is repeated in Table 4-1:

Table 4-1: Explosion hazards for Class 5.1 materials

Event	Cause	Consequence	Mitigation
Leaks, mixing of Class 5.1 and Class 3 or other combustibles, or contamination with sensitising substance plus initiating event	Poor inventory control, inadequate analysis, poor housekeeping Poor segregation of DGs. Poor control of consolidation or repackaging of DGs.	Fire Explosion (not likely)	Accurate analysis of DGs Segregate Class 5 from all incompatible flammable/ combustible materials Maintain housekeeping standards Fire detection and control systems, emergency procedures. Limit inventory
Fire involving Class 5.1 (ammonium nitrate) plus initiating event	Class 3 or other flammable/ combustible warehouse fire in adjoining storage areas	Explosion (not likely)	Limited inventory, small stockpile, unconfined. No Class 1 accepted. Segregation of flammables/ combustibles according to standards Fire detection and control systems, emergency procedures. Maintain good housekeeping standards.

The IAEA method allocates bulk explosives of up to 200 tonnes to effect category CI, with an effect distance of 50-100 m and an effect area of 3 ha. It should be noted that no material classed as explosive would be accepted by the facility. As explosive material would only be formed by the inadvertent mixing of Class 5.1 ammonium nitrate, it is extremely unlikely that this quantity would be produced, and the consequence and frequency estimates are therefore likely to be very conservative. It is assumed that 50% of Class 5 movements (i.e. 250 per annum) would involve potentially explosive material such as ammonium nitrate. The effectiveness of any explosion that did occur would probably be small.

The consequences are estimated from:

effect area (effect category CI)	A	3	ha

population density in the surrounding area	D	5	persons per hectare
population correction factor	f_A	0.05	5% populated fraction
correction factor for mitigation for explosives	f_m	1	
external consequences: $C_{a,s} = A \times d \times f_A \times f_m$	**$C_{a,s}$**	**0.75**	**fatalities**

The probability is estimated from:

average probability number for explosive storage from Table IX	$N^*_{I,s}$	7	
correction for loading/unloading frequency from Table X(A)	n_l	-1.5	up to 250 loading and unloading cycles per annum
correction parameter for organisational safety from Table XII	n_o	0	conservatively assume to be average performance
correction factor for wind direction from Table XIII	n_p	0	for effect area category I
adjusted probability number $N_{i,s} = N^*_{i,s} + n_l + n_o + n_p$	**$N_{i,s}$**	**5.5**	

and the frequency is $10^{-Ni,s} = 3 \times 10^{-6}$ per annum.

This F-N point (0.75 fatalities, 3×10^{-6} per annum) is in the negligible region of the societal risk criterion.

Because explosives (Class 1) will not knowingly be accepted at the facility, and the risk of formation of Class 1 material will be minimised by segregation of Class 5.1 from potential fuel sources (e.g. Class 3 goods), the frequency estimated by the IAEA method is considered to be an upper limit, and the actual frequency of any event involving explosives is likely to be lower, probably by up to an order of magnitude.

Class 5 – Oxidising Materials- Toxic release

The hazard identification for Class 5 materials and the potential for toxic release from section 2 is repeated in Table 4-2:

Table 4-2: Toxic escape hazards of Class 5.1 materials

Event	Cause	Consequence	Mitigation
Leaks, mixing of Class 5.1 (e.g. calcium hypochlorite or sodium hypochlorite) and Class 8 (acids)	Poor inventory control, inadequate analysis, poor housekeeping Poor segregation of DGs. Poor control of consolidation or repackaging of DGs.	Reaction and emission of toxic gases such as chlorine possible (large emissions considered unlikely)	Accurate analysis of DGs to identify hazards. Segregate Class 5 from all incompatible Class 8 materials Maintain housekeeping standards Limit inventory

The maximum quantity of Class 5.1 materials that would be held is 60 m^3, assumed to be approximately 60 tonnes of mixed waste. If it was all calcium hypochlorite (as an example), it could theoretically generate up to 30 tonnes of chlorine gas, but only if sufficient acid was present to drive the reaction. This would be highly unlikely due to the segregation distances and bunding of incompatible dangerous goods. As the waste would be in drums (or possibly intermediate bulk containers), it is unlikely that more than 200 L or perhaps up to 500 kg of calcium hypochlorite would be available to react as a result of a drum rupture. The maximum credible amount of chlorine that could be emitted would therefore be 250 kg if the waste was completely reacted with an acid. It is unlikely that this would occur very quickly in any credible scenario.

There is no directly applicable IAEA method for such a situation. The following analysis has been undertaken as if the Class 5 material was actually chlorine, a Class 2.3 toxic gas. If the chlorine was stored as a liquid under pressure, up to 200 kg would not have an effect category, and 200-1000 kg would have an effect category of CII, with an effect radius of 50-100 m and an effect area of 1.5 ha. It is assumed that 50% of Class 5 movements (i.e. 250 per annum) would involve material such as calcium or sodium hypochlorite. The distance to the nearest boundary is 90 m, but only to the south, so the percentage of the affected area that is populated is 5%.

The consequences are estimated from:

effect area (effect category CII)	A	1.5	ha
population density in the surrounding area	d	5	persons per hectare
population correction factor	f_A	0.1	5% populated fraction
correction factor for mitigation for toxic gases	f_m	0.1	
external consequences: $C_{a,s} = A \times d \times f_A \times f_m$	**$C_{a,s}$**	**0.075**	**fatalities**

The probability is estimated from:

average probability number for toxic gas storage from Table IX	$N^*_{I,s}$	6	
correction for loading/unloading frequency from Table X(A)	n_l	-1.5	up to 250 loading and unloading cycles per annum
correction parameter for organisational safety from Table XII	n_o	0	conservatively assume to be average performance
correction factor for wind direction from Table XIII	n_p	0.5	for effect area category II
adjusted probability number $N_{i,s} = N^*_{i,s} + n_l + n_o + n_p$	**$N_{i,s}$**	**5**	

and the frequency is $10^{-N_{i,s}} = 1 \times 10^{-5}$ per annum.

This F-N point (0.075 fatalities, 1×10^{-5} per annum) is below the (extrapolated) negligible societal risk criterion. This analysis assumes that the dangerous material is present as a liquefied toxic gas under pressure. It would actually be present as a solid or liquid at ambient conditions that would need to be mixed with an incompatible material such as acid for a hazard to exist. Given that stringent controls would be in place to segregate incompatible dangerous goods, it is likely that the actual frequency of hazardous events would be much smaller, probably by an order of magnitude. The probability of significant quantities of incompatible materials mixing is also small, so the estimated consequences are probably also conservative.

4.1.4 Class 6.1 – Toxic materials

Toxic materials such as cyanides and pesticides will be stored at the Facility and will be segregated and bunded in accordance with Australian Standards. The precise nature of the material in storage will be subject to continual change, but the presence of high toxicity material in liquid form is assumed in order to be conservative. Alternatively, the risk from combustion products should be considered in the event of a fire involving Class 6.1 material such as pesticides.

The material will be located in a bunded package store, so that the direct effect category for 60 tonnes of class 6.1 material is CIII. The effect distance is 50-100 m and the effect area (A) is 0.3 ha. The distance to the nearest boundary is 90 m, but only to the south, so the percentage of the affected area that is populated is 5%.

The consequences are estimated from:

effect area (effect category CIII)	A	0.3	ha
population density in the surrounding area	d	5	d persons per hectare
population correction factor	f_A	1	5% populated fraction
correction factor for mitigation for toxic liquids	f_m	0.05	
external consequences: $C_{a,s} = A \times d \times f_A \times f_m$	**$C_{a,s}$**	**0.075**	**fatalities**

The probability is estimated from:

average probability number for toxic liquid storage from Table IX	$N^*_{I,s}$	5	
correction for loading/unloading frequency from Table X(A)	n_l	-1.5	up to 500 loading and unloading cycles per annum
correction parameter for organisational safety from Table XII	n_o	0	conservatively assume to be average performance
correction factor for wind direction from Table XIII	n_p	1.5	for effect area category III
adjusted probability number $N_{i,s} = N^*_{i,s} + n_l + n_o + n_p$	**$N_{i,s}$**	**5**	

and the frequency is $10^{-Ni,s} = 1 \times 10^{-5}$ per annum.

This point F, N point (0.075 fatalities, 1×10^{-5} per annum) is below the (extrapolated) negligible societal risk criterion.

Although the estimated frequency is significantly above the criterion of 1×10^{-7} per annum below which a qualitative assessment is generally considered adequate, the consequence is much smaller than 1, and the frequency of any event causing serious off-site consequences is therefore likely to be much smaller than the estimated value.

The effect category for toxic combustion products (Ref No. 43, IAEA 1996) for 60 tonnes arising from pesticides is DIII, with an effect distance of 100 – 200 m and an effect area of 1 ha. The distance to the boundaries is between 90 and 110 m in three directions, and over 200 m in the fourth. The populated fraction of the effect area is therefore approximately 56%. The category III population correction factor is 1 for all populated fractions.

The consequences are estimated from:

effect area (effect category DIII)	A	1	ha
population density in the surrounding area	d	5	d persons per hectare
population correction factor	f_A	1	56% populated fraction
correction factor for mitigation for toxic liquids	f_m	0.05	
external consequences: $C_{a,s} = A \times d \times f_A \times f_m$	**$C_{a,s}$**	**0.25**	**fatalities**

The probability is estimated from:

average probability number for combustion products for Ref 43 from Table IX	$N^*_{I,s}$	3	
correction for loading/unloading frequency from Table X(A)	n_l	-1.5	up to 500 loading and unloading cycles per annum
correction parameter for organisational safety from Table XII	n_o	0	conservatively assume to be average performance
correction factor for wind direction from Table XIII	n_p	0.5	for effect area category III
adjusted probability number $N_{i,s} = N^*_{i,s} + n_l + n_o + n_p$	**$N_{i,s}$**	**2**	

and the frequency is $10^{-Ni,s} = 1 \times 10^{-2}$ per annum.

This point F, N point (0.25 fatalities, 1×10^{-2} per annum) is outside the area covered by the societal risk criteria, but falls within the extrapolated ALARP societal risk criterion.

4.1.5 Classes 6.2 and 8 – Toxic (infectious) and corrosive materials

No Class 6.2 (infectious waste) material will be accepted by the facility.

All storage and handling of Class 8 corrosive materials will be strictly in accordance with the relevant Australian Standards:

- AS3790 – 1994: The storage and handling of corrosive substances;
- AS3833 – 1998: The storage and handling of mixed classes of dangerous goods;
- referenced standards within those documents.

All materials in these classes will be tested and classified prior to acceptance at the Facility and retested on delivery by trained, technical staff. Details will be recorded to allow tracking of individual batches and to control processing, and all containers will be suitably labelled. Incompatible classes of materials will be segregated in storage.

Compliance with the Australian standards, together with implementation of the proposed testing, stock control and safety management systems, is considered adequate to ensure that the risk to persons located off-site is kept below the acceptable criteria, and that no significant risks will be created.

4.2 Cumulative F-N assessment for societal risk

The risk arising from each class of dangerous material is generally independent of risk for each other class, and the total risk is therefore considered additive. The exception in the case of the Rutherford operation is that Class 5.1 material might give rise to an explosive risk or a toxic release (depending on the nature of the material at any time and the initiating event), but probably not both together for any particular material. However, since the risk of a toxic release assumed only a single container of waste, the risk of a toxic release and an explosion of material up to the total inventory could exist concurrently. It is assumed that the risk from both may exist simultaneously at the maximum estimated levels for each.

It should be noted that this analysis does not take into account the potential for reducing the frequency of incidents that is afforded by applying above-average industry practices for risk management at the facility, which TPI proposes to implement. In addition the facility will be new and well documented. These factors would reduce the frequency by a factor of 3, but have not been included in order to be conservative in the screening process.

The ranking of risks by the number of fatalities estimated using the IAEA method is summarised in Table 4-3.

Table 4-3: Ranking of societal risks based on IAEA method

Hazard	Effect radius	Buffer distance	Consequences N	Frequency F
Class 2	Below minimum quantity		0	0
Class 3 – fire	25 m	25 m	0 fatalities offsite	3 x 10^{-7} pa
Class 5.1 – explosion	50-100 m	90 m	0.75 fatalities	3 x 10^{-6} pa
Class 5.1 – toxic	50-100 m	90 m	0.075 fatalities	1 x 10^{-5} pa
Class 6.1 – toxic	50-100 m	90 m	0.075 fatalities	1 x 10^{-5} pa
Class 6.1 – combustion products	100-200 m	90 m	0.25	1 x 10^{-2} pa

These F-N points are plotted in Figure 4-1.

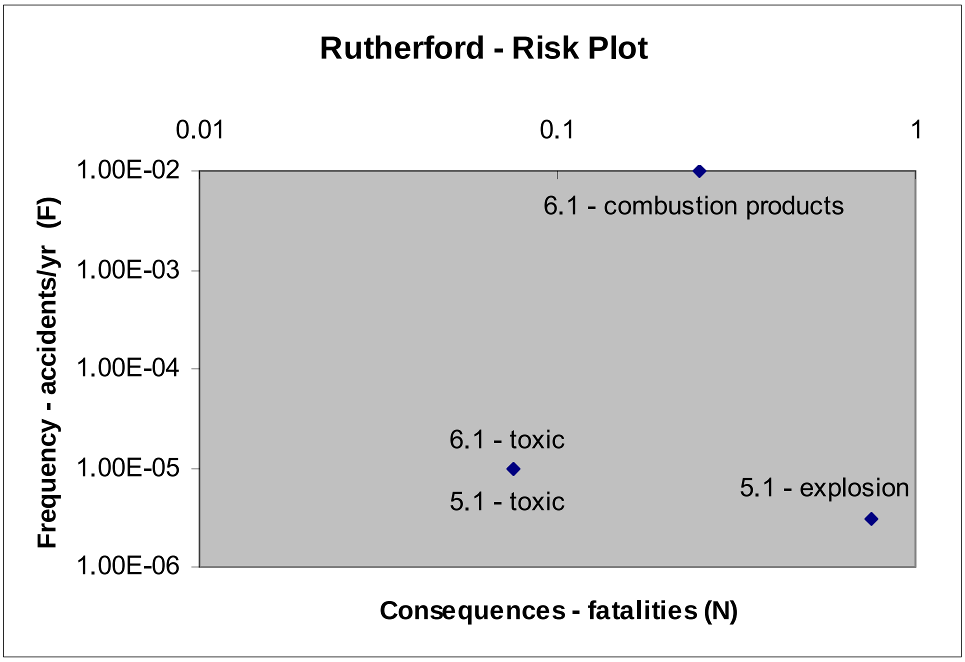


Figure 4-1: Risk plot for Rutherford facility

With no point having a value of N exceeding one, no event is likely to result in a fatality off-site, although the estimated frequency of events involving combustion products from Class 6.1 toxic substances is significant. The cumulative F-N data is plotted in the F-N curve shown in Figure 4-2. With all points below N=1, it is not clear how the F-N curve for the facility should be interpreted against the guideline criteria. The F-N curve indicates that there is only a small probability of a fatality per event as a result of relatively frequent events. Low consequence events are generally considered acceptable by society even where events are relatively frequent and the average rate of death is therefore similar to events with higher consequences but lower frequency.

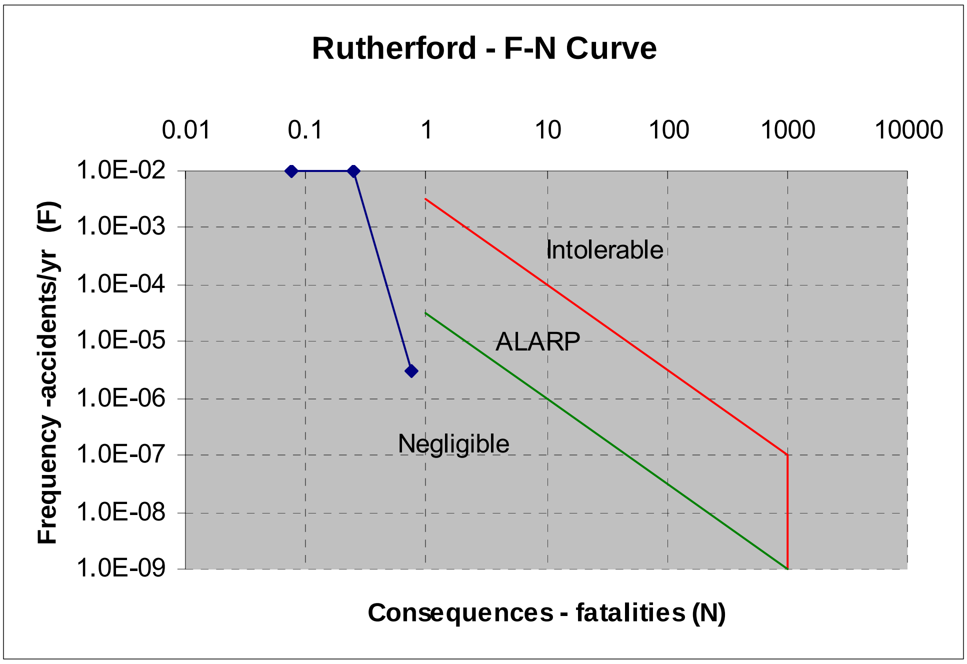


Figure 4-2: **F-N curve for Rutherford facility**

4.3 Summary of results against screening criteria

The IAEA analysis has indicated that the most significant estimated societal risk items are all of relatively low consequence but in some cases are likely to be quite frequent, and generally fall outside the societal risk guidelines. The risk of toxic combustion products from Class 6.1 toxic materials in the event of a fire is the most significant.

The analysis shows that events with consequences extending beyond the boundary and a frequency of more than once in 10^7 years are possible, so the risks can not be assumed to be negligible and further risk assessment is appropriate. However, the events with higher frequencies are seen to have relatively limited consequences in terms of the number of potential fatalities that might result.

The materials and processes are all well understood for the Rutherford plant. Transpacific Industries already operates similar resource recovery sites in other parts of Australia. The methane reforming plant is a unit designed and built by a specialist company in the USA. The hydrogenation plant is being designed by FFS in South Africa based on a plant operating successfully there. The significant risk items are seen to be material in storage and not the process plants. These risks must be managed by appropriate procedures and engineering. Technical staff will be based on site to ensure that appropriate testing and control procedures are observed at all times.

There are no sensitive land uses in the vicinity of the plant that would be affected by any off-site impacts. It would be expected that occupants of surrounding areas would be able to avoid any affects such as toxic emissions. Existing land uses are similar to the proposed facility.

4.4 Assessment against individual risk criteria

HIPAP No 4 – Risk Criteria for Land Use Safety Planning (DUAP 1997a) provides a criterion for risk of death to an individual in an industrial setting of 50 in a million per year (50 x 10^{-6} per annum). This assessment is undertaken for the "person most at risk", in this case assumed to be someone working in an adjoining premise close to the western end of the site where the process plant, tank farm and drum store will be located.

The total risk to an individual would not be likely to exceed the sum of the frequencies for all the different types of events assessed using the IAEA method, assuming a person most at risk located within the effect radius, or 1 x 10^{-2} per annum. These risks are repeated in Table 4-4 below. The sum of the estimated risks is approximately 200 times the criterion level, with almost all of this risk contributed by the emission of toxic combustion products from Class 6.1. The total of all the other risks is well within the criteria for individual risk.

Table 4-4: Estimate of individual risk

Hazard	Effect radius	Frequency
Class 5.1 – explosion	50-100 m	3 x 10^{-6} pa
Class 5.1 – toxic	50-100 m	1 x 10^{-5} pa
Class 6.1 – toxic	50-100 m	1 x 10^{-5} pa
Class 6.1 – combustion products	100-200 m	1 x 10^{-2} pa
Total		0.01 pa

4.5 Conclusions from the screening assessment

The classification and prioritisation assessment has shown that classes 2.1, 3 and 8 dangerous goods do not result in risks that are likely to extend beyond the boundary of the facility. However, classes 5.1 and 6.1 have the potential to create risks to people outside the site as a result of the possibility of explosion, toxic release and the generation of toxic combustion products.

Further assessment of these materials is therefore required and is described in the following section.

5. Further risk assessment

The classification and prioritisation assessment has shown that dangerous goods in classes 5.1 and 6.1, which will be stored at the facility, have the potential to create risks to people outside the site as a result of the possibility of explosion, toxic release and the generation of toxic combustion products.

The IAEA classification and prioritisation screening assessment has shown that consequences are generally very limited, with no event likely to cause an off-site fatality, mainly as a result of the separation distances and limited at-risk populations associated with the surrounding land uses. However, the estimated frequency of some types of events based on the IAEA methodology is quite high, with the risk from fires and associated combustion products from class 6.1 dangerous goods being the main contributor to the overall risk.

5.1 Combustion products from Class 6.1 goods

The estimated frequency of events involving combustion products from class 6.1 goods using the IAEA method (10^{-2} per annum) is consistent with a reported frequency of warehouse fires averaged across all sectors of approximately 10^{-2} per annum (HSE 2002).

The continually changing nature of the goods received and stored in the facility makes more detailed consequence modelling of limited value in estimating consequences for credible events. It is likely that the materials stored will include a range of organic and inorganic agricultural chemicals, together with industrial chemicals such as cyanides. However, the IAEA consequence and frequency estimates are generally the maximum likely for credible events. In practice, engineering and management controls will be important to reduce the frequency of events, escalation rates and severity.

The dominant causes of warehouse fires (HSE 2002) are typically:

- malicious ignition (arson)
- electrical faults
- friction heat and sparks
- careless disposal of smoking materials
- hot work including shrink wrapping
- malfunctioning fork-lift trucks
- truck fires
- spillage of incompatible chemicals
- storage of unstable compounds near to sources of heat
- ignition of spills of flammable liquids
- static ignition of flammable liquids during transfer operations

All these possible causes could be relevant to the Rutherford facility warehouse and should be addressed in order of importance.

The Rutherford facility would be expected to experience less than the historical average rate of fires in warehouses as a result of good design and operation including:

- continuously staffed site with appropriate security fencing and other systems to resist malicious attack
- fully renovated warehouse buildings with a new electrical system designed to meet relevant explosion protection (ExP) standards.
- no equipment operating in warehouses that might generate friction or other sources of heat and contribute to risk of ignition
- a strict smoking ban in all hazardous warehouse and process areas
- properly maintained equipment (such as fork lifts) suitable for the relevant hazardous area classification
- all incompatible dangerous goods classes properly and completely segregated with appropriate fire separation distances created and maintained (including use of fire walls etc where necessary) according to AS1940.
- all spills quickly and completely cleaned up
- no transfer operations in the warehouse area. All transfer operations via properly earthed systems
- no dangerous goods accepted unless in packaging complying with the ADG Code with steel drums preferred where possible to limit rate of spread of fire
- sprinkler or foam systems if indicated by the fire study
- fully bunded warehouse sections to limit the spread of fire and prevent the discharge of contaminated fire-water
- training for employees in correct equipment operation, accident prevention and emergency response including fire fighting

For the purpose of illustration, it has been assumed that the warehouse contains 30 tonnes of combustible Class 6.1 toxic agro-chemicals, 15 tonnes of chlorpyrifos and 15 tonnes of paraquat dichloride. These materials have the following characteristics:

Table 5-1: Characteristics of example materials of Class 6.1

Compound	MW	Formula	TEEL-2	TEEL-3
Chlorpyrifos	350.59	$C9\ H11\ Cl3\ N\ O3\ P\ S$	10 mg/m^3	75 mg/m^3
Paraquat dichloride	257.18	$C12\ H14\ N2\ Cl2$	1 mg/m^3	1 mg/m^3

TEELs are Temporary Emergency Exposure Limits (USDOE 2005). TEEL-2 is the maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action; TEEL-3 is the maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

For one tonne of each material, the combustion products would typically be:

Table 5-2: Products of combustion of typical Class 6.1 materials

Emissions from:	HCl kg	SO_2 kg	HCN kg	NO_2 kg	CO kg
Chlorpyrifos	297	183	3.9	6.6	36
Paraquat dichloride	270	0	10.5	17.9	65
Conversion of atomic species	0.95	1	0.05	0.05	0.05
TEEL-2	22 ppm	0.75 ppm	7.1 ppm	12.5 ppm	83 ppm
TEEL-3	100 ppm	27 ppm	15 ppm	20 ppm	330 ppm

If during the initial stages of a fire controlled by limited ventilation involving these materials the rate of combustion of each is 2500 kg/h, and the survival rate of the material in the smoke plume is 10% (HSE 2002), the rate of emission of each is 0.07 kg/s. A Gaussian plume dispersion calculation (AIChE 2000) assuming a neutrally buoyant smoke plume being emitted at 10 m above ground level gives the following estimates of concentration for two different Pasquill atmospheric stability classes, D and F.

Table 5-3: Examples of effect distances and concentrations of Class 6.1 materials

		Stability classes					
	TEEL-2/TEEL-3 (mg/m^3	D, wind 3 m/s, urban landscape			F, wind 2 m/s, urban landscape		
		distance to maximum	maximum conc.	conc. at nearest boundary	distance to maximum	maximum conc.	conc. at nearest boundary
Chlorpyrifos	10/75	50 m	46 mg/m^3	31 mg/m^3	90 m	59 mg/m^3	59 mg/m^3
Paraquat dichloride	1/1	50 m	46 mg/m^3	31 mg/m^3	90 m	59 mg/m^3	59 mg/m^3

These results are quite sensitive to the nature of the terrain: use of a rural setting (with lower roughness) results in a maximum of 39 mg/m^3 being reached at 120 m from the warehouse for stability class D, and 30 mg/m^3 at 470 m for class F, for both substances.

For paraquat, the ground-level concentration under the worst stability conditions (class F) fall to the TEEL-2/TEEL-3 level (1 mg/m^3) at a distance of 1750 m from the store. The nearest area zoned for residential use is located approximately 1500 m to the east. At this distance, the estimated concentration of paraquat would be 1.25 mg/m^3, slightly above the TEEL-2/TEEL-3 limit.

The results for combustion products are given below.

The ERPGs quoted are emergency response planning guidelines prepared by the American Industrial Hygiene Association, with similar definitions to TEELs (USDoE, 2005). TEELs are adopted for substances when no ERPG has yet been determined.

Table 5-4: Effect distances and concentrations of typical combustion products

		Stability classes					
	ERPG-2/ ERPG-3	D, wind 3 m/s, urban landscape			F, wind 2 m/s, urban landscape		
		distance to maximum	maximum conc.	conc. at nearest boundary	distance to maximum	maximum conc.	conc. at nearest boundary
HCl	20/ 150	50 m	17 ppm	12 ppm	90 m	22 ppm	22 ppm
SO_2	3/15	50 m	3.3 ppm	2.2 ppm	90 m	4.2 ppm	4.2 ppm
HCN	10/25	50 m	0.6 ppm	0.4 ppm	90 m	0.8 ppm	0.8 ppm
NO2	15/30	50 m	0.6 ppm	0.4 ppm	90 m	0.8 ppm	0.8 ppm
CO	350/ 500	50 m	4.0 ppm	2.7 ppm	90 m	5.1 ppm	5.1 ppm

Based on the assumptions made about the nature and quantities of materials involved and the resulting fire, it can be seen that off-site ground-level concentrations of surviving agrochemicals could be expected to exceed levels at which serious or irreversible health effects may occur, or affected persons might be rendered unable to take evasive action. Some combustion products (in this case HCl and SO_2) could also be at or slightly above these levels. With the exception of paraquat however, concentrations would not be expected to reach levels at which life-threatening health effects would be likely.

It should be noted that TPI staff have no memory of ever having accepted paraquat at any of their facilities, and receipt of a large quantity of such a highly toxic material, such as considered above, is considered most unlikely. Its use here is for illustrative purposes only, and its low exposure limits are therefore likely to represent a worst case scenario.

This consequence analysis does not attempt to do more than provide an example of one possible scenario for a fire involving flammable Class 6.1 materials (or other classes of combustible materials with a subsidiary risk class of 6.1). Because of the large number of variables involved and the continually changing nature of the materials likely to be held in the store, a rigorous analysis covering the full range of possible parameters is considered to be beyond the scope of a preliminary hazard analysis, and possibly impractical.

From the example given above however it is clear that significant levels of risk are likely to exist outside the Rutherford facility as a result of the storage of Class 6.1 materials. This is a situation that is likely to apply to a significant number of facilities manufacturing or storing materials such as agrochemicals in many locations. The risk for the Rutherford facility will be limited by a combination of engineering and procedural controls to limit the frequency of fires and their consequences using the methods described above.

5.2 Toxic release from Class 6.1 goods

The frequency of events giving rise to toxic releases of Class 6.1 goods (other than as a result of fire), is much smaller than for events involving fire, using the IAEA method (1×10^{-5} per annum for a direct release compared to 1×10^{-2} per annum for fires). The consequences are also less, with 0.075 fatalities per event for a direct release, compared to 0.25 per event for fires.

Although the precise nature of the materials stored can not be detailed because of the continually changing nature of wastes likely to be accepted by the facility, it is generally not expected that significant quantities of materials with high volatility would be involved.

Provided material is kept in appropriate packaging and migration routes for spills (principally drainage paths from storage and handling areas) are kept secure, it is not likely that either the frequency of events or the consequences would exceed the risk from fire, which has been analysed above. This conclusion is arrived at given that, although much material involved in a fire is combusted, the rate of release of the original material is likely to be much larger than for any other credible event involving lower volatility substances, and at least during the initial stages of a fire there is a substantial fraction of the original material that survives. In addition, the combustion products are themselves hazardous.

A direct release that is likely to have any significant off-site impact will typically require failure of packaging (either as a result of faulty packaging or damage to packaging during transport or handling); incorrect packaging for the material involved; and potential for reactions between incompatible materials.

Many of the control measures needed to minimise the risk of fire are also appropriate to a direct release. In particular:

- continuously staffed site with appropriate security fencing and other systems to resist malicious attack
- properly maintained equipment (such as fork lifts) to minimise the risk of damage to packaging
- all incompatible dangerous goods classes properly and completely segregated
- all spills quickly and completely cleaned up
- no transfer operations in the warehouse area
- no dangerous goods accepted unless in packaging complying with the ADG Code, with steel drums preferred where possible to limit potential for damage and leakage
- fully bunded warehouse sections to limit the spread of leaked material.
- training for employees in correct equipment operation, accident prevention and emergency response to leaks and spills

With the relatively low frequency and consequences estimated using the IAES method, no further analysis of storage of this class of goods is considered necessary.

5.3 Toxic release from Class 5.1 goods

As previously detailed, the inadvertent mixing of incompatible dangerous goods can lead to a release of toxic material. The most likely scenario is considered to be the mixing of a material such as calcium hypochlorite with an acid, releasing chlorine. A cyanide salt and an acid reacting to form hydrogen cyanide is another credible scenario. The IAEA method was applied as if the material concerned was a high toxicity gas under pressure. This includes the inference that the material would be released relatively quickly, rather than involving a slow release similar to the boil-off of a liquid under pressure when released.

Except in the case of a transport-related accident involving incompatible classes of goods (not necessarily on the same vehicle), the most likely scenario is of a single container of (for example) calcium hypochlorite spilling and mixing with an acid. This should only happen if testing, labelling or segregation procedures break down and a substantial leak subsequently develops involving the both incompatible materials. The probability of large quantities of incompatible goods coming into contact is therefore considered relatively remote. If such contact did occur, a release of up to 200 kg of chlorine appears credible (if unlikely) as a result of 80% of a 500 kg container of calcium hypochlorite reacting with acid.

Since it will require some time for the incompatible materials to mix and react fully, it is assumed that the release occurs at ground level over a period of 5 minutes, a release rate of 0.67 kg/s. As it is more likely that an incident of this sort would occur during normal working hours, Class C stability will be assumed, with a wind speed of 2 m/s in an urban setting. The concentration at the boundary (90 m from the store) under these conditions would be 104 ppm. This is over five times the TEEL-3 of 20 ppm. However, calculation of the probability of a fatality as a result of exposure to 104 ppm chlorine for 5 minutes is less than 0.1% based on the probit equation (AIChE 2000). A shorter, more rapid generation of chlorine would result in an exposure at the boundary of 208 ppm for 2.5 minutes, which would result in a 0.4% probability of fatality. An exposure of 500 ppm for 10 minutes representing the release of a much larger quantity of chlorine would result in a 60% probability of fatality. This would be equivalent to 80% of a 5 tonne load of calcium hypochlorite reacting with acid to generate 2 tonnes of chlorine within 10 minutes. This scenario does not appear credible.

Any release of chlorine would be amenable to mitigation by water sprays or fog to knock down chlorine, and use of alkaline materials to neutralise the acid and/or assist in absorbing and neutralising the chlorine being generated. Similar methods can be used for other toxic vapours. Such methods should only be used however by persons properly trained and practised in emergency response. An emergency response plan will be developed, and TPI will provide staff with all the necessary training and personal protective equipment needed for its implementation.

5.4 Explosion of Class 5.1 goods

Goods classified as explosives (Class 1) will not be accepted at the facility. However, some goods in Class 5.1 such as ammonium nitrate can explode under certain conditions. Contamination, particularly with organic material and some metals, may result in spontaneous combustion and/or explosions. Some contaminants sensitise these materials to shock, friction or heat. Confinement will increase the risk that they explode rather than deflagrating or simply burning. (The distinction between explosion and deflagration is unlikely to be very important in determining consequences).

The IAEA method suggests a frequency for explosions of 3×10^{-6} per annum. This is within the range for individual risk considered acceptable for industrial land use under the planning guidelines (DUAP 1997a).

It is assumed that approximately half of the maximum quantity (60 m^3) of Class 5.1 material would be potentially explosive ammonium nitrate. This would give a maximum quantity of perhaps 30 tonnes of ammonium nitrate.

There is evidence that a stack of less than 300 tonnes of ammonium nitrate will not detonate unless involved in a fire and subjected to an initiating shock (HSE 2002).

For the purpose of estimating the consequences of an ammonium nitrate explosion, it is assumed either that contamination of at least a part of the 30 tonne inventory has been sufficient to sensitise it or that it is involved in a fire, and that some initiating event such as falling debris or a high speed missile provides the initiating event to trigger the explosion or deflagration.

For ammonium nitrate, a typical TNT equivalent model is generally used. Ammonium nitrate has a TNT equivalence of approximately 10-15% allowing for both the released energy and efficiency of the explosion or deflagration. For a 30 tonne inventory, the TNT equivalent is therefore approximately 4 tonnes. The scaled distance (AIChE 2000, HSE 2002) at the nearest site boundary (90 m) is

$$z = 90 / 4000^{1/3} = 5.67 \text{ m.kg}^{-1/3}$$

This scaled distance results in a peak overpressure of 35 kPa, which is sufficient to cause severe general structural damage and potentially require demolition of some buildings, and to cause serious damage to plant, including potentially the rupture of oil tanks. At this level there is an approximately 50% risk of fatality for anyone in a conventional building, and a 12% chance of fatality for someone in the open. The overpressure at 200 m from the store would be approximately 11 kPa, which would be enough to destroy some buildings and make some structures uninhabitable, but the risk of fatality for anyone in a building would be only about 5%, and the risk to people outside would be almost zero.

Based on the estimated IAEA frequency for explosions of 3×10^{-6} per annum, the most-at-risk individual is exposed to a risk of 1.5×10^{-6} per annum at the plant boundary, which is well within the planning criteria of 50×10^{-6} per annum.

The domino effect on other sections of the plant would be particularly important in the case of an explosion. Standard separation distances will not be sufficient to limit damage to other plant. Large storage tanks could be ruptured and the process plant could be seriously damaged, leading to the potential for serious fires. It has already been shown in the screening process that the quantities of flammable and combustible materials are not sufficient to create a major risk outside the site. However, an explosion could result in multiple fires and also damage to systems such as fire-water mains, which might result in an escalation of the risk.

6. Risk management

The principal methods by which risk might be reduced for the operation include:

- elimination or reduction of dangerous material inventories
- moderation of process conditions (temperature, pressure)
- substitution of dangerous materials with less dangerous materials
- separation of hazardous process plant and storages from other parts of the operation, protected works etc.
- management systems (policies, procedures etc)
- engineering controls

The types of dangerous goods accepted by the Rutherford site will be limited to those materials that can be stored and handled safely by the equipment and systems in place. The process plant has been designed to meet relevant engineering standards, and should therefore be capable of safe operation with the appropriate engineering and management controls in place. Inventories are intended to provide operating flexibility without significant risk. The plant design is generally compact, and equipment items in plant areas operating at high temperature and pressure do not have large process inventories.

Dangerous goods storage inventory for the Rutherford operation is largely dictated by the flows of waste materials being received and the rate at which they can be processed, consolidated and dispatched. Maximum quantities of all dangerous goods in storage have been specified, and the risk assessment indicates that these will not result in an unacceptable level of risk for the surrounding areas for any classes of dangerous goods, except perhaps for the risk arising from combustion products from Class 6.1, however, as discussed in Section 5 the consequences are very limited with no one event likely to cause an off-site fatality. Surrounding land uses and the distance of the facility from residential areas means that it is unlikely that a fatality would result from such an event. These risks must be managed by appropriate procedures and good engineering design. Facilities storing similar materials are not uncommon, and the Rutherford facility will be designed and operated to meet the best practice for such facilities.

The main hazards affecting the process plant that might lead to off-site risks are fire, toxic release and explosion. The layout of the plant has been designed in accordance with the separation distances required under AS 1940:2004 – The storage and handling of flammable and combustible materials, and with consideration for AS 2430:2004 – Classification of hazardous areas, to minimise the risk of fire or explosion in either the process plant or any of the storages from resulting in significant off-site risks. The principal separation distances required are given in Table 6-1. Distances have been calculated based on oil storage tank diameters of 5 m (100 kL process tanks) and 7 m (450 kL storage tanks). Minor variations would be required for different tank sizes.

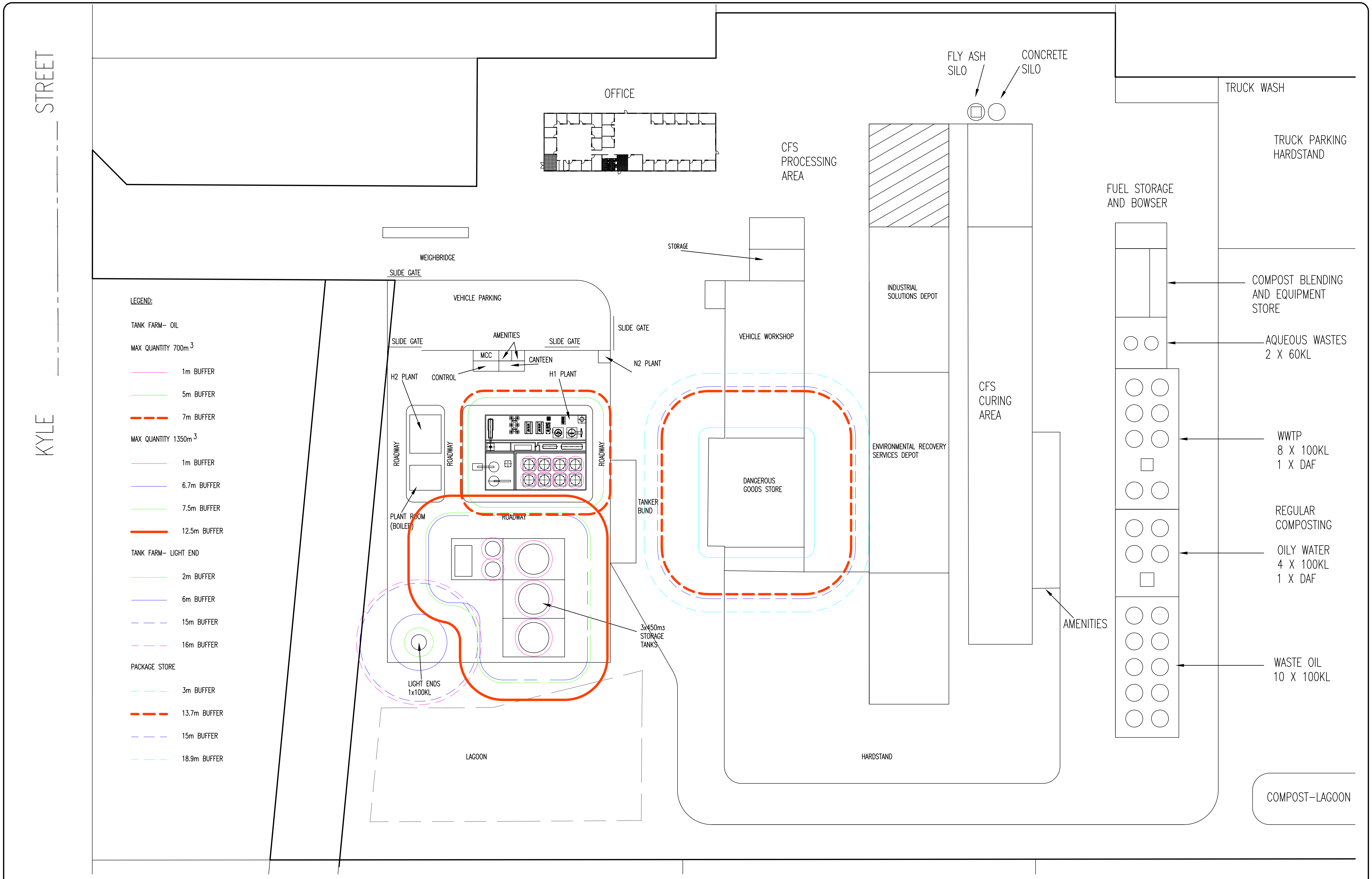
All these requirements are met fully and comfortably with the proposed process plant, tank farm and package store layout.

Table 6-1: Separation distances required by AS 1940

Material and class	Maximum quantity	Minimum distances (m)					
		Between tanks	To fill points, package storage	To process areas, warehouses	To security fence	To off-site protected works	To a public place
Tank farm							
Waste or refined oil	700 m^3						
C1 or C2		1	5	7	5	7	
Waste or refined oil	1 350 m^3						
C1 or C2		1	6.7	7.5	6.7	12.5	
Light ends	100 m^3						
Class 3 PG II		2	6	15	6	16	
Package store							
Class 3	600 m^3				15	18.9	3 (8*)
Class 3 PG I	60 m^3			13.7	13.7	13.7	3 (8*)

* 8 m required if the storage includes a decanting area.

The requirements of AS 2430:2004 are readily met on the Rutherford facility by conforming to AS 1940:2004 and providing in addition an appropriate exclusion zone for all ignition sources (including vehicles) in the hazardous areas in and around the process plant, tank farm, tanker loading and unloading points and package stores. Refer to Figure 6-1.



REV	DESCRIPTION	DATE	APPROVED

Scale A3 ORIGINAL

5 0 5 10 15 20 25 Metres

Scale 1 : 750 A3

Drawn	Date
Designed	
Drawing Check	
Design Check	
Project Approval	

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Project
RUTHERFORD RECYCLING FACILITY
SITE LAYOUT

Job No
2118506A

Drawing No
001

Cad File
2118506A

Rev
13

7. Conclusions

The proposed Rutherford resource recovery facility is a potentially hazardous industry under SEPP 33 – Hazardous and Offensive Development, and a preliminary hazard analysis has therefore been undertaken as part of the environmental impact assessment supporting the planning application.

The facility will accept, store, process and dispatch a range of dangerous goods including Class 3 flammable liquids, Class 5.1 oxidising agents, Class 6.1 toxic substances, and Class 8 corrosive substances, as well as combustible liquids. It will generate and use Class 2.1 flammable gases under pressure, but will not store any Class 2.1 material.

Initial hazard identification indicates that the most significant risks arising from the plant are likely to involve fire, explosion and toxic releases. Other hazards could arise, but are not likely to result in any risk outside the site boundaries. It is not expected that the transport of goods to or from the facility would result in any significant increase in risk to the public along the routes taken, although the movement of any Class 6.1 dangerous goods requires particular attention.

The quantities of Class 3 dangerous substances handled on the site are below the SEPP 33 screening quantities. The maximum quantities of Classes 5.1, 6.1 and 8 dangerous goods that would be stored at the facility, and the estimated maximum quantity of Class 2.1 dangerous goods present in the process plant, exceed the SEPP 33 screening thresholds, and these classes have been subjected to further analysis using the IAEA categorisation and prioritisation method.

An assessment using the IAEA method as recommended by the Department of Planning guidelines has confirmed that Class 3 dangerous goods are not a serious risk, and that Class 8 is also not a high risk priority. It has shown that societal and individual risk levels are likely to be below the guidelines for fire and toxic releases of Classes 5.1 and 6.1 both separately and in aggregate. However, societal and individual risk from toxic combustion products from Class 6.1 material are likely to be higher than planning guidelines. Warehouse fires are relatively frequent events, and a fire involving Class 6.1 materials might result in concentrations of toxic compounds exceeding safe levels outside the site boundary, depending on the nature of the material in storage at the time.

Further quantitative risk assessment has been undertaken to confirm the likely consequences of specific hazards associated with Class 2.1, 5.1 and 6.1 materials. This has confirmed that fires involving Class 2.1 flammable gases are not likely to have an effect radius extending beyond the site boundary; that the consequences of explosions or toxic releases from Class 5.1 materials is not likely to be significant; but that the combustion products from a fire involving Class 6.1 materials could extend well beyond the site boundary with significant risk of serious injury. It should be noted that warehouses handling materials of this sort are not uncommon. The location of the Rutherford facility in an industrial area, with no areas zoned for residential use within 1500 m, minimises the societal and individual risk because the occupancy is relatively low, there are no nearby locations where large numbers of people are likely to congregate, and all potentially exposed people in the area are likely to be mobile and able to avoid exposure to toxic .

Risk management systems including relevant Australian standards, design codes and company procedures are available and will be implemented as part of the design and operation of the facility to ensure that its operation will not expose persons living or working in the area to unacceptable levels of risk.

8. References

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Appendix A

Hydrogenation plant HAZOP

Appendix A

Hydrogenation plant HAZOP

Hazard Assessment Report for

Waste Oil Processing & Bulk Storage Tank Installation

and

Proposed Hydrogenation Plant

at

16 Herschensonn Road, Mason’s Mill, Pietermaritzburg

for

FFS Refiners (Pty) Ltd

REPORT 1 of 2

Revision 6, September 2004

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Important Notice

The information accumulated for analysis purposes, as contained in this and other documents pertaining to the assessment of hazard and risk at the bulk storage installation situated at 16 Herschensonn Road, Mason's Mill, Pietermaritzburg, KwaZulu Natal is privileged and confidential and may not be used or communicated in any way without the written consent of Messrs. FFS Refiners (Pty) Ltd.

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The assessment has been performed in good faith, based on the premise that all information is accurate and has been supplied in good faith by the employers as noted above. This assessment must be repeated every five years if the facility is declared a MHI, before any change to processes is planned or introduced, or if a major incident has occurred.

Signed ___________________________________ **Date** _______________________

Barry Coetzee (Pr.Eng. Reg Cert Eng, MBL)

TABLE OF CONTENTS

Executive Summary (PMB)

The **aim of the hazard and risk assessment is to assist the company to conform to statutory and organisational requirements** of the *Major Hazard Installation (MHI) Regulations* and of the *Occupational Health and Safety (OHS) Act (Act 85 of 1993, as amended)*. The assessment was performed in conjunction with the representatives of the employers, as **generally contemplated in Section 8** of the *OHS Act*, and specifically **in accordance with the requirements of the *MHI Regulations*.**

This hazard assessment is the first of a two-part assessment, and has been performed at the request of the owners and operators, FFS Refiners (Pty) Ltd. The report describes the outcome of **an assessment of potential hazards and risks that could be associated with the existing oil processing (refining) and aboveground and underground bulk oil storage installation and its related processes** situated at 16 Herschensonn Road, Mason's Mill, Pietermaritzburg, KwaZulu Natal. The general area is zoned for industrial land use, but has also seen a proliferation of informal dwellings in the immediate vicinity.

FFS Refiners is also planning the **construction and operation of a hydrogenation plant** that will **include an electrolytic hydrogen manufacturing installation** that will produce hydrogen gas that will be used in a process to make the rerefining process of waste oils (Polyoil) received from Sasol more economical. This preliminary hazard and risk assessment will be done according to information that has been made available by the FFS.

The **hazard and risk assessment process** methodology is set out in **Annexure A**. The assessment **methodology** conforms to the **Guidelines set out in *SANS 10089, Part 1 (1999), Annex A***, in order to produce supporting documentation as part of the complete pre-construction risk assessment of the planned bulk storage facility. **Site visits on 17 October 2003**, and on **27 August 2004** and various follow-up consultations with FFS representatives were used to collect data regarding the current and new plant design and planned lay-out, processes, staffing, operating and maintenance procedures, training and related systems on site. The final EIA Report by Walmsley & Associates was also consulted.

Annexure B sets out a checklist of **documentation that was requested as part of the assessment**, and which also **forms the basis of a health, environmental and safety management system** that is used at the premises **to control hazards and limit the operating risk to a reasonable and acceptable minimum**.

Conclusions and Preliminary Recommendations (PMB)

Current Installation

From **observations made during the site visit**, and an evaluation of available documentation, **the current plant's hazard and risk levels appear to be acceptable**. Without having done a detailed inspection of equipment, the installation's current condition appears to be satisfactory and the equipment in a safe working order, with statutory inspections being up to date.

From the review with the local branch manager and plant manager, and the assessment of the applicable documentation, it is apparent that FFS is an established company in the oil industry, and has well-documented procedures that have been incorporated in an ISO 14001 Environmental Management System (EMS).

The EMS is used to reduce and control the on-site hazards as far as possible. The operational staff members who were interviewed with regard to plant and process operation appear to be knowledgeable and well-versed, and have been trained in the use and application of these procedures.

For the **current installation, the following is specifically recommended**:

1. All currently installed critical valves and emergency shut-off switches must be marked;
2. A simple Process & Instrumentation Diagramme (P&ID) must be drawn up as part of the SOP's (which should be available to train new staff), which can also be included in the Emergency Response Plan for training purposes;
3. The critical valve and shut-off switches, together with other emergency information must be added to a drawing that can be included and used for training and emergency response purposes;
4. The upgrade of the soil floor to seal the floor in the large bund must continue;
5. SOP's and other procedures that are part of the company's ISO 14001 EMS should be amended with the above and other relevant information to ensure that the SOP's are specific to the FFS Pietermaritzburg installation;
6. The emergency response procedures must be adapted to be site-specific (similar to the SOP's where critical valves and equipment are marked and noted in the documentation).
7. A hotwork permit system must be applied rigorously to minimise spark generation in hazard zones – conservatively, the whole site, excluding the office block, should be considered hazardous and this procedure should be applied to ensure that especially third party contractors are alerted to on-site hazards and hazardous conditions that may arise while they work;
8. The policy and procedures regarding the use of cellphones in and adjacent to the hydrogen and hydrogenation plants must be applied rigorously by all staff, in conjunction with appropriate warning signs. This is particularly relevant when visitors have to enter these areas of the plant.
9. Whenever product/slops transfer takes place, this must be done with the driver or a supervisor in attendance and only after all safety precautions have been effected;
10. Sufficient foam for fire fighting must be kept in stock on site as a means of an efficient first line response to a bund or process fire.
11. Steam lances must be readily available at strategic places in the hydrogen and hydrogenation plants as a means of first line response to a fire involving leaking hydrogen.
12. The routine maintenance programme for all key equipment must continue to be applied to control and reduce the hazards and risks due to potentially poorly or under-maintained equipment and plant;
13. Electrical equipment in hazardous areas must be included on a register that is to be tested and inspected every two years, by a person who should be a "competent

person" (as defined per the Electrical Regulations and the OHS Act) – the register must be signed off by the person performing the inspection;

14. Electrical bonding/earthing equipment at the tanker loading rack must be tested for electrical continuity on a regular basis (every six months) as part of the maintenance and prevention programme;
15. Lightning protection equipment/measures must be installed at the hydrogen plant.
16. The age of the second-hand tanks (the majority on site) is uncertain – a non-destructive tank testing and inspection cycle should be considered and initiated as a precautionary measure to prevent unexpected tank shell failure in the future.
17. In general, it has been noted that injuries are recorded as per the General Administrative Regulations of the OHS Act, but are not recorded as an EMS non-conformance incident. Injuries are not "environmental", and are thus excluded from the EMS's non-conformance criteria. Technically, this is inconsistent with general incident and loss prevention practice. For consistency, however, it is recommend that injuries be included as part of non-conformance procedure.

New Installations (Coil Lube Cracking Plant)

FFS is proposing to install a coil lube cracking plant that will have a positive reduction on the current level of risk, as the equipment will be new and will be replacing the high temperature stills. The same recommendations regarding SOP's and the marking of emergency equipment are applicable here.

New Installations (Hydrogenation Installation)

A hydrogenation installation that will include a small hydrogen plant is also being planned for construction and use. This plant will increase the hazards and risks to employees and the public and non-employees in the immediate vicinity. It is recommended that if the installation's establishment is approved by the respective authorities:

1. The new installation/plant must included in the EMS, and the relevant SOP's be generated;
2. All new critical valves and emergency shut-off switches must be marked;
3. The emergency response procedures for the new plant must be adapted to be site-specific (similar to the SOP's where critical valves and equipment are marked and noted in the documentation);
4. SCUBA equipment placed at strategic places and gas release monitoring and alarm equipment will be essential to safeguard staff;
5. Emergency shut-down equipment, either controlled by remote (electronic or computerised) or manual means, must be positioned in easily accessible places that will allow staff to act within the shortest possible time of an emergency occurrence;

6. The control and early warning/monitoring equipment must be added to a strict inspection and maintenance schedule to ensure that plant integrity and general safety can be maintained at the highest possible level;
7. Expert supervision and training will be essential for at least six months to establish the competence of the local operating staff with the new system that should be aimed at "zero-tolerance" of incidents;
8. Use of the process must be strictly limited to the operability of the process control and monitoring equipment - a "stop production immediately" procedure must be introduced if daily inspection or operational monitoring indicates that any part of the hydrogenation plant is compromised and will compromise health or safety;
9. A new certificate of operation will have to be issued by the Pietermaritzburg Fire Department, if the by-products of the hydrogenation process are considered and are to be stored on site (even temporarily).
10. It will be incumbent on the Pietermaritzburg metropolitan municipality to ensure that residents of the informal settlement that borders directly on the FFS facility are relocated to an area that will reduce health and safety risks. The local authority must also ensure that any future residential development does not encroach on the industrial area that might create hazards to the general public, which do not currently exist. FFS will have to start a formal process to notify the municipality of its duties in terms of Town Planning Ordinances and statutes, and the MHI Regulations to ensure that it becomes a matter of public record that will result in the necessary steps be taken to avoid the encroachment.

1 Assessment Methodology

FFS Refiners (Pty) Ltd operates an oil processing and a bulk storage tank installation on an existing site, zoned for industrial use, at 16 Herschensonn Road, Mason's Mill, Pietermaritzburg. The installation is situated about 4.5 km south-west of the main hub of Pietermaritzburg, approx 2 km north-east of the closest residential area of Imbali, about 2.5 km east of Ashdown, and about 3 km north-north-east of the Edendale township and Edendale Hospital. The methodology for assessing hazards and estimating the associated risks at an existing installation and a proposed plant is set out in **Annexure A** and entails:

1. **Reviewing the lay-out of plant and equipment** to assess regulatory compliance and the incorporation of mitigation measures as far as possible;
2. **Reviewing the newly established hydrogenation plant, processes, hazardous chemical substances (HCS's) and procedures, which include a second-hand hydrogen plant** to assess potential hazards with a view to mitigating these as far as possible for statutory compliance measures;
3. **Reviewing existing processes** associated with **HCS's** – this includes storage, transfer, handling, manufacture, transportation, use and waste disposal;
4. Understanding the **inherent hazards of the hazardous chemical substances** (HCS's) that could cause potential harm to humans and the environment;
5. **Reviewing the mitigation measures**, such as spill containment and fire fighting equipment and infrastructure;
6. **Gathering the relevant information** regarding:
    a. neighbouring installations and their staffing levels;
    b. environmental aspects, such as vegetation, water and the weather; and
    c. residential areas and other high density public places;
    d. public movement, including traffic patterns that could contribute to hazards and/or incident magnitude or that could be affected;
7. Considering **potential energy and ignition sources, including surrounding vegetation that would increase the fire risk;**
8. Compiling potential **major incident scenarios** due to operating equipment, transferring, transporting, using, storing or manufacturing hazardous chemical substances;
9. Performing an **estimation of incident consequences and the probability** of an incident occurring to pronounce on the status of the installation as an MHI.

This **hazard assessment has key areas of focus** that are not aimed at the lower level job-related hazards that employees could experience – these are not part of the base assessment of hazard, although, if encountered, were highlighted and discussed with management. The main focus is to review:

1. **the existing installation,** processes, the plant and equipment involving the HCS's currently being handled, transferred, stored and processed, and the associated hazardous conditions that give rise to risk;
2. **the proposed coil lube cracking plant; and**
3. **the new hydrogenation plant (including a second-hand electrolytic hydrogen manufacturing plant),** processes and associated risks.

2 Application of Statutory and Regulatory Requirements

In order to ensure that either by design or for the operation, and as part of the OHS Act S.8's intended hazard reduction measures, all the **necessary statutory and regulatory requirements are complied** with, an on-site consultative session was conducted with the FFS plant manager during visits to site on 17 October 2003, and 28 August 2004. Various follow-up communications with FFS staff also informed the review:

The **aims of the hazard review exercise** are:

1. to inform the risk assessment of all **potential hazards and impacts related to the operation involving HCS's;**
2. to establish whether the hazards of the **plant according to existing equipment lay-out,** have been minimised **by design and mitigation measures;**
3. to establish whether the potential hazards of the **lay-out of a new hydrogenation installation, including a second-hand hydrogen plant and equipment** have been minimised **by design and additional mitigation measures;**
4. to ensure that the **operating processes and procedures (current and future), and emergency response procedures** are adequate to minimise human and environmental health and safety risks on the premises, as well as the risk posed to surrounding populations, installations and the general environment.

As far as could be ascertained, the application for, and issuing of an operating certificate for the current installation by the Pietermaritzburg Fire Department was underpinned by the company's design engineers or agents applying the appropriate **SANS Codes of Practice (notably SANS 1010089, 10108, 10142, 10228, 10263 and 10400),** as well as instituting good operating and safety practice that is commonly used in the petro-chemical industry.

The HCS substances and their **associated hazards** are listed in **Annexure C**. The necessary **Material Safety Data Sheets** are appended in **Annexure C**, and cover the HCS's that are or will be used, transferred to/from or stored on site.

3 Description of Installation and Key Processes

3.1 Process and Storage Installation

The Pietermaritzburg plant was established circa 1979. **FFS has been operating the plant since 1989**, with various additions being made since the original plant was established. The most notable is the construction of two additional vertical aboveground bulk storage tanks (AST's) and a bund about seven years ago.

The **current plant, equipment and facilities** at the Pietermaritzburg installation include:

1. Various waste, process and product tankfarms and bunds, incorporating 20 vertical aboveground storage bulk tanks (AST's) (detail list shown in Annexure D);
2. Eleven underground storage tanks (UST's) for oil;
3. Bulk truck loading rack (overhead loading and bottom off-loading BTLR);
4. Boiler installation, consisting of 2 oil-fired steam boilers,
5. Two waste oil processing plants, which include centrifuge, filtration, evaporation, high temperature distillation, stills, vacuum, cooling towers equipment;
6. Oily water separator (OWS) linked to general area and bunds by inverted rectangular drainage;
7. Various catchpits and containment drainage;
8. A complex consisting of small quality testing laboratory, where process samples are tested, a flammable liquid store and toilets and a change room;
9. Compressor room and filter press;
10. Electrical installation, including transformers and MCC Control gear;
11. A control centre where the process is controlled with computerised PLC equipment;
12. An effluent settling tank and treatment plant (using Dissolved Air Flotation, or DAF biotechnology - on trail at present);
13. An office complex;
14. A perimeter wall of approx 3 metres high with two entrances (both leading into Herschensonn Road, equipped with electric gates and manned by a security guard on a 24-hour basis).

3.2 Key Processes (Current)

The key **processes involving HCS's at the Pietermaritzburg** installation involve **receiving various types and grades of waste oil** by means of bulk road tankers, and are **stored in bulk AST's**. The oils include used lubricating oil, and other waste oils from a number of suppliers, notably including SASOL.

Depending on the nature and source of the incoming oil, the **used oil is processed (thermally cracked) through dehydration** to reduce the water content to a minimum, cleaning/filtering, high temperature vacuum distillation, and blended to produce a range of low-sulphur furnace fuel oils (Light Oil, Heavy Furnace Oil or Industrial Burner Oil) that are stored in bulk storage tanks on site, before being **transferred to bulk road tankers for resale** in the local market.

The **hazardous installation currently consists of a waste oil processing (refining) plant**, where used **lube and waste oils are processed by steam-heated evaporation, filtration, and high temperature vacuum distillation equipment**. The plant also produces coating oil where wax is melted and blended with a light oil. The processes are summarised in **Table 3.1** and are described with some detail further on:

Table 3.1: Key Processes at the FFS Pietermaritzburg (Current)

• Unload waste oil from bulk road tankers (30 000 to 40 000 litre capacity per vehicle) at a bulk truck loading rack (BTLR) and transferring to bulk aboveground storage tanks (AST on-site total capacity 8 476 m^3);
• Settling and emulsion breaking;
• Evaporation at elevated temperature to remove water;
• High temperature vacuum distillation through one of the existing two plants;
• Caustic wash to remove other contaminants;
• Filtration to improve quality of product;
• Blending of oils to produce final product grades;
• Transferring processed oils to AST's;
• Separate contaminants from process effluent in OWS, storing and transferring contaminated (hazardous) waste for onward disposal at a class H:h waste disposal site (Shongweni, near Durban) by a licensed contractor (Waste Tech);
• Releasing effluent to stormwater system after quality testing;
• Loading of final products into road tankers for delivery to customers

Reticulation and transfer equipment is part of the installation used to move product and waste oil to and from bulk road tankers. During processing, **intermediate products are passed through a variety of aboveground process tanks**. The **process tank areas** have non-impervious concrete floors with bund walls to contain possible spills. On completion of various the various key processes, **products are stored in AST's and UST's in twelve separate bunded areas.**

The storage tankfarm and process areas **contain 41 vertical ASTs, and nine UST's,** where waste oil and refined oils of various grades are stored. The **total process and storage tank capacity of 8 342 m^3**, with a current average operating thru-put of 4 450 m^3 per month (about 53% of capacity).

The **two largest (and newest) tanks** on the property are situated in the main storage tank farm, **each with a capacity of 2 121 m^3 (or 51% of the total tank capacity on site)**. This tank farm has a bund with a soil floor and has soil bund walls that **comply with SANS 10089 Part 1 (1999)**. There are plans to seal the soil floor in the future.

The **tank farms, the road tanker loading rack, and the process plant area are all linked via containment drainage to an OWS and effluent treatment plant**. A bio-degrading effluent treatment plant intended for cleaning contaminants from the waste water is being tested using short trial runs at the moment. Treated and cleaned process and rainwater effluent is released to the municipal sewer system. Regular quality testing ensures that effluent standards are met to prevent damage to the environment.

Contaminated solid waste produced during the process, is filtered and separated, stored temporarily and then collected by Waste Tech, a licensed contractor, and disposed of at Shongweni, north of Durban, a registered class H:h waste disposal site. Liquid oily wastes are returned to the process for further recovery of oil.

Other facilities on-site include a storage area, **a small quality-testing laboratory**, where process samples are tested, a **boiler installation**, consisting of an oil-fired steam boiler, and an office complex. The installation is equipped with a **dedicated fire fighting system** that deploys foam via strategically-placed delivery equipment, as well as various well-placed dry powder chemical fire extinguishers.

4 Current On-site Processes

4.1 Product/Waste Oil Transfer to/from Bulk Road Tankers

In overview, the **transfer of product to/from bulk road tankers** at the bulk truck loading rack (BTLR) at the FFS Pietermaritzburg installation entails:

- Park vehicle and secure (handbrake up, spring brakes activated, chock wheels);
- Engine off;
- Electrically earth/ground vehicle, using earthing/bonding cable;
- Place handheld dry powder chemical (DPC) fire extinguishers in position;
- Loading to be undertaken manually/visually (no process instrumentation installed on bulk trucks for sensing storage tank levels);

- If top loading: Climb on tanker and visually check and ullage tank compartments and estimate/calculate loading time before loading with overhead loading rack;
- If bottom unloading: Check bulk storage tank level visually (no process instrumentation installed for sensing bulk storage tank levels);
- Couple the plant static line from plant and the truck's flexible transfer hose to link tanker to product transfer system;
- Ensure all transfer system valves are open before starting transfer pump;
- Start the transfer pump (delivery rate 60 m^3/h, or 1 000 litres/min) at the BTLR and observe off-loading (person in charge of loading operation to be prevent at all times, to stop transfer at anytime in case of incident or emergency);
- When pump is shut off, break the coupling, and store the flexible hose (a dry-break coupling is used to minimise spillage during uncoupling);
- Store and secure fire extinguishers;
- Continue to destination, proceeding with care and driving defensively.

4.2 Waste & Used Lube Oil Processing (Thermal Cracking)

Generally, the **refining process** involves the transfer of waste and used lube oils (slops) to storage and then to the processing installation, where the key **processes are dehydration and removal of light ends through evaporation, filtration, processing of heavier ends through thermal cracking**, transferring refined products to storage, and transferring and separating tail-end process waste. Recycling for the recovery of waste oils is also included to optimise recovery.

1. Waste and used lube oils that could contain up to 15% water, are transferred mechanically from the bulk trucks to bulk tanks (bottom loading process) for settling and emulsion breaking, when most of the water content is removed before being transferred to the process plant to form the feed stock for the process;
2. The heated feedstock is fed to an evaporator and heated to about 140 °C via indirect steam heating that is supplied from one of the oil fired boilers on site (max 2000 kPa, normal operating pressure: 500 kPa) – this is employed to drive off as much of the remaining water and light ends as possible;
3. Light ends are collected in a closed circuit system to minimise smells (light ends are streamed to the flare or used as boiler fuel);
4. The dehydrated feedstock (heavier ends) is fed to a high temperature still (operating under vacuum at max 400 °C);
5. Re-refined products are drawn off at different points in the process;
6. Heavy ends are not processed further and are drawn off and stored in the bottoms tanks, before being loaded for transportation to FFS Teakwood (Durban) in bulk road tankers, where further processing takes place to produce HFO;
7. The middle ends are filtered to produce light fuel oil products before final transfer to bulk AST's for interim storage prior to loading of bulk road tankers.

4.3 Wax Blending Processing

Solid wax is fed into the black wax tank, heated at 120 °C and melted. LO10/dehydrated lube oil is added and blended to form coating oil, which is stored in heated tanks before transfer to bulk road tankers.

4.4 Flare Liquid Processing

Flare liquid (LO2) is delivered by bulk road tanker (mainly from Sasol Secunda) and stored in the receiving tanks before being fed into the Thin Film Evaporator, where it is heated to 130 °C. During this process, the bottom fraction is removed and blended with LO10 stock. **For the time being LO2 is not being processed.**

4.5 Largest Hazards in Refining Process

The biggest hazard in the refining process is fire. The *FFS Still Operating Procedure* clearly spells out that it is vital that the process in the high temperature still, that takes place at 400 °C (well above the auto-ignition temperature of the feedstock), happens in the absence of oxygen. If it does not, boil-over of hydrocarbons will happen, resulting in a process fire.

The **most important control measures** at stake during the still process are:

1. There must be no leakage to **avoid oxygen entrainment** (the system must be maintained leak-free);
2. The **operator must know and operate at pre-determined set-points** (a function of knowing, understanding and applying procedure);
3. The **trips must sound an alarm** that alerts the operator that he must respond (a function of the control system being operational and the training and experience of the operator).

Spillage due to faulty or failing equipment is another key hazard that can be controlled by routine (daily) inspection, repairs and maintenance, as well as following correct and safe operating procedure. All of the above are a function of training and application of safe work procedures under adequate supervision. These procedures are part of the FFS ISO 14001 EMS and are being applied consistently as far as could be ascertained.

4.6 Total HCS Inventory

The **operating certificate issued by the Pietermaritzburg Fire Department** currently stipulates that the **flammable liquids** (not solids) that may be kept or handled on site **may not exceed** the quantities as per Table 4.2:

Table 4.2: Maximum Allowed Quantities of Flammable Liquids at FFS PMB

SANS Classification	Max Allowable quantity
Class I	242 000 litres
Class II	3 673 000 litres
Class III	4 458 000 litres
TOTAL FLAMMABLE LIQUIDS	**8 373 000 litres**

For the total manufacturing and recycling operation, the **maximum tankage** at the FFS tank farms at the Pietermaritzburg installation is **8.342 million litres, which includes a 120 000 litre tank for contaminated stormwater and process effluent**. The details per tank and the tank farms and bunded process areas are as per **Annexure D**. The **typical operating volumes are less than the maximum tank capacities at 4.45 million litres (or 53%)**. The typical production volumes are **as per Table 4.3.**

Table 4.3: Average Monthly Process Thru-put at FFS PMB

SANS Classification	Ave Thru-put
Used lube oil	350 – 500 tonnes/month
Flare liquid (LO2)	Currently nil
Wax	60 tonnes/month
Sasol final product	360 tonnes/month
AVE MONTHLY THRU-PUT	**770 – 940 tonnes/month**

4.7 Waste Handling

The final process **product is passed through a filter press to remove as much of the remaining particulate matter**. The solids are stored temporarily prior to disposal.

Liquid waste water from the evaporation plant, boiler blow down, excess cooling water, floor washings and contaminated rain water is drawn off and fed to the effluent treatment plant, and/or via an OWS. Static gravity separation of liquid contaminants takes place in a standard three-chamber OWS, and finally passes through the DAF unit (still being tested).

The recovered waste oil from the OWS and DAF is pumped back to the plant for processing. The effluent is treated before being released into the sewer system. This is regularly tested for quality as per the EMS to ensure that remaining contaminants do not exceed the local water authority's standards.

4.8 Spill Containment Volume

According to data supplied by FFS, the designed g**ross bund volumes** around the bulk process and storage tanks total **approx 6 596.1 m^3** (as per Annexure D). The net **bulk storage tank farm containment bund volume meets the SANS 10089 requirements.** The combined OWS, other containment drainage volume at the bulk tanker loading point and plant that leads to the OWS, and DAF volume is in excess of 120 m^3. The stormwater tank storage volume is 120 000 litres.

5 Description of Proposed New On-site Processes: Hydrogenation

FFS plans to add another installation as part of its ISO 14001 EMS in an attempt to improve plant safety and efficiencies, and to reduce process wastes of the refining process.

The **two installations that will be reviewed** in terms of the proposals to establish whether the level of hazard will increase or not, are:

1. A Coil Lube Cracking plant with a vertical coil is proposed to replace both of the existing high temperature stills;
2. A Hydrogenation Plant meant to reduce the SO_2 levels in the combusted waste stream of refined oil products (with broader environmental benefits during production and end-use).

The current and planned lay-outs are shown on FFS Drawing 3691 (FFS Pietermaritzburg – Hazard Area Classification, see **Annexure E**). The Hydrogenation project is scheduled to be completed in two phases due to capital constraints. This will include **equipment and plant for the Hydrogenation Plant, that will include a hydrogen (H_2) production plant (phase 1) and a Desulphurisation Plant (phase 2).** The quantities of HCS's stored or processed would have to be revised. The operating certificate will have to be reassessed by the Pietermaritzburg Fire Department on the proviso that a Risk Assessment (as per this evaluation) and an EIA are accepted and approved by the various controlling authorities.

5.1 Coil Lube Cracking Plant

A new and more modern Coil Lube Cracking plant with a vertical coil is **proposed to replace the ageing high temperature stills**. According to the EIA exemption application that was submitted to the authorities, it is beneficial in economic and environmental terms, as it would operate at higher efficiencies and would be more versatile in terms of the type of feedstock that can be processed.

Although the process is similar to the existing cracking process involving the high temperature still (max operating temperature of 400 °C), the **level of operating hazard will be reduced by the new lube cracking equipment**.

5.2 Hydrogenation Plant

FFS recovers waste oils and produces oils for the industrial and other markets to be used as furnace fuels. It is part of a global process to recycle spent lubricants and waste oils for reuse to reduce the impacts from the use of fossil fuels. As an ISO 14001-accredited company, it **strives to meet stringent quality and environmental standards** as a producer of low-sulphur fuel products.

FFS has erected a **hydrogenation plant** at the existing Pietermaritzburg Plant to **purify and improve the colour of lube base oils and Polyfuel** from Sasol. The proposed hydrogenation plant will utilise Polyfuel or low-sulphur Waste Lube Oil as feedstock. The feedstock is stored in 3 bulk AST's (~80 m^3 each) at approximately 30 °C. Storage tanks have been fitted with conservation vents to prevent the venting of volatiles to atmosphere.

Instead of cracking the feedstock to lower viscosity products waste oil is cleaned via the hydrogenation route, which increases the commercial and environmental value of the final product dramatically. The best-known way of achieving this result is by treating the oil with hydrogen under pressure and at elevated temperatures in the presence of a catalyst. Hydrogenation is also used in conventional refineries to remove sulphur from oil (classic Klaus process). The FFS process is similar, but at a much smaller scale and has been designed to optimise the life of the catalyst in the reactor. An improvement to process is being designed and planned for the future, at which time the feedstock's sulphur content will increase and require a desulphurisation plant. This will require a separate assessment due to the change in process, equipment, byproducts and storage requirements.

Various dark-coloured oils are available from Sasol that can be cleaned using this process to substantially enhance their value. These **oils have very little sulphur present as it has been removed at the start of the Sasol process**. In the hydrogenation process, hydrogen is used to remove unsaturated carbon chains (double bonds in the olefinic materials in Polyfuel), which are the cause of the colour and the instability in these oils.

The **reactions** take place in the presence of a catalyst **at temperatures in the region of approximately 380°C to 400°C, and at a maximum pressure of 3500 kPa**. The gases produced in this process (including methane, ethane and propane), provide the necessary heat for the reactions.

5.2.1 Hydrogen Plant

A small second-hand plant has been purchased from Afrox for the purpose of generating hydrogen on site instead of having to transport and store cylinders on site. High voltage alternating current is converted to high amperage direct current in an electrolytic hydrogen manufacturing process. The electrical equipment is housed in a separate and isolated room of the plant building.

Low pressure **hydrogen gas is generated in the plant** using a bank of electrolytic cells that are housed adjacent to the electrical equipment. The process involves a 10% caustic soda solution and demineralised water (operating at 60° C and 3"/ 76.2mm water gauge pressure) to generate hydrogen. Oxygen produced by the process is vented to atmosphere.

The generated H_2 is reticulated and stored in an intermediate steel vessel (outside of the plant rooms) at 9"/ 228.6 mm water gauge pressure. From here, it is drawn from the storage tank by a mechanical blower and passed through a high-pressure compressor to a pressure of 130 bar (13 MPa), and stored in a bank of 54 special high-pressure **cylinders (total hydrogen storage capacity is 253 kg)**.

5.2.2 Hydrogenation Process Description

The hydrogenation process involves the following steps:

1. A direct-fired heater, using a combination of stored fuel oil and low-boiling hydrocarbon waste liquids and gasses, heats the low sulphur Polyfuel.
2. From the storage facility the feedstock is fed through reverse circulation heat exchangers to raise the temperature to approximately 150° C. The use of the reverse circulation heat exchanger maximizes the use of heat in the process and reduces the need for additional heat generation.
3. The heated oil is fed into a reactor together with the hydrogen, of which the pressure has been reduced to 20 bar (2 MPa). An exothermic reaction increases the process temperature to around 400° C, at about 15 bar (1.5 MPa).
4. The oil, excess hydrogen and off-gasses are cooled by being passed through a pinch heat exchanger.
5. The saturated oil is drained from the high-pressure system through a high-pressure separator, and then a low pressure separator. From the reactor, the oil is sent to a high-pressure separator where water is separated from the waste oil. Volatile Organic Carbon (VOC) compounds, together with hydrogen are sent to a compressor, from which the hydrogen is recycled and the VOC gases are used fuel gas for the charge heater and re-boiler. The separated water is sent to the scrubber, while the product is sent to the light end strippers.
6. The gas is re-cycled via a compressor and a controlled amount of off-gas is purged from the system to maintain the required hydrogen concentration.
7. The saturated oil is drained through a high-pressure system then pumped into the vacuum strippers where the heavy and light fuel oil fractions are separated. Any residual hydrogen, other gases and light ends will be removed at this stage.
8. The light-ends or low-flash material, which have been stripped from the oil are directed through a knock out drum, where the light fuel oil is condensed and the gas is used a fuel gas in the charge heater and re-boiler. The light-ends, or low-flash material as well as the off-gasses are used as an auxiliary energy source in the fired heater to reduce stack emissions and to improve process efficiency.
9. An LPG-fired incinerator (or safety flare) is provided as a standby to allow for the direct-fired heater to be shut down for whatever reason.

10. The product from the light-end strippers goes through a re-boiler as a final step to producing the final product. It is pumped to 80 m3 vertical aboveground storage tanks that are situated in a bunded area close to the hydrogenation plant. The configuration of the six tanks is flexible. At present one is used for fuel storage of the direct-fired heater, while the other five AST's are used for product storage.

6 Hazards and Risk Mitigation Factors considered

A number of factors were taken into account to review the extent of **precautionary, preventative and/or risk reduction measures (good practice)** that are currently in place (refer **Table 6.1**).

Regarding the control of hazards and risk reduction in the **existing refining plant**, attention was given to:

- physical **separation distances** between the bulk storage area and other installations (the closest neighbouring buildings or structures outside the perimeter have a separation distance in excess of 15 metres from the nearest tank);
- **physical separation, installation and position** of bulk tanks and transfer piping containing flammable substances, from equipment, energy sources and other pressurised equipment – the closest steam boiler, housed in a roofed structure is situated more than 20 metres from the closest storage tank on the SW side;
- **spill containment measures** – mostly impervious, bunded process areas and tank farms, an effluent treatment plant, OWS, rectangular drainage channels and temporary measures (e.g. absorbent for spills) are available;
- the position and availability of **emergency shut-off arrangements** (critical valves and switches for power sources) – these should be identified and clearly marked, as well as indicated on a drawing for the emergency plan (still to be generated showing emergency equipment positions on site);
- the **electrical installation** (class and type of equipment for operation in or close to potentially flammable atmospheres – e.g. MCC's, transfer pump sets and lighting protection) – comply with SANS codes of practice;
- the type, installation and use of other **sources of energy** (office, workshop, workshop tools, boiler, oxy-acetylene equipment, gas for test laboratory, etc);
- **standard operating procedures** (SOP's) which take start-up, normal operation, emergency response/shutdown, clean-up and restart into account;
- **training requirements** during normal and emergency conditions (operators and supervisors);
- **escape and evacuation routes** (two unobstructed exits leading directly into the road that would make escape from the general industrial area possible);
- **emergency plan**; and
- **evacuation procedures** (own staff and warning of other facilities' staff).

In addition to the above, and with respect to the control of hazards and risk reduction in the **newly-erected hydrogenation plant** (including the second-hand hydrogen plant), the following was noted:

- physical **separation distances** between the hydrogen plant, the hydrogenation plant, product storage tanks, process equipment and transfer piping containing flammable substances, other installations and structures or populations. The high energy sources in the hydrogen plant are physically and mechanically separated from the hydrogen cells and high-pressure storage cylinders, whilst by the nature of the process, the direct-fired heater is in the hydrogenation process area;
- **age and condition of equipment**: the hydrogenation plant is a second-hand installation that was first commissioned in 1951, but which was fully refurbished prior to commissioning. The hydrogenation process installation, is practically new. The fuel and product storage tanks are second-hand;
- **oxygen sampling measures**– methods, frequency and equipment: a manually-operated pyrogellal sampler is used at about two-hour frequencies to sample oxygen concentration in the hydrogen plant, for possible corrective measures to be taken;
- **process protection equipment in the hydrogen plant** – mechanical control equipment will be installed to prevent oxygen entrainment into the hydrogen process;
- The availability and use of **automated (computerised) process control** instrumentation – the hydrogenation plant is automated;
- The availability of **back-up power** for the process control instrumentation in the event of a power failure – a UPS with 20 to 30 minutes of power is available and sufficient to effect a process shut-own;
- the position and availability of **emergency shut-off arrangements** (critical valves and switches for power sources) – these should be identified and clearly marked if not already done, as well as indicated on a drawing for the emergency plan (still to be generated showing emergency equipment positions on site);
- the **electrical installation** (class and type of equipment for operation in or close to potentially flammable atmospheres – e.g. MCC's, transfer pump sets and lighting protection) – compliance with SANS codes of practice;
- **fire protection measures/ fire fighting equipment** – the use of nitrogen and steam lances as standard measures and equipment for quelling and quenching a process fire in the hydrogenation process plant, is standard and is available;
- **standard operating procedures** (SOP's) which take start-up, normal operation, emergency response/shutdown, clean-up and restart into account;
- **training requirements** during normal and emergency conditions (operators and supervisors);
- **on-site emergency plan**; and
- **evacuation procedures** (own staff and warning of other facilities' staff).

In the short term, the **hydrogen plant will not be equipped with automatic oxygen sampling, monitoring and process control equipment**, and will require strict operating procedures that include frequent oxygen monitoring, operator training and supervision to ensure that equipment failure or process problems will not compromise safety. Equipment for this purpose has been ordered.

The **accidental release of the highly hazardous H_2 will have to be prevented by continuous attention to equipment integrity (frequent checking during operation), plant maintenance only when the process equipment is not in operation, strict application of operating procedures, through training and supervision.**

The hydrogen plant's general **earthing** is according to code, but a **lightning protection** system must still be brought up to specification.

The **principle hazards**, therefore, introduced by the hydrogen gas that is manufactured for, and used in the **hydrogenation process** are:

- the accidental release of the manufactured **H_2, which is classified as a highly flammable gas (class 2.1, UN No.1049), which becomes explosive between 4% and 75% v/v in the presence of oxygen;**
- **The entrainment of oxygen during the high-pressure stage of the hydrogen manufacturing process;**
- **Control of all types of equipment that could emit flames or sparks (even low energy equipment such as cell phones) in close proximity to the hydrogen plant.**
- **Equipment failure that will lead to a release of hydrogen in the high temperature area;**
- **Failure to respond to process control warnings.**

Table 6.1: Summary of Factors taken into account during preliminary Hazard Assessment to pre-empt and reduce Hazards and associated Risks at FFS Bulk Tank Farm and Waste Oil Processing Facilities, Pietermaritzburg

Hazard/ Risk Factor	Recommendation to reduce/control Hazard and Risk
Arrangement of Plant and Equipment	Safety and separation distances are generally adhered to according to SANS 10089. New plant will also comply. **Informal dwellings built right next to FFS perimeter fence must be removed well away from the site (this is a local authority responsibility in terms of Town Planning Ordinances and general community fire safety norms**).
Mechanical integrity	Where possible, condition and age of equipment were taken into account for estimating potential risk related to mechanical integrity. In particular, most of the bulk AST's are second-hand (no records of age for most tanks) vertical steel tanks of welded construction that are installed on a reinforced concrete bases. The new hydrogenation plant is being commissioned, with the hydrogen plant being a second-hand, refurbished acquisition.
Electrical installation	The installation of explosion proof electrical equipment (motors, lighting, etc) in pre-determined hazard areas/zones is a minimum requirement and has been met.
Uncontrolled use of energy sources in or close to the hydrogen and hydrogenation plant areas	A standard control procedure and signage should be sufficient to ensure that cellphones or other low or high energy emission sources will be in use in these areas as a key risk control measure
Fire fighting equipment	The installation has a dedicated system for the tank farms and plant. The type and installation appears to be adequate if required in the event of a fire. A fire can be controlled in the new plant through the addition of a nitrogen system and the use of steam to quench a hydrogen fire in the process plant.
After-hours security arrangements	After-hours security at the two entrances is based on locked gates with security monitoring. Day-time security control is also in place.
Separation distances/ building openings	Separation distances of bulk storage and process equipment, and clearances between boundary fences and other structures beyond are adequate. In the event of a major hydrogen release, it is extremely unlikely that the gas will be contained due to its high buoyancy relative to air and the unrestricted, well-ventilated area and buildings.

Hazard/ Risk Factor	Recommendation to reduce/control Hazard and Risk
Drainage/spill containment	Drainage in the bunds can be regulated and shut off in the event of a major spill. Also the storage bund has been sized greater than regulatory requirements. The containment plant's drainage, which includes the OWS and the rectangular channels, and effluent tank (120 m^3 capacity), can be regulated and controlled in the event of a major spill.
Process control equipment	The new hydrogenation plant is monitored, operated and controlled by automated, computerised equipment and process instrumentation. Pre-set conditions can trigger high or low level alarms that the chief operator on shift must respond to. Backup in the form of an uninterrupted power supply is available for 20 to 30 minutes in the event of a power failure, which is time enough for a safe process shutdown that will involve lowering the system pressure to 7 bar (0.7 MPa), at which time nitrogen is introduced in the process to prevent a hydrogen fire from starting. Oxygen levels in the hydrogen plant are manually sampled and checked. This is done every two hours, but should perhaps be done more frequently during the commissioning phase to ensure plant operators become familiar with extraordinary conditions, and until the automated sampling and monitoring equipment arrives and has been commissioned.
Emergency shut-off arrangements	Positioning of critical equipment for shutting off processes and transfer of product in current installation is good. For new plant, the availability and strategic positioning of critical shut-off equipment is a key consideration.
Standard Operating Procedures (SOP's)	SOP's are generically available as per the FFS ISO 14001 EMS for training of staff to reduce the risk of human error, which is likely to be the root cause of most incidents. The SOP's should be customised for the site (using valve numbers, tank numbers and switch identification positions in conjunction with a marked-up site plan). New SOP's for the coil lube cracking and hydrogenation plants (process plant, hydrogen plant and desulphurisation plant) will be will be crucial for continuous safe operation.
Maintenance procedures	Formalised routine maintenance procedures for key process equipment are used to optimise equipment integrity. The product sales cycle dictated by winter weather and other economic conditions could lead to sub-optimal maintenance conditions that increase hazard and risk, and this should be guarded against. Additional procedures for the new plant will be vital to maintain this plant's integrity at the highest

Hazard/ Risk Factor	Recommendation to reduce/control Hazard and Risk
	standard due to the inherent process risks that could arise from under-maintained equipment and plant. A SOP for repairs and maintenance on the hydrogen and hydrogenation plants must stipulate that while the plant is operational, no maintenance may be undertaken until all processes have been shut down and the operator has locked out the system.
Emergency Response Procedures	Existing on-site emergency response procedures (ERPs) should be made site-specific/rewritten to address current and new incident scenarios, and should be comprehensive, detailed, and should be integrated with ongoing training. New plant and additional incident scenarios will require additional response procedures specifically aimed at gas release. Summarised versions of the ERPs should be prominently displayed at key telephone and operational points, and should especially include the emergency number list.
Training (emergency and operating)	New emergency and operating procedures would require further training of staff on site. Regular emergency training combined with SOP training and supervision will be important as part of the risk control measures to minimise the likelihood of secondary events and the final outcome of a release incident.

7 Plant Location and Surrounding Hazard/Risk Factors

7.1 Physical Location

With reference to the attached site plan and general arrangement drawing, the FFS installation is located in the Mason's Mill industrial township in the SW sector of the Pietermaritzburg municipal area. It is located at 16 Herschensonn Road. The **site occupies approximately 36 000 m^2**, of which approximately 40% is currently used for the refining operation. This figure has increased to approx 45% after the hydrogenation plant was added.

The FFS installation is situated at the end of the road, and has another industrial concern, a scrap metal dealer 50 metres adjacent to the south-east. The gravel road forms a separation boundary SW, and both sides of the road have a cleared area of at least a three-metres wide. Most, but not all of an informal settlement is situated on the opposite side of the roadway. The **informal dwellings that have been established right next to the FFS perimeter wall are a key concern for public safety, and should receive appropriate and speedy attention by the local authority**.

7.2 Topography/ Environment

The FFS installation is situated almost at the top of a hill, and the terrain slopes with a clearly discernable negative gradient of about 15° from south-west to the north-eastern boundary, and from south to north on the north-western boundary side. On the northern-western side, the Umzinduze River is about 1 km away, and flows in a valley next to the hills and mountains that form a larger valley, which runs towards the town area of Pietermaritzburg.

The property is mostly unpaved, and has impervious concrete surfaces in all of the bunds around the storage tanks and process equipment, except for the most-recently established bund.

7.3 Meteorological Considerations

The climate is typical for the KwaZulu Natal Midlands, which are situated in the summer rainfall region of the country – **hot summers** (average max 26 °C, with highest recorded temp of 42 °C in December) marked by some **thunder/electric storms**, followed by **cold, usually-dry winters with atmospheric inversions** (average min 11 °C, lowest temperature of –4 °C in June and July), and intermittent rain in the spring and autumn. **Prevailing winds are generally north-easterly and south-westerly**, and brisk to strong in summer, while the intensity drops in winter.

SW winds will carry any noxious vapours or products of combustion in the direction of the **southern extremities of the industrial concerns that have been noted, and towards the Pietermaritzburg residential areas** beyond (Pelham and Scottsville are the closest, being approx 2.5 km away). **NE winds would affect the informal settlement that is situated across the road from and beyond** the installation, and would probably require an evacuation of these residents if a major fire or toxic vapour release were to occur. Vapours and products of combustion carried by NE winds would **probably also affect the residents of Imbali, about 2km away**.

Hydrogen, as the lightest substance know, when released to atmosphere, will probably dissipate rapidly (depending on temperature and inversion conditions). Also, as there is an extremely likelihood of a process fire, it is highly unlikely

Heat radiation would present an immediate danger to persons working at or close to the tank farm or the processing plant, and to persons immediately adjacent to the FFS site until they escaped/evacuated. The **perimeter wall would create a physical radiation shield for persons beyond the boundary.** There are unrestricted escape routes from the area via the roads leading out of the Mason's Mill area (Edendale Road) that would make a **quick escape and evacuation possible**.

7.4 Vegetation

Apart from lawn and some trees that are present on the western extremities of the property inside the perimeter wall, the property is free of vegetation in side the perimeter. **If the grass on FFS property is not maintained regularly, it could present a fire hazard**. The external terrain is generally covered by veld grass and trees that appear to be mainly indigenous to the area. Due to spatial separation, it is **unlikely that the external vegetation would present an immediate threat to the installation if a veld-fire were to occur**.

7.5 Population – FFS workforce

For the time being, the company employs 30 workers. **Twenty workers are usually on site** during daylight hours. A minimum of three persons will be on shift after-hours to keep the continuous process supervised and running.

7.6 Population – Neighbouring Installations and Facilities

Industrial businesses are situated on Herschensonn Road S and SE uphill from FFS. It is estimated that **up to 50 people work at the industrial sites in the immediate vicinity of the FFS installation**, mainly during daylight hours.

Transnet owns the land to the north-east, where a railway siding is situated about 100 metres downhill from the FFS boundary. Other larger industrial concerns (e.g. Huletts Aluminium) are situated well beyond the siding at distances more than 500 metres away from FFS.

7.7 Population – General Public

As has been mentioned, there is **no formal residential area within 500 metres, but there is an informal settlement immediate adjacent to the FFS installation**. It is difficult to estimate the informal population numbers, except to say that the dwellings are close together and are increasing in number, with some right up against the FFS boundary wall. **Members of the general public use Herschensonn Road (a *cul de sac*) on foot and in vehicles** to travel to and from the informal settlement. **Edendale Hospital is situated about 2.5 km SW and the township of Edendale is about 3 km SW of the site on the other side of the hill**.

7.8 Traffic Patterns and Road Conditions

Roads to the Mason's Mill area are all tarred and give easy access to and from the general Pietermaritzburg area, but Herschensohn Road is a gravel road. **Low to medium vehicular traffic volumes were noted on the Edendale Road** (which is a main access road to/from this area), with **very low vehicular volumes on Herschensohn Road, consisting of cars, and mini-bus taxis. Collisions with bulk tankers leaving the installation are not considered a significant hazard**, as speeds observed are low due to the short road length and the apparent *cul de sac*, as long as bulk tanker drivers take the necessary defensive driving precautions when leaving the FFS site.

The **two entrances to the premises are just more than one vehicle width, and will make for a difficult exit** for articulated vehicles in an emergency, despite the road being unobstructed and wide enough for such a vehicle to turn.

7.9 Other MHIs and Industrial Sites

As far as could be ascertained, there are **currently no other MHI's that border directly on the FFS premises or are closer than 500 metres**. It is noted that there is apparently a MHI installation at the Huletts Aluminium factory approx 1.5 km NE.

The closest industrial concern is about 50 metres away. Other general industrial and commercial concerns are situated immediately SE and S, and include a scrap metal dealer, a concrete brick making concern, a timber yard, and general dealers, each situated on either corner of Herschensonn Road.

7.10 Potential Ignition Sources

- **Non-compliant electric motors and other electrical equipment** (e.g. lighting, distribution boards, all fittings and switches, etc.): in or close to hazardous areas comply with SANS 10089, Part 3 requirements and SANS 10108.
- **The use of non-spark proof equipment in hazardous areas (cellphones, etc)**
- **Welding, grinding and other uncontrolled hotwork** on site must be strictly controlled by hotwork permits, as is the current practice.
- **Striking/scraping metal to metal** (spark generation) must be avoided in hazardous zones through the use of appropriate tools (non-ferric materials) – hand tools should, where applicable, be non-spark producing (non-ferrous).
- **Smoking on-site**, especially close to or near hazardous zones.

- **Petrol-powered vehicles** must be restricted from entering identified hazard zones to avoid the risk of a backfire.
- The risk of **static electrical discharge** that generates sparks must be strictly controlled when transferring hazardous product by applying bonding/earthing cables (currently in use).

7.11 Other Noted Conditions

FFS has made the necessary precautions to prevent a major spill as well as to treat contaminated effluent. The installation is equipped with bunds, and mostly has a closed circuit containment drainage system, which connects the tankfarm bunds to the OWS, an effluent holding tank (approx volume of 120 m^3), and a bio-degrading effluent (DAF) plant where the effluent is treated before releasing to sewer.

The municipal sewer system does not appear to link with any of the immediate water bodies (Umzinduze River). Due to the sloping hill, any contaminated water will flow freely into the veld on the northern side, which would cause contaminants to end up in the natural depression and the river that runs south to north (approx. 1 000 metres to the north-west).

7.12 Inherent Process Hazards – Current Installation

- **Mechanically transferring hydrocarbon products** from/to bulk road tankers for on-site storage: leaking pump glands, seals and pipe connections can release flammable vapour and hazardous liquid (this can be controlled through frequent inspection and repairs as per the SOP's);
- **Transfer equipment failure** (broken or mechanically damaged pipe, pump gland or valve - primary incident) will cause a major release of HCS while the transfer pump is still running and before valves are shut (the possibility of a secondary event – a jet fire could occur in the presence of an ignition source);
- **Failed/ faulty/ leaking process equipment** (primary incident) will cause a major release of HCS into a bund that could cause a fire if an ignition source were present (secondary incident);
- **Failed/ leaking process equipment involving the high temperature stills** (primary incident) will cause a fire due to oxygen entrainment and contact with process liquids (HCS) (primary incident), leading to further fires involving equipment (secondary incident);
- **Failed process control equipment used for monitoring pressure and temperature**, combined with incorrect operating procedure when operating high temperature still equipment that leads to over-temperature conditions that would cause a fire involving HCS in the still (primary incident), leading to further fires involving equipment (secondary incident);
- **Incorrect operating procedure when operating high temperature stills** that could cause a fire involving HCS in the still (primary incident), leading to further fires involving equipment (secondary incident);

- **Transfer and other electrical equipment involving potential ignition sources (electrical sparks):** For the class III-types of liquid, Zone 1-type electrical equipment should be installed in or next to the bunds and process areas;

- **Incorrect operating procedure when operating transfer equipment** while loading/ unloading hydrocarbons: leaving a critical valve open that could lead to a tank draining into a bund (primary incident) that could cause a fire if an ignition source were present (secondary incident);

- **Bulk storage tank failure** (primary incident) will cause a major release of HCS into a bund that could cause a fire if an ignition source were present (secondary incident);

- **Leaving a bund drain valve in the "normally-open" position** and causing a major spill out of the bund (primary incident) that would perhaps be too large to contain with the OWS and other spill containment drainage ("normally-closed" position should be the correct operating position at all times);

- **Leaving the OWS or effluent tank drain valve in the "normally-open" position** ("normally-closed" position should be the correct operating position to prevent contaminated effluent that does not comply from being accidentally released);

- **Uncontrolled release of contaminated release from the effluent treatment plant** (incorrect operation of plant);

- **Pre-loading and parking vehicles overnight:** mechanical damage due to collision and spillage;

- **Bulk vehicles may collide** on site causing mechanical impact damage to the tank (primary incident), followed by a product spill (secondary incident) that could create further flammable conditions (tertiary incident).

- **Unprotected/non-insulated hot equipment surfaces:** ignition source in the case of an accidental spill of HCS if surface temperature is above flashpoint of HCS.

7.13 Inherent Process Hazards – New Hydrogenation Plant

- The **principle hazard in the hydrogen manufacturing and hydrogenation processes is the potential release of H_2**, which is a highly flammable and explosive, noxious, lighter-than-air, and colourless gas. The release could be due to operator error (potentially higher probability initially due to inexperience with new equipment), process equipment failure (unlikely due to age of new equipment, unless incorrectly installed and commissioned) or process monitoring and control equipment failure.

- **Fire involving process equipment and H_2** is also possible (high temperature operation involving a hydrogen primarily as well as a number of flammable/combustible process HCS's);

- **Unconfined vapour explosion hazard** due to uncontrolled release of **H_2** in the presence of an ignition source.

7.14 Routine Procedures and Additional Measures

The maintenance programme, as currently implemented and part of the FFS ISO 14001 Environmental Management System (EMS), is **part of the risk control and standard operating programme to reduce the hazards and risks** associated with questionable equipment integrity. This should include an inspection and non-destructive testing programme for the bulk storage tanks, most of which were second-hand when installed (with no age records available), except two for D12 and D13 that were constructed about 7 years ago.

As noted from documentation that was presented, routine maintenance **procedures, especially for statutory regulated equipment** including the electrical installation, fire protection equipment, steam boilers, air compressor, and other pressurised systems (there are nine registered pressure vessels currently on site) have been implemented **are on schedule** as a further means to control the hazards and risks associated with poorly or non-maintained equipment. Bulk tankers are maintained in Durban and are not the responsibility of the management in Pietermaritzburg.

SOP's generated as part of the company's EMS are generic – these should be amended specifically for the Pietermaritzburg installation. This would form more specific training material to ensure that staff will be able to operate the transfer and storage equipment with greater confidence to lower the associated risks.

Making the SOP's site-specific will be especially relevant for the proposed installation, i.e. the hydrogenation process plant, the hydrogen plant and desulphurisation plant.

7.15 Emergency Procedures

Existing Emergency Response procedures are generic and should be rewritten according to incident scenarios that will be part of Report 2 (Risk Assessment). Staff training must continue as part of the response programme that will be necessary to mitigate and control the effects of any incident that may occur due to activities on site.

For the new plant, additional response procedures will have to be generated for the On-site Emergency Plan. The identification of emergency shut-off equipment and positioning of emergency personal protective equipment (SCUBA, etc) will be particularly important to ensure that operator safety is optimised. Training in SOP's and emergency procedures will be vital for the new plant and equipment to ensure that the effects of an incident can be minimised.

8 Observations: Hazards and Risk - PMB Installation

Various hazard and risk factors have been noted and discussed as above. As an existing installation with a lengthy operating history (the plant was established in approx 1979, and FFS has been operating the plant since 1989), the **existing operating hazards at FFS Pietermaritzburg appear to be well under control**. As per the previous EIA, there have been nuisance-type incidents that have occurred due to smells and odours that been seem to have been addressed

Incidents involving HCS's and process equipment have occurred, notably process fires, one of which occurred in the past six months, but without serious consequences. It is perceived that the **training and prompt action by staff, as well as the prompt speed of response by the Pietermaritzburg fire department, have prevented major consequences**.

8.1 Current Installation

There are **no apparent critical non-compliance issues that affect the level of hazard.** When considering staff or the public, the **risk profile of the current plant and equipment is therefore acceptably low**. From observations during the site visit on 17 October 2003, and an evaluation of available equipment inspection documentation, the installation and condition of equipment appears to comply with statutory requirements, SANS and other Codes of Practice, and the **current condition appears to be satisfactory and the equipment in a safe working order**. During the review with the local plant manager, which included reviewing the applicable documentation, it is clear that FFS is an established company in the oil industry that has well-documented SOP's that have been incorporated in an ISO 14001 Environmental Management System. The **EMS is actively used to reduce and control the on-site hazards and limit incidents as far as possible**. When incidents occur, there is a concerted effort to follow-up and to take remedial action to prevent recurrences. The **operational staff members appear to be knowledgeable and well-versed in the use and application of these procedures and the operation of equipment and plant.**

8.2 New Coil Lube Cracking Plant

The **impending construction and commissioning of a coil lube cracking plant that will replace the two high temperature stills, will not introduce additional hazards** in terms of the current installation and operation, but will rather reduce the risk of equipment failure due to the equipment being new. This will lower operating risk of the refining process.

8.3 New Hydrogenation Plant

The **new hydrogenation installation will be part of a process to reduce environmental emissions** due to the refining process (normally released into the atmosphere as SO_2). From the interview with FFS's process design engineer and the local plant manager, and the evaluation of increased hazards, it is clear that the **new installation will increase the risk profile of the Pietermaritzburg installation**.

The accidental release and spread of hydrogen gas (H_2) in the presence of uncontrolled ignition sources (which are highly likely to occur in the informal settlement SW of the installation) **could have serious fire and explosion effects, which will be deemed a "major incident" as per the OHS Act**.

The **accidental release of hydrogen gas (H_2) during the chemical conversion process** has the **potential to render operating staff unconscious with fatal consequences which will be deemed a "major incident" as per the OHS Act**. Due to the process, such a release will not necessarily be stopped immediately when an emergency shutdown is done, as the volume of HCS entrained in an affected part of the plant will continue to be converted for some time until the processing of that liquid is completed.

The highly flammable, explosive and toxic gas release to atmosphere **also has the potential to affect non-staff and members of the public in the immediate vicinity and beyond**. The prevailing SW/NE winds will mean that the lighter-than-air gas would be spread and would dissipate rapidly. Depending on the combination of wind speed and direction, and an atmospheric inversion (winter months), the population immediately downstream from the installation is bound to be affected (minimally – depends on outcome of isopleth analyses). This will undoubtedly raise the risk profile of the installation. During a toxic release, it is (un)**likely that a large scale evacuation would be required, except for the informal settlement immediately adjacent to the plant and that the local authority's assistance would be required**.

As a means **to prevent major incidents, FFS will have to ensure that all reasonable measures are applied to control the potential hazards.** This should include installing essential monitoring, control and critical safety equipment, performing regular maintenance and inspections, and training staff in the safe operation of the new plant. Supervision and process monitoring will be crucial from the start-up onwards. The standard of equipment maintenance will also have to be exceptional. Alarm equipment, if not already installed for warning persons external to the plant about impending danger, should be installed.

9 Systems and Documentation

From the review with the local branch manager and the environmental manager, and the review of the applicable documentation, **it is apparent that as an established company in the oil industry, FFS has well-documented operating and emergency procedures that have been incorporated in an ISO 14001 Environmental Management System. These are actively used to reduce and control the on-site hazards as far as possible.** The operational staff members appear to be knowledgeable and well-versed, and have been trained in the use and application of these procedures. This will have a significant reduction in operating, environmental, health and safety risk if applied as intended.

The applicable documentation for the establishment, operation, maintenance and dealing with emergencies have been summarised in **Annexure B.**

As a cursory observation, it was noted that separate systems are used when either dealing with injuries (as per OHS Act), or for other incidents (as per EMS – so-called non-conformance reports, or NCR's). As an injury is a deviation from a standard (thus non-conformance), it would make sense to integrate the two approaches and have a standard when logging, investigating and following up on any type of incident.

10 Preliminary Recommendations (PMB)

From the hazard assessment above, it is **specifically recommended** that:

10.1 Current Installation

1. All currently installed critical valves and emergency shut-off switches must be marked;
2. A simple Process & Instrumentation Diagramme (P&ID) must be drawn up as part of the SOP's (which should be available to train new staff), which can also be included in the Emergency Response Plan for training purposes;
3. The critical valve and shut-off switches, together with other emergency information must be added to a drawing that can be included and used for training and emergency response purposes;
4. The upgrade of the soil floor to seal the floor in the large bund must continue;
5. SOP's and other procedures that are part of the FFS ISO 14001 EMS should be amended with the above and other relevant information to ensure that the SOP's are specific to the FFS Pietermaritzburg installation;
6. The emergency response procedures must be adapted to be site-specific (similar to the SOP's where critical valves and equipment are marked and noted in the documentation).
7. A hotwork permit system must be applied rigorously to minimise spark generation in hazard zones – conservatively, the whole site, excluding the office block, should be considered hazardous and this procedure should be applied to ensure that especially third party contractors are alerted to on-site hazards and hazardous conditions that may arise while they work;
8. Whenever product/slops transfer takes place, this must be done with the driver or a supervisor in attendance and only after all safety precautions have been effected;
9. Sufficient foam for fire fighting must be kept in stock on site as a means of an efficient first line response to a bund or process fire.
10. The routine maintenance programme for all key equipment must continue to be applied to control and reduce the hazards and risks due to potentially poorly or under-maintained equipment and plant;
11. Electrical bonding/earthing equipment at the tanker loading rack must be tested for electrical continuity on a regular basis (every six months) as part of the maintenance and prevention programme;
12. A record book must be established for the electrical installation, which must be signed off after inspection and testing is performed by competent person in terms of the electrical regulations and codes of practice that apply to a hazardous installation;
13. The age of the second-hand tanks (the majority on-site) is uncertain – a non-destructive tank testing and inspection cycle should be considered and initiated as a precautionary measure to prevent unexpected tank shell failure in the future.

14. In general, it has been noted that injuries are recorded as per the General Administrative Regulations of the OHS Act, but are not recorded as a EMS non-conformance incident. Technically, this is inconsistent with general incident prevention practice, even though injuries would not be "environmental", and are thus excluded from the EMS. For consistency, however, it is recommend that injuries be included as part of non-conformance procedure.

10.2 Recommendations: Proposed Coil Lube Cracking Plant (PMB)

1. All new critical valves and emergency shut-off switches must be marked;
2. A simple Process & Instrumentation Diagramme (P&ID) must be drawn up as part of the SOP's (which should be available to train new staff), which can also be included in the Emergency Response Plan for training purposes;
3. SOP's and other procedures that are part of the FFS ISO 14001 EMS should be amended with the above and other relevant information to ensure that the SOP's are specific to the FFS Pietermaritzburg installation;
4. The emergency response procedures for the new plant must be adapted to be site-specific (similar to the SOP's where critical valves and equipment are marked and noted in the documentation);

10.3 Recommendations: Proposed Hydrogenation Plant (PMB)

1. All new critical valves and emergency shut-off switches must be marked;
2. The emergency response procedures for the new plant must be adapted to be site-specific (similar to the SOP's where critical valves and equipment are marked and noted in the documentation);
3. SCUBA equipment placed at strategic places and gas release monitoring and alarm equipment will be essential to safeguard staff;
4. Emergency shut-down equipment, either controlled by remote (electronic or computerised) or manual means, must be positioned in easily accessible places that will allow staff to act within the shortest possible time of an emergency occurrence;
5. Expert supervision and training will be essential for at least six months to establish the competence of the local operating staff with the new system that should be aimed at "zero-tolerance" of incidents;
6. A frequent inspection and maintenance programme will have to be instituted to ensure that plant integrity can be maintained at the highest possible level;
7. A "stop production immediately" procedure must be introduced if daily inspection or operational monitoring indicates that any part of the hydrogenation plant is compromised and will compromise health or safety;

8. A new certificate of operation will have to be issued by the Pietermaritzburg Fire Department, if the by-products of the hydrogenation process are considered and are to be stored on site (even temporarily);

9. It will be incumbent on the Pietermaritzburg metropolitan municipality to ensure that informal dwellings and residents are moved to an appropriate location to ensure their safety, and that future developments (formal or informal) do not encroach on the industrial area that might create further hazards and risk to the general public. FFS will have to start a formal process to notify the municipality of its duty in terms of the various statutes, Town Planning Ordinances and specifically the MHI Regulations to ensure that it becomes public record that will result in positive action.

ANNEXURE A: MHI RISK ASSESSMENT PROCESS & METHODOLOGY

The process agreed to with Management and followed to perform the risk assessment at FFS Refiners (Pty) Ltd (Pietermaritzburg installation), is set out below:

Protocol Steps	Comments and Explanations
1. Review facilities, plant and installation	▪ Apply all codes of practice, statutes, guidelines and good safety practice to review whether hazards and risks have been reduced through design and required and/or mitigation measures as far as reasonably possible.
2. Identify risk zones & spatial relationships	▪ The risk zones should be pre-identified from drawings during a desktop exercise, but the spatial relationships, topography and physical presence of unusual conditions would need independent examination and confirmation. This would also involve planned changes to plant or processes that will require an assessment.
3. Identify type of substances	▪ The list of hazardous substances and/or materials and/or raw materials is confirmed, together with the maximum potential storage volumes, and storage vessel types.
4. Identify hazards, hazardous conditions, operational and process risks	▪ Plant & Process – hazard objects could be pre-identified, but will be confirmed by assessor, especially chemical inventories and energy sources, together with protection and prevention steps. ▪ Operating procedures – adequacy of existing procedures, and consequences of exceptions to standard procedures (non-adherence to set procedures). The scope of this proposal does not include writing or re-drafting of operating procedures.
5. Draft 1st report for client	▪ A draft report is submitted, identifying non-compliance issues with recommendations for further attention (preferably immediate attention) by the client.
6. Interventions by client or agents	▪ Client to remedy problems that affect compliance in order to reduce level of perceived hazard and associated risk.
7. Identify risk type (potential incidents and consequences)	▪ Potential incidents are pre-identified by evaluation of the historic incident data, but are confirmed as part of the on-site inspection, especially where extraordinary processes or equipment, or unusual physical conditions are present.
8. Rate incident probability	▪ Use UN table to estimate probability – for common incidents, this could also be done prior to on-site evaluation.

The process agreed to with Management and followed to perform the risk assessment at FFS Refiners (Pty) Ltd (Pietermaritzburg installation), is set out below:

Protocol Steps	Comments and Explanations
9. Identify threatened objects	▪ Gather data to identify life, environment and property that can be threatened, their proximity and relative position to the installation (i.e. topography), as well as typical climatic data for the area. ▪ This aspect may also require contact with local authorities to obtain data, but once captured, this would be available for future use.
10. Evaluate existing organisation, emergency equipment and procedures	▪ Evaluate information about current staffing (organisation) and the on-site emergency plan. ▪ The on-site plan, emergency equipment and staffing should be in relation to the nature of hazard that could realistically occur and would influence the speed of development vs. the speed of response. ▪ The incident/accident record should also be evaluated to confirm potential incidents that have been pre-identified. ▪ If an on-site plan is not available, this must also be compiled according to a standard format for inclusion in the final report. The scope of this proposal does not include writing or re-drafting of emergency procedures.
11. Consider speed of reaction	▪ This involves gathering information about staffing, training, the on-site emergency plan, exercises to test the plan, protective and preventative measures, availability and extent of emergency services, prevailing weather conditions.
12. Consider speed of development & consequences per incident	▪ This part of the evaluation requires integrating information about the hazard objects, topography, weather, threatened objects, potential incidents, and speed of reaction ▪ Use UN tables to estimate speed of development and consequences.
13. Rate severity of outcome	▪ The severity is estimated in terms of loss of Life, Environmental and Property loss or damage using the UN tables. ▪ The severity could also be estimated as a monetary cost.
14. Categorise consequences	▪ Categorising consequences is a relative ranking of potential incidents and their outcomes in terms of risk. ▪ A graphical presentation of Severity vs. Probability, shown on a matrix, is used to depict all potential incidents.
15. Pronouncement on findings	▪ This would entail expressing an opinion on the total risk that an installation and its potential incidents hold for the bio-physical environment. If the risks are low and the surrounding environment or communities are not in danger of being

The process agreed to with Management and followed to perform the risk assessment at FFS Refiners (Pty) Ltd (Pietermaritzburg installation), is set out below:

Protocol Steps	Comments and Explanations
	affected, the pronouncement could well preclude it from being declared a Major Hazard Installation, making it unnecessary to take the process any further.
16. Draft report for client	▪ If the site, in the opinion of the consultants, should be declared a MHI, a draft report is submitted and the client has the opportunity to question results and conclusions made in the report, before it is finalised and released for the public record.
17. Inform all interested parties (if MHI)	▪ According to Regulations the community should be informed by posting notices and using the media to give the community and other role players the opportunity of expressing opinion, and/or insight into the EIA scoping report (60 day response allowed). ▪ Employees must be consulted through the H&S rep or committee (60 day response period allowed)
18. Final declaration and reporting to authorities – submit drawings and other supporting documentation	▪ Depending on comment and adjustment, the risk assessment report, which includes the emergency plan, must be signed (assessor and responsible person) and submitted to local authority (emergency service) and the Department of Labour, with a copy to the installation manager for safe-keeping and availability by an inspector.
19. Amend if authorities require	▪ Apply any additional measures as required by local authority or environmental authorities.
20. Finalise	▪ Consult authorities - final time.
21. Start construction and operation	▪ Construct as per recommendations and requirements ▪ Commission after receiving necessary written authorisation from authorities.

Note: Process and methodology is consistent with Guidelines as contained in SANS 10089, Part 1 (1999), Annex A.

ANNEXURE B: List of Documentation scrutinised for Assessment and for Statutory Compliance

No.	DESCRIPTION	DOCUMENT TYPE	COMMENTS	APPLICABLE (Y/N)
1.	**Company Registration Details (Ownership, Reg No., Directors, Physical Address of Operation, Contact Details)**	Document (Registration Certificate)	As per FFS letterhead	Y
2.	**Organogram showing Management and H&S Management**	Diagramme	See Risk Assessment (per FFS Doc L3P)	Y
3.	**Statutory Appointments (S.16.1 (CEO); S.16.2 (Managers); Supervisors; first-aid; H&S Reps)**	Appointment Letters	Available	Y
4.	**Health & Safety Committee Member names, appointments**	Staff Records	Available	Y
5.	**Process Description (Existing Installation)**	Document	As per description in Hazard Assessment	
6.	**Process Description (Proposed Hydrogenation Installation)**	Document	As per description in Hazard Assessment from interview with Pierre Rossouw at FFS Head Office 16/10/2003	Y
7.	**Hazardous Chemicals: Names and max quantities on site - raw materials and finished product**	Register/ List	As per Annexure C & D – needs confirmation	Y
8.	**Material Safety Data Sheets (all Hazchems and finished product on site)**	Data Sheets conforming to GAR 7	Available on site	Y
9.	**Fire Department Operating Authority**	Certificate	Copy available	Y

No.	DESCRIPTION	DOCUMENT TYPE	COMMENTS	APPLICABLE (Y/N)
10.	**Hazardous Waste Disposal Records (e.g. waybills, weighbridge tickets, site disposal records)**	Records	System established and in operation (file, as per company ISO 14001 system), uses Shongweni, near Durban (Class H:h).	Y
11.	**General Arrangement Drawing (Plant & Equipment: New installation, plus fire fighting and safety equipment)**	Drawing	As attached per Annexure E	Y
12.	**Process & Instrumentation Diagramme (P&ID - intended change/new installation)**	Diagramme	Simple arrangement at tank farm would need to be drawn up for Emergency Response Plan; also for when Hydrogenation Plant is established.	Y
13.	**Statutory Equipment Inspection Registers (e.g. Electrical, Pressure Vessels, Lifting equipment, etc.)**	Register	Equipment recently inspected. Electrical installation will require inspection by MIE, to be completed and recorded every two years.	Y
14.	**Fire Fighting Equipment Inspection Registers**	Register	Available – separate ring main (no reservoir)	Y
15.	**Bulk Storage Tank Data (Size, date of construction, inspection & repair records**	Document	Newest tanks D12 & D13 (2000 m^3 each) built about 7 years ago (1996), others were second hand. Recommend establishing a routine tank inspection and testing programme (NDT).	Y
16.	**Transfer equipment (testing & inspection records: fixed system & flexible hoses, valves & pumps)**	Document	Product pressure line 3 bar, steam pressure lines 10 bar max working pressure. No hydrostatic testing at	

No.	DESCRIPTION	DOCUMENT TYPE	COMMENTS	APPLICABLE (Y/N)
			present. Visual inspection as per EMS Procedure 46. Oldest flexible hose is 1 year (replaced regularly)	
17.	**Forklift Operator Records (Training certificate)**	Staff Records	Not applicable	Y
18.	**Bulk Tanker licences and COF's**	Documents	Kept at Head Office	Y
19.	**Driver records (PrDP, licences, medical certificates, hazchem certificates**	Documents	Kept at Head Office	Y
20.	**Shift work schedule**	Document	3 workers on shift on a 3-shift, 4-week cycle system	Y
21.	**Hazardous waste disposal records**	Documents	Shongweni site (H:h) south of Durban, records available	Y
22.	**Standard Operating Procedures/ Safe work procedures (Reducing risk to Process)**	Document	As per company SOP's – refine and make applicable to Pietermaritzburg plant: recommend marking all critical valves and then including detail in SOP's for site	Y
23.	**Employee induction programme**	PowerPoint Presentation	Not translated into third language, should have voice-over – would be useful for illiterate persons not able to read	
24.	**Contractor induction programme**	PowerPoint Presentation, Documents	Available	

No.	DESCRIPTION	DOCUMENT TYPE	COMMENTS	APPLICABLE (Y/N)
25.	**Training Registers (e.g. fire fighting, first-aid, spill training)**	Registers	Available and up to date	Y
26.	**Incident Register**	Register	Available, injuries recorded as per GAR, but are not as a result of the EMS non-conformance procedure. Recommend that injuries be included as part of non-conformance procedure.	Y
27.	**On-site Emergency Response Plan (ERP)**	Document	Part of Final Risk Assessment. Diagramme showing lay-out of emergency equipment, critical valves, switches, etc to be updated by FFS	Y
28.	**Emergency Contact Numbers**	Tel List	As per ERP – see EMS Doc	Y
29.	**Emergency Response Procedures**	Document	Refer EMS Procedures L1P and L3P. Should be site-specific and linked to incident scenarios in a documented Emergency Response Plan (refer)	Y
30.	**Emergency Response Training Procedures**	Document	As per ERP	Y
31.	**Emergency Response Training Records**	Register/Staff Records	Available	Y

ANNEXURE C: List of Properties of Hazardous Chemical Substances to be used, stored or transferred (PMB)

Process and Chemicals involved	UN No	Flash Point (C @20°C)	Boiling Point (°C)	S.G. (@ 20°C)	Storage volume (litres@ ave SG)	No. of tanks	Container type	Flammable as defined per International codes	Fire extinguishing medium
LO2 (Flare fuel)	1268	75 °C		0.74 – 0.81 est.	See Annex D	-	AST	NFPA class 3, IMDG Group III	Fluoro-protein foam, dry powder chemical, CO_2
LO10 (gas oil)	1268	55 °C	185°C	0.82 – 0.86	See Annex D	9	AST	NFPA class 3, IMDG Group III	Fluoro-protein foam, dry powder chemical, CO_2
LO20	1268				See Annex D	5	AST	NFPA class 3, IMDG Group III	Fluoro-protein foam, dry powder chemical, CO_2
WO 21S coating oil	1268	60 °C	350 °C	0.88	See Annex D	1	AST	NFPA class 3, IMDG Group III	Fluoro-protein foam, dry powder chemical, CO_2
IBO	1268	48 °C	185°C	0.85	See Annex D		AST	NFPA class 3, IMDG Group III	Fluoro-protein foam, dry powder chemical, CO_2
Diesel	1202	69 °C		0.84	See Annex D	1	UST	NFPA class 3, IMDG Group III	Fluoro-protein foam, dry powder chemical, CO_2
Waste oil/ Slops (hydrocarbons)	1268	50 – 120 °C variable	230 – 280 °C	0.86 – 0.98 est.	See Annex D	10+6	AST + UST	NFPA class 3, IMDG Group III	Fluoro-protein foam, dry powder chemical, CO_2
Hydrogen (gas), H2	1049		-252.78 °C	0.0696					Nitrogen or steam lance

Compiled by Barry Coetzee, confirmed by Arno van der Merwe (FFS), date of information: December 2003

Annexure D: Maximum Hazardous Chemical Substance Bulk Storage Tank Inventory

The flammable liquid inventory is made up of aboveground bulk storage tanks (the majority of which are storage tanks with rest being process tanks), and underground fuel storage tanks.

Aboveground Tanks (AST)

Aboveground Bulk Tank No.	Tank Type	Product	Est. Tank Capacity (litres)
A1	Process	Lube	68 000
A2	Process	LO20	68 000
A3	Process	LO10	68 000
A5	Process	Bottoms	24 000
A6	Process	Lube	23 000
B8	Process	LO10	42 500
Sub-Total Aboveground Tank Farm (A Tanks Bund) (A Tanks Gross Bunded Volume 170 m3)			
B1	Process	Bottoms	23 000
B2	Process	Bottoms	24 400
B3	Process	Waste Oil	24 500
B4	Process	Waste Oil	22 500
B5	Process	Waste Oil	14 000
Sub-Total Aboveground Tank Farm (B Tanks Bund) (B Tanks Bunded gross volume 88 m3)			
B6	Process	WO21S	42 500
Sub-Total Aboveground Tank Farm (Coating Oil Bund) (Coating Oil Gross Bunded Volume XX m3)			
B9	Process	LO20	82 000
B10	Process	Waste Oil	82 000
B11	Process	Waste Oil	82 000
B12	Process	Bottoms	99 000
Sub-Total Aboveground Tank Farm (Big B Tank Bund) (Big B Tank Gross Bunded Volume 119 m3)			
C5	Process	LO10	20 000
Sub-Total Aboveground Tank Farm (Pot still Bund) (Pot still Gross Bunded Volume 13.2 m3)			
D10	Storage	LO10	426 191
D11	Storage	LO10	426 191

Aboveground Bulk Tank No.	Tank Type	Product	Est. Tank Capacity (litres)
D12	Storage	LO10	2 120 575
D13	Storage	Lube	2 120 575
D14	Storage	LO20	195 000
D15	Storage	Bottoms	785 000
D16	Storage	LO20	785 000
Tank Farm Gross Bunded Volume 5 497 m3			
F1	Process	Waste Oil	27 370
F2	Process	Waste Oil	22 772
F Tank Bunded volume 19 m3			
F3	Process	Waste Oil	15 086
Thin Film Feed Tanks Goss Bunded Volume 4.6 m3			
F5	Process	Lube	13 251
F6	Process	Lube	40 000
F7	Process	Lube	40 000
B7	Process	LO10	23 000
Evaporator Tank Bund Gross Bunded Volume 59 m3			
F8	Process	LO30	12 000
F9	Process	Waste Oil	39 000
Behind Thin Film Tanks Gross Bunded Volume 11 m3			
STORM	**Stormwater**	**Stormwater**	Unmeasured
Aboveground Stormwater Bund Gross Volume (unmeasured)			
BF2	Process	Waste Oil	37 760
Green Bottoms	Process	Bottoms	12 164
Boiler Tanks Gross Bunded Volume 12.8 m3			
L1	Process	LO10	40 000
Silver Bottoms	Process	Bottoms	22 653
Behind Still Tanks Gross Bunded Volume 46 m3			
?	Storage	Direct Feed Burner Fuel Oil	65 600

Aboveground Bulk Tank No.	Tank Type	Product	Est. Tank Capacity (litres)
?	Storage	Refined Oil?	65 600
?	Storage	Refined Oil?	65 600
?	Storage	Refined Oil?	65 600
?	Storage	Refined Oil?	65 600
?	Storage	Refined Oil?	65 600
Fuel & Product Tanks (Hydrogenation Process) **Gross Bunded Volume 94.5 m3 (oil s.g. est = 0.82)**			
TOTAL ABOVEGROUND STORAGE (Existing, plus new) **8 082 210 +393 600 litres**			**8 475 810 litres**

Underground Tanks (UST)

Underground Bulk Tank No.	Tank Type	Product	Est. Tank Capacity (litres)
U2	Process	Turposol	10 000
U3	Process	Turposol	10 000
U5	Process	LO20	10 000
US1	Storage	Waste oil	39 631
US2	Storage	Waste oil	39 631
US3	Storage	Waste oil	23 000
US4	Storage	Waste oil	23 000
US5	Storage	Waste oil	23 000
US6	Storage	Waste oil	14 000
TOTAL UNDERGROUND STORAGE			**192 262 litres**

MAX FLAMMABLE LIQUID VOLUME IN BULK STORAGE (Aboveground + Underground)	**8 475 810 litres + 192 262 litres**

Note: Bulk volumes do not include plant process pipeline volumes.

Operating volumes are unlikely to be 100% of the max storage volume. Current volumes are about 53%, or 4 450 m^3

UNBUNDED Aboveground Storage

P3	Drum filler Process	LCO	5 000
ISO T	Temp. trail Process	Turposol	1 962
F4	Process	Not in use	13 251

Other Flammable Substances Stored (Hydrogen Plant): Hydrogen Gas in Manufactureded Steel Cylinders

H_2	54 Pressurised Process Gas Cylinders (“Bombs”)	253 kg @ 130 bar

Other Flammable Substances Stored (Laboratory) Drums or other Containers

NaOH	Drums	1 800 kg
FeCl	Drums	450 kg
H_2SO_4	Drums	900 kg

ANNEXURE E: References

1.	Environmental Impact Assessment – Pietermaritzburg Facility, C.A. Stephenson (MIEME (UK), MIAIAsa), 22 March 2001.
2.	EIA/3248 FFS PMB Exemption Application, V. King, WSP Walmsley Environmental Consultants, (not dated, estimated to have been authored mid-to-late 2002)
3.	EIA / 4068 FFS REFINERS (PTY) LTD: Proposed Hydrogenation Plant, Pietermaritzburg, ENVIRONMENTAL SCOPING REPORT, Department of Agriculture and Environmental Affairs Reference: EIA / 4068, J. Fuller, WSP Walmsley Environmental Consultants (Pty) Ltd, P. O. Box 1442, Westville, 3630
4.	FFS Pietermaritzburg Major Hazard Installation Risk Assessment – Oil/Diesels and Organics, Occutech Job No 11655, 5 August, 2002
5.	FFS Still Operating Procedures – Pietermaritzburg, P Froude, 7 October 1996
6.	FFS Doc L1P, PMB Emergency Telephone List, Rev 6, 12/02/03
7.	FFS Doc L2P, PMB Fire Team, Rev 1, 25/5/99
8.	FFS Doc L3P, PMB Major Oil Spill Teams, Rev 1, 23/4/03
9.	FFS Procedure 21P, PMB Structure and Responsibilities (including Organisational Structure), Rev 10, 11/08/03
10.	FFS Environmental Management System Doc 6G Major Oil Spill, Rev 2, 19/09/02
11.	FFS Environmental Management System Doc 11G Major Fire, Rev 2, 19/09/02
12.	Map 2930CB Pietermaritzburg, 1:50 000 Topographic Map, Government Printer, Private Bag X85, Pretoria, 0001, 3rd Edition, 1989
13.	UNEP IE/PAC: "Hazard Identification and Evaluation in a Local Community". Technical Report No. 12, United Nations Environment Programme Industry and Environment Programme Activity Centre, 39-43 Quai André Citroen, Paris, France, 1992.
14.	Council of the European Union, "Council Directive of 9 December 1996 on the Control of Major-accident hazards involving Hazardous Substances", 96/82/EC, Official Journal of the European Communities, 1996.
15.	Technica, Ltd "Techniques for Assessing Industrial Risk - a Manual" World Bank Technical Paper Number 55, World Bank, 1818 H Street, N.W. Washington DC 20433, U.S.A.
16.	"A Guide to the Control of Industrial Major Accident Hazards Regulations, 1984" Reference to Regulations of the British Health and Safety at Work Act, 1984.
17.	Occupational Health and Safety Act (No. 85 of 1993, amended).
18.	"Major Hazard Installation Regulation" (Regulation of the Occupational Health and Safety Act, No 85 of 1993, per Government Gazette 22506, 30 July 2001).
19.	"Hazardous Chemical Substances Regulation" of the Occupational Health and Safety Act, No 85 of 1993.

20.	SANS 10089, Part 1: Code of Practice for the handling, storage and distribution of Petroleum Products.
21.	SANS 10089, Part 2: Code of Practice Electrical Code (Petroleum Industry).
22.	SANS 10108: Code of Practice – The classification of Hazardous Locations and the selection of Apparatus for use in such Locations.
23.	SANS 0131 Part II - 1979: Code of Practice for the storage and handling of liquid fuel – Large consumer installations.
24.	SANS 10142 – 2001: Code of Practice for the wiring of Premises – Low voltage Installations.
25.	Hazardous Substance Act (No. 15 of 1973, amended, Government Gazette 15907, 12 March 1995).
26.	SANS 10228: Code of Practice for The identification and classification of dangerous substances and goods (Government Gazette 16596, 25 August 1995).
27.	"Recommendations on the Transportation of Dangerous Goods" (United Nations Orange Book).
28.	Dangerous Goods Digest (Orange Book of Southern Africa).
29.	SANS 10400 - 1990: Code of Practice for the application of the National Building Regulations.
30.	BOC Gases Handbook (BOC Group, September 2001)

ANNEXURE F: Drawings & Diagrammes

1. FFS Drawing No. 3691 (revision 00) - FFS Pietermaritzburg – Hazard Area Classification.
2. FFS Drawing No. 3153/01 - Coil Lube Cracker: Process Flow Diagramme (5/03/2001).
3. FFS Drawing No. 3551 (revision 00) – PMB Distillation Plant.
4. FFS Drawing No. 97/2373/A – PMB Stills Flow Diagram.
5. 4 Diagrammes (not numbered or dated) showing Pietermaritzburg process flow and process equipment arrangements.

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HAZARD OPERABILITY STUDY

The following is the Hazard Operability Study (HAZOP) for the new used lubrication oil hydrogenation plant to be located in Rutherford, New South Wales, Australia.

The technical committee set up to carry out this HAZOP is listed below:

NAME	DESIGNATION	FIELD OF EXPERTISE	QUALIFICATIONS
Don Hunter (DWH)	Principle Engineer	Structural & Civil	Pr.Eng. MSc(struc) MSAICE
Gregg Hurter (GAH)	I & C Engineer	Instrumentation & Control	BSc(mech)
Petrus Scholtz (PS)	Process Engineer	Refinery Processes	BSc(Chem Eng)
Pierre Rossouw (PR)	Process Engineer	Refinery Processes	BSc(Chem Eng)
Antony Steynberg (AS)	Mechanical Engineer	Mechanical Engineering	BSc(mech)

The process objectives are to capture the requirements to ensure a safe plant that has taken cognisance and provided mitigation of all the reasonably foreseen hazards likely to occur during start-up, operation, shut-down and maintenance.

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **1 OF 2**
SECTION: **HYDROGEN FEED LINE**	DRAWING Nos.: **PFD 4067 REVISION 00**	DATE: **7TH March 2005**
EQUIPMEN **FLOW METER, PRESSURE TRANSMITTER, PRESSURE RELIEF VALVE, FLOW CONTROL VALVE,**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _ _ PRESS. _X_ LEVEL __ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF __ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
1	Pipeline	Pressure	Rupture of pipeline resulting in fire hazard	Pipe and Flange design	Design pressure 3000 kPa – Schedule 80 pipe and ASA 300 flanges	DWH	
		Over pressure from hydrogen plant	Rupture of pipeline resulting in fire hazard	Pressure relief valve	Set relief pressure at 2500 kPa	GAH	
		Leaks	Fire hazard	Isolation valves	Provide isolation valves at both ends of the line	GAH	
		Under pressure	Low flow to reactor leading to loss of product quality and reactor coking Reverse flow from reactor circuit	Pressure transducer and flow meter Non-return valve	None	DWH	
		Control valve	Hydrogen leak – fire hazard	Isolation valves before and after control valve	To allow safe maintenance	GAH	

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE 2 OF 2
SECTION: **HYDROGEN FEED LINE**	DRAWING Nos.: **PFD 4067 REVISION 00**	DATE: **7TH March 2005**
EQUIPMEN **FLOW METER, PRESSURE TRANSMITTER, PRESSURE RELIEF VALVE, FLOW CONTROL VALVE,**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _ _ PRESS. _X_ LEVEL __ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF __ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
		Leak past isolation valves into vessels	Explosion	Spades provided for vessel isolation	Write into safety procedures for vessel opening and entry	PR	
		Blockage of valve	No hydrogen flow results in coking of reactor and fired heater	By-pass and alarm on flow meter			
		Valve control loss		Flow indication Isolation valve	Valve must stay in set position from last signal	GAH	

FFS REFINERS (PTY) LTD

HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **1 OF 3**
SECTION: **OIL FEED LINE**	DRAWING Nos.: **PFD 4067 revision 00**	DATE: **7th March 2005**
EQUIPMEN **VALVES, PUMPS, INSTRUMENTATION, NON-RETURN, BY-PASS, HEAT EXCHANGER, FIRED HEATER**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _X_ PRESS. _X_ LEVEL __ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
1	Pipeline	Pressure	Rupture and fire hazard	Design to 3000 kPa	Schedule 80 pipe with ASA 300 flanges except in fired heater use boiler tube	DWH	
		Over pressure	Rupture and fire hazard	Pump spill back pressure limitation System pressure relief valve	Set at 2500 kPa No isolation valves from fired heater to reactor and pressure relief system	DWH	
		Pump failure	No flow – heater coking – damage to heater	Flow meter for flow signal with Nitrogen &/or hydrogen purge	Use mass flow meter with temperature correction Dual pumps for automatic switch over Automatic purge on no flow condition	GAH	

FFS REFINERS (PTY) LTD

HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **2** OF **3**
SECTION: **OIL FEED LINE**	DRAWING Nos.: **PFD 4067 revision 00**	DATE: **7th March 2005**
EQUIPMEN **VALVES, PUMPS, INSTRUMENTATION, NON-RETURN, BY-PASS, HEAT EXCHANGER, FIRED HEATER**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _X_ PRESS. _X_ LEVEL __ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
		Line rupture	Spraying of hot oil Fire in fired heater	Pressure testing and piping weld procedures	Non-return valve in line to prevent pressure from reactor blowing back into fired heater	GAH	
		Over temperature in fired heater	Rupture and fire hazard	Fire contained within combustion chamber inside fired heater and stack Temperature control on heater back-end, piping skin thermocouples and outlet temperature. SCADA alarms. Automatic burner shut down for on over-temperature	Routine inspections required for tube thickness measurement Limit skin temperatures to 650°C , back-end temperature to 350°C and stack outlet temperature to 410°C Permanent pilot flame	PS, GAH PS GAH	

FFS REFINERS (PTY) LTD

HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **3 OF 3**
SECTION: **OIL FEED LINE**	DRAWING Nos.: **PFD 4067 revision 00**	DATE: **7th March 2005**
EQUIPMEN **VALVES, PUMPS, INSTRUMENTATION, NON-RETURN, BY-PASS, HEAT EXCHANGER, FIRED HEATER**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _X_ PRESS. _X_ LEVEL __ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
		Reverse flow	Explosive gas in feed tank	Non-return valve to prevent oil and combustible gas return from reactor		DWH	
		No flow	Coking of fired heater – production delays	Flow indication No flow alarm Hydrogen stream Nitrogen pruge			
2	Pump	Pump failure	Maintenance required No flow	Isolation vales Dual pumps	Automatic pump change over if set on automatic	DWH	
3	Flow transmitter	Instrument failure	Maintenance required	Isolation valves	By-pass to allow operation while instrument is repaired	PR	

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **1** OF **2**
SECTION: **GAS CIRCULATION SYSTEM**	DRAWING Nos.: **PFD 4067 revision 00**	DATE: **7th march 2005**
EQUIPMEN **REACTORS, HEAT EXCHANGERS, HP SEPARATOR, COMPRESSOR**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _X_ PRESS. _X_ LEVEL _ _ COMPOSITION _X_ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
1	Piping	Over pressure from pump (spill-back failure), drag gas control valve failure, reactor temperature control failure or hydrogen feed over-pressure	Rupture Release of toxic and explosive gasses	Pressure relief system Direct release to flare stack Quench control on reactor	No isolation valves allowed	DWH	
		Over-temperature from loss of reactor temperature control	Damage to reactor and possible Rupture	SCADA alarms Reactor hydrogen purge system Product recycle mode		PS	
		Leak at flanged joints	Explosive and toxic gas release	Appropriate gasketing material Pressure testing	Routine bubble testing during operation	PR	
		Toxic and explosive gas	Heath and safety hazard	Nitrogen purge system	The full system is to be purged with nitrogen before any maintenance is carried out on the system	PR	

					Safe entry permit system		
2	Valves	Leaks	Explosive and toxic gas release	Appropriately specified valves	Hydrogen and hydrogen sulphide suitable fire safe valves	GAH	
		Temperature	Failure	No valves in the hot sections of line		GAH	
3	Reactors	Steel delamination and corrosion from hydrogen	Damage to equipment leading to eventual rupture	Use appropriate steel grade	Routine inspections to monitor corrosion rate. Pressure testing after each ~8000 hours of operation	DWH	
		Over-temperature	Rupture Hot spots – material damage Excessive gas production	Hydrogen quench Product recycling Fired heater burner shut-down Flare stack	Temperature alarms Automatic quench, recycle and burner shut-down	DWH PS	
		Over-pressure	Rupture	Drag gas pressure control valve Drag gas by-pass Pressure relief system			
4	Compressor	No Flow	Damage to equipment – reactor coking	Flow meter and hydrogen and nitrogen purge		PS	

FFS REFINERS (PTY) LTD

HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **1 OF 1**
SECTION: **DRAG GAS LINE**	DRAWING Nos.: **PFD 4067 revision 00**	DATE: **7th March 2005**
EQUIPMEN **CONTROL VALVE, FLOW TRANSMITTER**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _ _ PRESS. _X_ LEVEL _ _ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
1	Control Valve	Control valve failure	Over-pressure Maintenance	Fail in current position valve Pressure relief system Control valve by-pass Isolation valves	Procedures for handling the eventuality required	PR	
2	Flow transmitter	Flow transmitter failure	Lack of indication and loss of valve control	Pressure relief system	None required		
3	Line	Over pressure	Rupture, release of explosive and toxic gasses	Direct to flare stack Permanent pilot flame			

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **1 OF 1**
SECTION: **FUEL GAS SYSTEM**	DRAWING Nos.: **PFD 4067 REVISION 00**	DATE: **7th March 2005**
EQUIPMEN **REACTORS, HEAT EXCHANGERS, HP SEPARATOR, COMPRESSOR**		REVISION: **00**

CHARACTERISTICS: **FLOW _ _ TEMP _ _ PRESS. _X_ LEVEL _X_ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
1	Off-gas Drum	Level – high Level - low	Liquid in fuel gas line Vacuum pump failure	Level switches & Sight glass Automatic top-up line on low level transmitter			
		Over-pressure	Rupture	Pressure relief valve Automatic flare stack combustion of excess gas By-pass on control valve	Continuous LPG pilot light in flare.	DWH	
		Over temperature	Excessive fuel gas	Cooling water coil			
		Oxygen ingress from flange and pump seal leaks	Partial combustion to possible explosion	Product colour loss is indication Inspection & maintenance	Pressure testing after maintenance.		

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE 1 OF 2
SECTION: **PROCESS TANKS**	DRAWING Nos.: **PFD 4067 Revision 00**	DATE: **8th March 2005**
EQUIPMEN **TANKS, VENTS, OVERFLOW POT, INLET, OUTLET**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP __ PRESS. _X_ LEVEL _X_ COMPOSITION __ POLLUTION _ _ SEWER __ MAINT. _X_ RELIEF _X_ LIGHTING __ FAILURE _X_ OTHER __**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
	Tanks	Over filling	Spillage	Level transmitter with high level alarm Over flow to pot Bunded area and hard surfacing			
		Over-pressure from rate of filling	Tank rupture	Adequate vent size Vapour space balancing			
		Venting to atmosphere	Pollution	Tank vent balancing across all tanks Vacuum – pressure break	Operate with as smooth an inflow and out flow of liquids to keep the tank vapour volume constant	PR	
		Leak	Spillage, pollution	Bunded containment area with hard surfacing	Ensure sump drain valved for controlled release of rain water	PS	
		Fire	Safety, smoke, fire damage, loss of containment	Nitrogen blanketing Foam monitors			

		Leaks	Spillage	Isolation valves on all tank outlets			
		Out-flow	Loss of tank contents ito bund	Isolation valves on outlets			
		Vapour production	Splashing of tank feed material Siphoning out of tank – reverse flow	Filling line to tank bottom Anti-siphon hole to prevent reverse flow			

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **1 OF 1**
SECTION: **HIGH PRESSURE SEPARATOR**	DRAWING Nos.: **PFD 4067 REVISION 00**	DATE: **8th March 2005**
EQUIPMEN		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP __ PRESS. _X_ LEVEL _X_ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF __ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
1	Separator	High level	Carry over of liquid to dry end causing compressor damage	High level indication on both wet and dry ends Dual level instruments	Multi level alarms	GAH	
		Low level	Release of excessive toxic and explosive gas to flare Over pressure of LP Separator	Sight glass for draining Manual block valve	Size drain valve to restrict flow Multi level alarms	GAH	
		Over pressure	Rupture, release of explosive and toxic gas	Pressure relief system			

HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **1 OF 1**
SECTION: **LOW PRESSURE SEPARATOR**	DRAWING Nos.: **PFD 4067 Revision 00**	DATE: **8th March 2005**
EQUIPMEN		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _ _ PRESS. _X_ LEVEL _X_ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
		Sour water discharge	Pollution	To water treatment	Requires treatment for hydrogen sulphide	PS	
		Sour water discharge pump failure	Contamination of product with sour water	Alarms Level indication and automatic pumping Site glass			
		Filling and emptying	Pressure and vacuum build-up	Vacuum –pressure break vented to vapour duct			
		Light-ends pump failure	Build-up of light-ends in separator	Level alarm Sight glass			

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE 1 OF 2
SECTION: **VACUUM STRIPPER**	DRAWING Nos.: **PFD 4067 Revision 00**	DATE: **8th March 2005**
EQUIPMEN **HEAT EXCHANGER, PUMPS, INSTRUMENTS, CONDENSOR**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _X_ PRESS. _X_ LEVEL _X_ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
		Over pressure	Rupture	Pressure relief valve to flare	Permanent pilot in flare stack	DWH	
		Over filling	Liquid in fuel gas system	Knock out pot	Procedure for routine draining	DWH	
		Loss of cooling water	Excessive vapour – high flare stack throughput	Temperature indication			
		Steam valve fails open	High temperature	System designed to cope with maximum steam temperature from 10 bar steam	Procedure required for start-up to prevent boil over.	PR	
		Loss of steam	None				
		Maintenance of vessels	Hydrogen sulphide presence Iron sulphide presence spontaneous combustion with oxygen contact	Procedures Nitrogen purge Water wash	Vessel opening procedures required due to the possibility of spontaneous combustion.	PR	
		Low level	Pump cavitation	Low level transmitter			

				Pressure gauge			
		Vacuum	Collapse of column	Design check	Check design against 2 mbar vacuum	DWH	
		Loss of vacuum	None				
		Circulation pump failure	None				
		Over temperature	Boil –over on start-up During running - none	Procedure Machine can run at maximum steam temperature (10 barg – 184^{o}C)			

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE **1 OF 1**
SECTION: **FLARE STACK**	DRAWING Nos.: **PFD**	DATE: **8th March 2005**
EQUIPMEN **STACK, VALVES, BURNER, FLAME DETECTION**		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _X_ PRESS. _X_ LEVEL _ _ COMPOSITION ___ POLLUTION _X_ SEWER ___ MAINT. _X_ RELIEF __ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
1	System	Control valve	Pollution – release to atmosphere of toxic and explosive gas	Duel control valve system with by-pass with independent permanent LPG pilot light			
		Excessive gas release	Failure of stack from over-heating	Refractory line stack			
		Loss of LPG gas	Pilot light goes out	Auto ignition ignitor Flame sensor and alarm			
		High reactor temperature, pressure and hydrogen purity	Excessive hydrogen sulphide production resulting in excessive sulphur dioxide emissions	Management control	Monitor feed and product sulphur content Carry out stack emission monitoring Restrict reactor temperature to known acceptable level	PS	
		Flame out	Release of toxic and explosive gas to atmosphere	Flame out detection on both pilot light and main flame Alarmed event.			

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HAZARD OPERABILITY STUDY

PROJECT: **HYDROGENATION PLANT - RUTHERFORD**	INTENTION: **TO ENSURE SAFE OPERABILITY**	PAGE 1 OF 1
SECTION: **RECYCLE COMPRESSOR -**	DRAWING Nos.: **PFD**	DATE: **8th March 2005**
EQUIPMEN		REVISION: **00**

CHARACTERISTICS: **FLOW _X_ TEMP _X_ PRESS. _X_ LEVEL _ _ COMPOSITION ___ POLLUTION _ _ SEWER ___ MAINT. _X_ RELIEF _X_ LIGHTING ___ FAILURE _X_ OTHER ___**

ITEM	DESCRIPTION	POSSIBLE CAUSES OF FAILURE	POTENTIAL CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY	ACTUAL IMPLEMENTATION
1	Compressor	Electrical motor failure	Loss of gas circuit flow – loss of reaction	Motor run signal alarm			
		Gear box over temperature	Compressor failure	Ditto			
		Mechanical seal failure	Leakage of oil and then gas leak	Site glass Visual inspections			

Appendix B

Representative Material Safety Data Sheets

PORTLAND CEMENT

1425
October 2001

CAS No: 65997-15-1
RTECS No: VV8770000

Hydraulic cement

TYPES OF HAZARD/ EXPOSURE	**ACUTE HAZARDS/SYMPTOMS**	**PREVENTION**	**FIRST AID/FIRE FIGHTING**
FIRE	Not combustible.		In case of fire in the surroundings: use appropriate extinguishing media.
EXPLOSION			

EXPOSURE		**STRICT HYGIENE!**	
Inhalation	Cough. Sore throat.	Avoid inhalation of dust.	Fresh air, rest.
Skin	Dry skin. Redness. See Notes.	Protective gloves. Protective clothing.	Rinse and then wash skin with water and soap.
Eyes	Redness. Pain. Severe deep burns.	Safety goggles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Burning sensation. Abdominal pain.	Do not eat, drink, or smoke during work.	Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	**PACKAGING & LABELLING**
Sweep spilled substance into containers. Do NOT wash away into sewer. (Extra personal protection: P1 filter respirator for inert particles.)	

EMERGENCY RESPONSE	**STORAGE**
	Dry. Well closed. Separated from strong acids.

IPCS
International
Programme on
Chemical Safety

UNEP

Prepared in the context of cooperation between the International Programme on Chemical Safety and the European Commission

SEE IMPORTANT INFORMATION ON THE BACK.

IMPORTANT DATA

Physical State; Appearance
LIGHT GREY OR WHITE POWDER.

Chemical dangers
Reacts with acids, aluminium metals and ammonium salts. Reacts slowly with water forming hardened hydrated compounds, releasing heat and producing a strong alkaline solution.

Occupational exposure limits
TLV: (particulate matter containing no asbestos and <1% crystalline silica) 10 mg/m^3 (ACGIH 2001).
MAK: I, 5 mg/m^3 (DFG 2000).

Routes of exposure
The substance can be absorbed into the body by inhalation.

Inhalation risk
A nuisance-causing concentration of airborne particles can be reached quickly when dispersed.

Effects of short-term exposure
The substance is irritating to the skin and the respiratory tract. The substance is corrosive to the eyes.

Effects of long-term or repeated exposure
Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged contact may cause skin sensitization.

PHYSICAL PROPERTIES

Melting point: >1000°C
Density: 2.7-3.2 g/cm^3
Solubility in water: reaction

ENVIRONMENTAL DATA

NOTES

The product is primarily a mixture of calcium silicates, aluminates, ferrites and calcium sulfate.
An added stabilizer or inhibitor can influence the toxicological properties of this substance, consult an expert.
Sensitization observed with cement is mainly due to the presence of hexavalent chromium. Some Portland cements may be free of hexavalent chromium.
In the presence of moisture, skin burns may occur 12 to 48 hours after exposure; there may be no pain at the time of exposure.

ADDITIONAL INFORMATION

DISTILLATES, PETROLEUM, solvent-refined light naphthenic

1430

October 2001

CAS No: 64741-97-5 RTECS No: PY8041000 EC No: 649-458-00-9	Base oil Lubricant base oil Lubricant oil Mineral oil

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/SYMPTOMS	PREVENTION	FIRST AID/FIRE FIGHTING
FIRE	Combustible.	NO open flames.	Foam, water spray, dry powder, carbon dioxide.
EXPLOSION			In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE			
Inhalation	Dizziness. Headache.	Local exhaust.	Fresh air, rest. Refer for medical attention.
Skin	Dry skin.	Protective gloves.	Remove contaminated clothes. Rinse skin with plenty of water or shower.
Eyes	Redness.	Safety spectacles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Diarrhoea. Nausea.	Do not eat, drink, or smoke during work.	Do NOT induce vomiting. Refer for medical attention. See Notes.

SPILLAGE DISPOSAL	PACKAGING & LABELLING
Ventilation. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place.	T Symbol R: 45 S: 53-45 Note: H, L

EMERGENCY RESPONSE	SAFE STORAGE
	Separated from strong oxidants.

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IMPORTANT DATA

Physical State; Appearance
LIQUID

Chemical dangers
Reacts with strong oxidants causing fire and explosion hazard.

Occupational exposure limits
TLV: (oil mist, mineral) 5 mg/m^3 Intended change (ACGIH 2001).

Routes of exposure
The substance can be absorbed into the body by inhalation of its aerosol and by ingestion.

Inhalation risk
Evaporation at 20/C is negligible; a harmful concentration of airborne particles can, however, be reached quickly when dispersed.

Effects of short-term exposure
The substance is irritating to the skin. If this liquid is swallowed, aspiration into the lungs may result in chemical pneumonitis.

Effects of long-term or repeated exposure
Repeated or prolonged contact with skin may cause dermatitis.

PHYSICAL PROPERTIES

Boiling point: 150-600/C
Relative density (water = 1): about 0.84 - 0.94 at 15/C
Flash point: > 124/C
Octanol/water partition coefficient as log Pow: 3.9 - 6 (calculated)

ENVIRONMENTAL DATA

NOTES

A raffinate contains C15-C30 hydrocarbons with a viscosity of less than 19 cSt at 40/C (100 SUS at 100/F). It contains few normal paraffins.
Depending on the raw material and the production processes, the composition and physical properties of this solvent can vary considerably.

The symptoms of chemical pneumonitis do not become manifest until a few hours or even a few days have passed and they are aggravated by physical effort.
Note L: the EU classification as carcinogen (R45) does not apply if it can be shown that DMSO extract (IP 346) is below 3% by volume. PY8041000 refers to mineral oil, petroleum distillate, solvent refined (mild) light naphthenic; PY8041001 refers to mineral oil, petroleum distillate, solvent refined (severe) light naphthenic. Card has been partly updated in April 2005. See section EU classification.

ADDITIONAL INFORMATION

LEGAL NOTICE

CALCIUM OXIDE

0409
April 1997

CAS No: 1305-78-8
RTECS No: EW3100000
UN No: 1910
EC No:

Lime
Burnt lime
Quicklime
CaO
Molecular mass: 56.1

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/SYMPTOMS	PREVENTION	FIRST AID/FIRE FIGHTING
FIRE	Not combustible.		In case of fire in the surroundings: all extinguishing agents allowed except water.
EXPLOSION			
EXPOSURE		**PREVENT DISPERSION OF DUST! STRICT HYGIENE!**	
Inhalation	Burning sensation. Cough. Shortness of breath. Sore throat.	Local exhaust or breathing protection.	Fresh air, rest. Refer for medical attention.
Skin	Dry skin. Redness. Skin burns. Burning sensation. Pain.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention.
Eyes	Redness. Pain. Blurred vision. Severe deep burns.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Burning sensation. Abdominal pain. Abdominal cramps. Vomiting. Diarrhoea.	Do not eat, drink, or smoke during work.	Rinse mouth. Do NOT induce vomiting. Give nothing to drink. Refer for medical attention.

SPILLAGE DISPOSAL	PACKAGING & LABELLING	
Sweep spilled substance into dry containers (extra personal protection: P2 filter respirator for harmful particles).	Symbol R: S: UN Hazard Class: 8 UN Pack Group: III	Do not transport with food and feedstuffs.

EMERGENCY RESPONSE	STORAGE
Transport Emergency Card: TEC (R)-67	Separated from strong acids, organics, water, food and feedstuffs. Dry.

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Prepared in the context of cooperation between the International Programme on Chemical Safety and the European Commission

SEE IMPORTANT INFORMATION ON THE BACK.

IMPORTANT DATA

Physical State; Appearance
HYGROSCOPIC, WHITE CRYSTALLINE POWDER.

Chemical Dangers
The solution in water is a medium strong base. Reacts with water generating sufficient heat to ignite combustible materials. Reacts violently with acids, halogens, metals.

Occupational Exposure Limits
TLV: ppm; 2 mg/m^3 (ACGIH 1996).
MAK: ppm; 5 mg/m^3; (1996).

Routes of Exposure
The substance can be absorbed into the body by inhalation of its aerosol and by ingestion.

Inhalation Risk
Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly when dispersed.

Effects of Short-term Exposure
The substance is corrosive to the eyes, the skin and the respiratory tract. The effects may be delayed. Medical observation is indicated.

Effects of Long-term or Repeated Exposure
Repeated or prolonged contact with skin may cause dermatitis. Lungs may be affected by repeated or prolonged exposure to dust particles. The substance may cause ulceration and perforation of the nasal septum.

PHYSICAL PROPERTIES

Boiling point: 2850°C
Melting point: 2570°C

Relative density (water = 1): 3.3-3.4
Solubility in water: reaction

ENVIRONMENTAL DATA

NOTES

Reacts violently with fire extinguishing agents such as water. Clumps of calcium oxide formed by reaction with moisture and proteins in the eye are difficult to remove by irrigation. Manual removal by a physician is necessary. NEVER pour water into this substance; when dissolving or diluting always add it slowly to the water.

ADDITIONAL INFORMATION

HYDROGEN CHLORIDE

0163
April 2000

CAS No: 7647-01-0 RTECS No: MW4025000 UN No: 1050 EC No: 017-002-00-2	Anhydrous hydrogen chloride Hydrochloric acid, anhydrous (cylinder) HCl Molecular mass: 36.5

TYPES OF HAZARD/ EXPOSURE	**ACUTE HAZARDS/SYMPTOMS**	**PREVENTION**	**FIRST AID/FIRE FIGHTING**
FIRE	Not combustible.		In case of fire in the surroundings: use appropriate extinguishing media.
EXPLOSION			In case of fire: keep cylinder cool by spraying with water.
EXPOSURE		**AVOID ALL CONTACT!**	**IN ALL CASES CONSULT A DOCTOR!**
Inhalation	Corrosive. Burning sensation. Cough. Laboured breathing. Shortness of breath. Sore throat. Symptoms may be delayed (see Notes).	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Half-upright position. Artificial respiration may be needed. Refer for medical attention.
Skin	ON CONTACT WITH LIQUID: FROSTBITE. Corrosive. Serious skin burns. Pain.	Cold-insulating gloves. Protective clothing.	First rinse with plenty of water, then remove contaminated clothes and rinse again. Refer for medical attention.
Eyes	Corrosive. Pain. Blurred vision. Severe deep burns.	Safety goggles or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion			

SPILLAGE DISPOSAL	**PACKAGING & LABELLING**
Evacuate danger area! Consult an expert! Ventilation. Remove gas with fine water spray. Personal protection: complete protective clothing including self-contained breathing apparatus.	T Symbol C Symbol R: 23-35 S: (1/2-)9-26-36/37/39-45 UN Hazard Class: 2.3 UN Subsidiary Risks: 8

EMERGENCY RESPONSE	**SAFE STORAGE**
Transport Emergency Card: TEC (R)-20S1050 NFPA Code: H 3; F 0; R 1	Separated from combustible and reducing substances, strong oxidants, strong bases, metals. Keep in a well-ventilated room. Cool. Dry.

SEE IMPORTANT INFORMATION ON THE BACK.

IMPORTANT DATA

Physical State; Appearance
COLOURLESS COMPRESSED LIQUEFIED GAS, WITH PUNGENT ODOUR.

Physical dangers
The gas is heavier than air.

Chemical dangers
The solution in water is a strong acid, it reacts violently with bases and is corrosive. Reacts violently with oxidants forming toxic gas (chlorine - see ICSC 0126). Attacks many metals in the presence of water forming flammable/explosive gas (hydrogen - see ICSC0001).

Occupational exposure limits
TLV: 2 ppm; (Ceiling value); A4 (not classifiable as a human carcinogen); (ACGIH 2004).
MAK: 2 ppm, 3.0 mg/m^3; Peak limitation category: I(2); Pregnancy risk group: C; (DFG 2004).

Routes of exposure
The substance can be absorbed into the body by inhalation.

Inhalation risk
A harmful concentration of this gas in the air will be reached very quickly on loss of containment.

Effects of short-term exposure
Rapid evaporation of the liquid may cause frostbite. The substance is corrosive to the eyes, the skin and the respiratory tract. Inhalation of high concentrations of the gas may cause pneumonitis and lung oedema, resulting in reactive airways dysfunction syndrome (RADS) (see Notes). The effects may be delayed. Medical observation is indicated.

Effects of long-term or repeated exposure
The substance may have effects on the lungs, resulting in chronic bronchitis. The substance may have effects on the teeth, resulting in erosion.

PHYSICAL PROPERTIES

Boiling point: -85/C
Melting point: -114/C
Density: 1.00045 g/l (gas)
Solubility in water, g/100 ml at 30/C: 67
Relative vapour density (air = 1): 1.3
Octanol/water partition coefficient as log Pow: 0.25

ENVIRONMENTAL DATA

NOTES

The applying occupational exposure limit value should not be exceeded during any part of the working exposure.
The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential.
Immediate administration of an appropriate inhalation therapy by a doctor or a person authorized by him/her, should be considered.
Do NOT spray water on leaking cylinder (to prevent corrosion of cylinder).
Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.
Other UN numbers: 2186 (refridgerated liquid) hazard class: 2.3; subsidiary hazard: 8; 1789 (hydrochloric acid) hazard class: 8, pack group II or III. Aqueous solutions may contain up to 38% hydrogen chloride.
Card has been partly updated in April 2005. See sections Occupational Exposure Limits, Emergency Response.

ADDITIONAL INFORMATION

LEGAL NOTICE

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 6540-10 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. +61 2 9832 8766

ERS PREMIER GUN WASH

INGREDIENTS	CAS No	%	TWA
cyclohexanone	108-94-1	1-9	
toluene	108-88-3	30-60	
methyl ethyl ketone	78-93-3	1-9	
other ingredients		30-60	

FLAMMABLE LIQUID 3

UN No: 1993
Hazchem Code: 3[Y]
DG Class: 3
Subsidiary Risk: None

PROPERTIES

Liquid.
Does not mix with water.
Floats on water.
Highly flammable.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Harmful if swallowed.
HARMFUL - May cause lung damage if swallowed.
Irritating to eyes and skin.
Can be absorbed through skin.
Vapours may cause dizziness or suffocation.
Vapours may cause drowsiness and dizziness.
May produce discomfort of the respiratory system*.
Inhalation and/or skin contact may produce health damage*.
* (limited evidence).

Chronic Health Effects:
May cause SENSITISATION by skin contact.
Possible risk of harm to the unborn child.
Harmful: danger of serious damage to health by prolonged exposure through inhalation.
Exposure may produce irreversible effects*.
Cumulative effects may result following exposure*.
* (limited evidence).

PRECAUTIONS FOR USE

Glasses:
Chemical goggles.

Gloves:
1.PE/EVAL/PE 2.NITRILE 3.

Respirator:
Type A Filter of sufficient capacity

Storage & Transport:
Keep container tightly closed.
Keep container in a well ventilated place.
Keep away from food, drink and animal feeding stuffs.
Store in cool, dry, protected area.
Restrictions on Storage apply. Refer to Full Report.

Fire/Explosion Hazard:
Highly flammable.
Vapours/ gas heavier than air.
Toxic smoke/fumes in a fire.

EMERGENCY

FIRST AID

Swallowed:
Give water (if conscious). Seek medical advice.

Eye:
Wash with running water (15 mins). Medical attention.

Skin:
Remove contaminated clothing. Wash with water and soap.

Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.

Advice to Doctor:
Treat symptomatically.
Evaluate for respiratory distress. Consider lavage with cuffed tube. NO adrenalin.

Fire Fighting:
Foam.

Spills & Disposal:
Eliminate ignition sources.
Prevent from entering drains.
Contain spillage by any means.
Control vapour with water spray/fog.
Absorb with dry agent.
Stop leak if safe to do so.
Take off immediately all contaminated clothing.
To clean the floor and all objects contaminated by this material, use water and detergent.

Issue Date: 18/5/2004 Print Date: 22/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 6507-90 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. +61 2 9832 8766

ERS AQUEOUS PARTS CLEANER DETERGENT

INGREDIENTS	CAS No	%	TWA
sodium metasilicate, pentahydrate	10213-79-3	30-60	2 mg/m3
sodium carbonate	497-19-8	10-30	10 mg/m3
sodium nitrite	7632-00-0	1-4	10 mg/m3
other ingredients, unregulated		10-30	

CORROSIVE 8

UN No: 1759
Hazchem Code: 2X
DG Class: 8
Subsidiary Risk: None

PROPERTIES

Solid.
Mixes with water.
Corrosive.
Alkaline.
Does not burn.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Causes burns.
Risk of serious damage to eyes.
Harmful by inhalation and if swallowed.

Chronic Health Effects:
Possible skin sensitiser*.
Exposure may produce irreversible effects*.
Cumulative effects may result following exposure*.
* (limited evidence).

PRECAUTIONS FOR USE

Engineering Controls:
General Exhaust Ventilation adequate.

Glasses:
Safety Glasses.

Gloves:
1.NATURALRUBBER 2.NITRILE 3.

Respirator:
Particulate

Storage & Transport:
Keep locked up.
Keep container in a well ventilated place.
Store in cool, dry, protected area.
Restrictions on Storage apply. Refer to Full Report.

Fire/Explosion Hazard:
Toxic smoke/fumes in a fire.

EMERGENCY

FIRST AID

Swallowed:
Contact doctor or Poisons Centre.
Give glass of water.

Eye:
Wash with running water (15 mins). Medical attention.

Skin:
Remove contaminated clothing. Wash with water and soap.

Advice to Doctor:
Supportive care.

Fire Fighting:
Keep surrounding area cool. Water spray/fog.

Spills & Disposal:
Avoid dust.
Prevent from entering drains.
Contain spillage by any means.
Sweep/shovel to safe place.
Take off immediately all contaminated clothing.
To clean the floor and all objects contaminated by this material, use water.

Issue Date: 18/3/2002 Print Date: 22/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 14357 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. +61 2 9624 0500

ERS PARTS CLEANING FLUID

INGREDIENTS	CAS No	%	TWA
solvent naphtha petroleum, heavy aliphatic	64742-96-7	100	500 ppm

NOT REGULATED UNDER UN CODE
FOR TRANSPORT OF DANGEROUS GOODS

PROPERTIES

Liquid.
Does not mix with water.
Floats on water.
Combustible.

HEALTH HAZARD INFORMATION

Acute Health Effects:
HARMFUL - May cause lung damage if swallowed.
Irritating to eyes and skin.
Vapours may cause dizziness or suffocation.
May produce discomfort of the respiratory system*.
Inhalation and/or ingestion may produce health damage*.
Vapours potentially cause drowsiness and dizziness*.
* (limited evidence).
Chronic Health Effects:
Cumulative effects may result following exposure*.
* (limited evidence).

PRECAUTIONS FOR USE

Engineering Controls:
Local Exhaust Ventilation recommended.
Glasses:
Chemical goggles.
Gloves:
PVC chemical resistant type.
Respirator:
Type A-P Filter of sufficient capacity
Storage & Transport:
Keep container tightly closed.
Keep container in a well ventilated place.
Keep away from food, drink and animal feeding stuffs.
Store in cool, dry, protected area.
Fire/Explosion Hazard:
Vapours/ gas heavier than air.
Toxic smoke/fumes in a fire.

EMERGENCY

FIRST AID
Swallowed:
Give water (if conscious). Seek medical advice.
Do NOT give milk or oil.
Do NOT give alcohol.
Eye:
Wash with running water.
Skin:
Remove contaminated clothing. Wash with water and soap.
Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.
Advice to Doctor:
Evaluate for respiratory distress. Consider lavage with cuffed tube. NO adrenalin.
Fire Fighting:
Foam.
Spills & Disposal:
Eliminate ignition sources.
Absorb with dry agent.
Stop leak if safe to do so.
Take off immediately all contaminated clothing.
To clean the floor and all objects contaminated by this material, use water and detergent.

Issue Date: 24/12/2003 Print Date: 22/11/2005

AMMONIUM NITRATE

0216
March 2001

CAS No: 6484-52-2 RTECS No: BR9050000 UN No: 1942	Nitric acid, ammonium salt NH_4NO_3 Molecular mass: 80.1

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/SYMPTOMS	PREVENTION	FIRST AID/FIRE FIGHTING
FIRE	Not combustible but enhances combustion of other substances. Explosive. Gives off irritating or toxic fumes (or gases) in a fire.	NO contact with combustibles or reducing agents.	Water in large amounts. NO other extinguishing agents. In case of fire in the surroundings: use flooding amounts of water in the early stages.
EXPLOSION	Risk of fire and explosion under confinement and high temperatures.		Evacuate danger area! In case of fire: keep drums, etc., cool by spraying with water. Combat fire from a sheltered position.
EXPOSURE		**PREVENT DISPERSION OF DUST!**	
Inhalation	Cough. Headache. Sore throat. See Ingestion.	Local exhaust or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
Skin	Redness.	Protective gloves.	First rinse with plenty of water, then remove contaminated clothes and rinse again. Refer for medical attention.
Eyes	Redness. Pain.	Safety goggles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Abdominal pain. Blue lips or fingernails. Blue skin. Convulsions. Diarrhoea. Dizziness. Vomiting. Weakness.	Do not eat, drink, or smoke during work.	Rinse mouth. Refer for medical attention.

SPILLAGE DISPOSAL	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Sweep spilled substance into non-combustible containers. Wash away remainder with plenty of water.	UN Hazard Class: 5.1 UN Pack Group: III

EMERGENCY RESPONSE	STORAGE
Transport Emergency Card: TEC (R)-540 NFPA Code: H 2; F 0; R 3; ox	Provision to contain effluent from fire extinguishing. Separated from combustible and reducing substances. Dry.

IPCS
International
Programme on
Chemical Safety

Prepared in the context of cooperation between the International Programme on Chemical Safety and the European Commission

SEE IMPORTANT INFORMATION ON THE BACK.

IMPORTANT DATA

Physical State; Appearance
COLOURLESS, HYGROSCOPIC TO WHITE SOLID IN VARIOUS FORMS

Chemical dangers
Heating may cause violent combustion or explosion. The substance decomposes on heating or producing toxic fumes(nitrogen oxides). The substance is a strong oxidant and reacts with combustible and reducing materials.

Occupational exposure limits
TLV not established.

Routes of exposure
The substance can be absorbed into the body by inhalation of its aerosol.

Inhalation risk
Evaporation at 20/C is negligible; a harmful concentration of airborne particles can, however, be reached quickly.

Effects of short-term exposure
The substance is irritating to the eyes, the skin and the respiratory tract. The substance may cause effects on the blood, resulting in formation of methaemoglobin. Medical observation is indicated. The effects may be delayed.

PHYSICAL PROPERTIES

Decomposes below boiling point at about 210/C
Melting point: 170/C

Density: 1.7g/cm^3
Solubility in water, g/100 ml at 20/C: 190

ENVIRONMENTAL DATA

This substance may be hazardous to the environment; special attention should be given to water quality.

NOTES

Becomes shock-sensitive when mixed with organic materials. Rinse contaminated clothes (fire hazard) with plenty of water. Depending on the degree of exposure, periodic medical examination is indicated. Specific treatment is necessary in case of poisoning with this substance; the appropriate means with instructions must be available.

ADDITIONAL INFORMATION

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 53848 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. -

WASTE OIL

INGREDIENTS	CAS No	%	TWA
polycyclic aromatic hydrocarbons	Various	<5	0.2 mg/m3
dibenz[a,h]acridine	226-36-8		0.005 mg/m3
mineral oil	Not avail.	>95^	

NOT REGULATED UNDER UN CODE
FOR TRANSPORT OF DANGEROUS GOODS

PROPERTIES

Liquid.
Does not mix with water.
Floats on water.
Highly flammable.

HEALTH HAZARD INFORMATION

Acute Health Effects:
HARMFUL - May cause lung damage if swallowed.
Vapours may cause dizziness or suffocation.
Inhalation and/or skin contact may produce health damage*.
May produce discomfort of the eyes, respiratory tract and skin*.
* (limited evidence).

Chronic Health Effects:
Exposure may produce irreversible effects*.
Cumulative effects may result following exposure*.
* (limited evidence).

PRECAUTIONS FOR USE

Glasses:
Chemical goggles.

Storage & Transport:
Keep container tightly closed.
Keep container in a well ventilated place.
Keep away from food, drink and animal feeding stuffs.
Store in cool, dry, protected area.

Fire/Explosion Hazard:
Highly flammable.
Vapours/ gas heavier than air.
Toxic smoke/fumes in a fire.

EMERGENCY

FIRST AID

Swallowed:
Rinse mouth with water.

Eye:
Wash with running water.

Skin:
Remove contaminated clothing. Wash with water and soap.

Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.

Advice to Doctor:
Assess airway and circulation. Consider lavage with cuffed tube. NO adrenalin.

Fire Fighting:
Foam.

Spills & Disposal:
Eliminate ignition sources.
Absorb with dry agent.
Stop leak if safe to do so.
Take off immediately all contaminated clothing.
To clean the floor and all objects contaminated by this material, use water and detergent.

Issue Date: 27/3/2003 Print Date: 18/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 12060 - NOT CONSIDERED HAZARDOUS (OSHA) / DANGEROUS (EC). - Company Contact No. +61 3 5245 1777

WASTE OILS-MACHINERY LUBRICANTS

INGREDIENTS	CAS No	%	TWA
mineral oil	Not avail.	Not spec.	
wear impurities		Not spec.	
fatty materials		Not spec.	
additives		Not spec.	

NOT REGULATED UNDER UN CODE
FOR TRANSPORT OF DANGEROUS GOODS

PROPERTIES

Liquid.
Does not mix with water.
Floats on water.
Combustible.

HEALTH HAZARD INFORMATION

Chronic Health Effects:
Cumulative effects may result following exposure*.
* (limited evidence).

EMERGENCY

FIRST AID

Swallowed:
Give milk or water (if conscious). URGENT MEDICAL ATTENTION.

Eye:
Wash with running water.

Skin:
Remove contaminated clothing. Wash with water and soap.

Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.

Advice to Doctor:
Emesis generally unnecessary. Debride for subcutaneous injection.

Fire Fighting:
Foam.

Spills & Disposal:
Eliminate ignition sources.
Absorb with dry agent.
Stop leak if safe to do so.

PRECAUTIONS FOR USE

Engineering Controls:
General Exhaust Ventilation adequate.

Glasses:
Chemical goggles.

Gloves:
PVC chemical resistant type.

Storage & Transport:
Store in cool, dry, protected area.

Fire/Explosion Hazard:
Toxic smoke/fumes in a fire.

Issue Date: 28/12/2004 Print Date: 18/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 4060-74 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. +1 800 321 8642 / +1 800 424 9300 (CHEMTREC)

HYDROCARBONS, C20 AND GREATER, PETROLEUM WASTES

INGREDIENTS	CAS No	%	TWA
1,3,5-trimethyl benzene	108-67-8	0.1-2.2	25 ppm
toluene	108-88-3	5-10	
ethylbenzene	100-41-4	0.2-1	
benzene	71-43-2	0.2-0.3	

NOT REGULATED UNDER UN CODE
FOR TRANSPORT OF DANGEROUS GOODS

PROPERTIES

Liquid.
Does not mix with water.
Floats on water.
Combustible.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Irritating to skin.
HARMFUL - May cause lung damage if swallowed.
Chronic Health Effects:
May cause CANCER.
May cause SENSITISATION by skin contact.
Possible risk of harm to the unborn child.
Harmful: danger of serious damage to health by prolonged exposure through inhalation.
Cumulative effects may result following exposure*.
* (limited evidence).

PRECAUTIONS FOR USE

Engineering Controls:
General Exhaust Ventilation adequate.
Glasses:
Not normally required.
Respirator:
Type A-P Filter of sufficient capacity
Storage & Transport:
Keep locked up.
Keep container tightly closed.
Keep container in a well ventilated place.
Keep away from food, drink and animal feeding stuffs.
Store in cool, dry, protected area.
Fire/Explosion Hazard:
Vapours/ gas heavier than air.
Toxic smoke/fumes in a fire.

EMERGENCY

FIRST AID
Swallowed:
Give water (if conscious). Seek medical advice.
Eye:
Wash with running water.
Skin:
Remove contaminated clothing. Wash with water and soap.
Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.
Advice to Doctor:
Emesis generally unnecessary. Debride for subcutaneous injection.
Fire Fighting:
Foam.
Spills & Disposal:
Eliminate ignition sources.
Absorb with dry agent.
Stop leak if safe to do so.
Take off immediately all contaminated clothing.
This material and its container must be disposed of in a safe way.
To clean the floor and all objects contaminated by this material, use water and detergent.

Issue Date: 3/4/2003 Print Date: 18/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 1789 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. +1 216 248 2600

HYDROCHLORIC ACID

INGREDIENTS	CAS No	%	TWA
hydrogen chloride	7647-01-0	30-35	
water	7732-18-5	Balance	100 mg/m3

CORROSIVE
8

UN No: 1789
Hazchem Code: 2R
DG Class: 8
Subsidiary Risk: None

PROPERTIES

Liquid.
Mixes with water.
Corrosive.
Acid.
Toxic or noxious vapours/gas.
Does not burn.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Harmful if swallowed.
Toxic by inhalation.
Causes burns.
Risk of serious damage to eyes.
Skin contact may produce health damage*.
* (limited evidence).
Chronic Health Effects:
Exposure may produce irreversible effects*.
* (limited evidence).

PRECAUTIONS FOR USE

Glasses:
Safety Glasses.
Chemical goggles.
Full face- shield.
Gloves:
1.BUTYL 2.BUTYL/NEOPRENE 3.PVC
Respirator:
Type B-P Filter of sufficient capacity
Storage & Transport:
Keep locked up.
Keep container tightly closed.
Keep container in a well ventilated place.
Keep away from food, drink and animal feeding stuffs.
Store in cool, dry, protected area.
Restrictions on Storage apply. Refer to Full Report.
Fire/Explosion Hazard:
Vapours/ gas heavier than air.
Toxic smoke/fumes in a fire.
Attacks metals to liberate hydrogen.

EMERGENCY

FIRST AID
Swallowed:
Contact doctor or Poisons Centre.
Give glass of water.
Rinse mouth with plenty of water.
Eye:
Wash with running water (15 mins). Medical attention.
Skin:
Flood body with water. Remove contaminated clothing.
Wash with water & soap. MEDICAL ATTENTION.
Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.
Advice to Doctor:
Airway problems100% O_2. Treat burns as thermal.
Retract eyelids - irrigate 30 mins.
Fire Fighting:
Keep surrounding area cool. Water spray/fog.
Spills & Disposal:
Spilled liquid has low temperature and evaporates quickly.
Control vapour with water spray/fog.
Absorb with dry agent.
Dilute with water.
Neutralize with soda ash/ lime.
Stop leak if safe to do so.
Take off immediately all contaminated clothing.
This material and its container must be disposed of in a safe way.
To clean the floor and all objects contaminated by this material, use water.

Issue Date: 17/6/2005 Print Date: 21/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 86044 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. 1800 039 008 (24 hours)

CAUSTIC SODA 50%

INGREDIENTS	CAS No	%	TWA
sodium hydroxide	1310-73-2	48-50	
water	7732-18-5	50-52	

CORROSIVE
8

UN No: 1824
Hazchem Code: 2R
DG Class: 8
Subsidiary Risk: None

PROPERTIES

Liquid.
Mixes with water.
Corrosive.
Alkaline.
Does not burn.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Causes severe burns.
Risk of serious damage to eyes.
Ingestion may produce health damage*.
* (limited evidence).

Chronic Health Effects:
Cumulative effects may result following exposure*.
* (limited evidence).

PRECAUTIONS FOR USE

Engineering Controls:
General Exhaust Ventilation adequate.

Glasses:
Safety Glasses.
Chemical goggles.
Full face- shield.

Gloves:
1.BUTYL 2.NEOPRENE 3.VITON

Respirator:
Particulate

Storage & Transport:
Keep locked up.
Store in cool, dry, protected area.
Restrictions on Storage apply. Refer to Full Report.

Fire/Explosion Hazard:
Toxic smoke/fumes in a fire.
Attacks metals to liberate hydrogen.

EMERGENCY

FIRST AID

Swallowed:
Give milk or water (if conscious). URGENT MEDICAL ATTENTION.
Do NOT delay.

Eye:
Wash with running water (15 mins). Medical attention.

Skin:
Flood body with water. Remove contaminated clothing.
Wash with water & soap. MEDICAL ATTENTION.

Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.

Advice to Doctor:
Supportive care.

Fire Fighting:
Keep surrounding area cool. Water spray/fog.

Spills & Disposal:
Absorb with dry agent.
Dilute with water.
Stop leak if safe to do so.
Take off immediately all contaminated clothing.
To clean the floor and all objects contaminated by this material, use water.

Issue Date: 5/4/2001 Print Date: 21/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 7506-70 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. +61 7 378 1570

LIME SALES LIQUID LIME (SLURRY)

INGREDIENTS	CAS No	%	TWA
calcium hydroxide	1305-62-0	30-60	
water	7732-18-5	30-60	
lime, unslaked	1305-78-8		

NOT REGULATED UNDER UN CODE
FOR TRANSPORT OF DANGEROUS GOODS

PROPERTIES

Liquid.
Does not mix with water.
Sinks in water.
Alkaline.
Does not burn.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Irritating to eyes, respiratory system and skin.

PRECAUTIONS FOR USE

Engineering Controls:
General Exhaust Ventilation adequate.
Glasses:
Chemical goggles.
Gloves:
1.NATURALRUBBER 2. 3.
Respirator:
Particulate
Storage & Transport:
Store in cool, dry, protected area.
Fire/Explosion Hazard:
Toxic smoke/fumes in a fire.
Attacks metals to liberate hydrogen.

EMERGENCY

FIRST AID
Swallowed:
Give milk or water (if conscious). URGENT MEDICAL ATTENTION.
Rinse mouth with plenty of water.
Eye:
Wash with running water (15 mins). Medical attention.
Skin:
Remove contaminated clothing. Wash with water and soap.
Inhaled:
Fresh air. Rest, keep warm.
Advice to Doctor:
Supportive care.
Fire Fighting:
Keep surrounding area cool. Water spray/fog.
Spills & Disposal:
Absorb with dry agent.
Stop leak if safe to do so.
To clean the floor and all objects contaminated by this material, use water and detergent.

Issue Date: 28/3/2003 Print Date: 21/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 13763 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. +61 8 8561 3100

PORTLAND CEMENT

INGREDIENTS	CAS No	%	TWA
calcium oxide	1305-78-8	12-16	
chromium trioxide	1333-82-0	<0.005^	
gypsum	13397-24-5	4-7	4 mg/m3
magnesium oxide	1309-48-4.	0.1-2	

NOT REGULATED UNDER UN CODE
FOR TRANSPORT OF DANGEROUS GOODS

PROPERTIES

Solid.
Does not burn.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Causes burns.
Risk of serious damage to eyes.
Inhalation may produce health damage*.
* (limited evidence).

Chronic Health Effects:
Possible respiratory and skin sensitiser*.
* (limited evidence).

PRECAUTIONS FOR USE

Engineering Controls:
General Exhaust Ventilation adequate.

Glasses:
Chemical goggles.

Respirator:
Particulate

Storage & Transport:
Keep locked up.
Keep container in a well ventilated place.
Store in cool, dry, protected area.

Fire/Explosion Hazard:
Toxic smoke/fumes in a fire.

EMERGENCY

FIRST AID

Swallowed:
Contact doctor or Poisons Centre.
Give glass of water.

Eye:
Wash with running water (15 mins). Medical attention.

Skin:
Remove contaminated clothing. Wash with water and soap.

Fire Fighting:
Keep surrounding area cool. Water spray/fog.

Spills & Disposal:
Avoid dust.
Sweep/shovel to safe place.
Take off immediately all contaminated clothing.
To clean the floor and all objects contaminated by this material, use water and detergent.

Issue Date: 15/7/2005 Print Date: 21/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 2582 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. +61 02 9839 4000

FERRIC CHLORIDE, SOLUTION

INGREDIENTS	CAS No	%	TWA
ferric chloride	7705-08-0	30-60	1 mg/m3
water	7732-18-5	30-60	

UN No: 2582
Hazchem Code: 2Z
DG Class: 8
Subsidiary Risk: None

PROPERTIES

Liquid.
Mixes with water.
Corrosive.
Acid.
Does not burn.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Harmful if swallowed.
Causes burns.
Risk of serious damage to eyes.
Chronic Health Effects:
Cumulative effects may result following exposure*.
* (limited evidence).

PRECAUTIONS FOR USE

Engineering Controls:
General Exhaust Ventilation adequate.
Glasses:
Safety Glasses.
Full face- shield.
Gloves:
1.BUTYL 2.NEOPRENE 3.VITON
Respirator:
Particulate
Storage & Transport:
Keep locked up.
Store in cool, dry, protected area.
Restrictions on Storage apply. Refer to Full Report.
Fire/Explosion Hazard:
Attacks metals to liberate hydrogen.

EMERGENCY

FIRST AID
Swallowed:
Contact doctor or Poisons Centre.
Give glass of water.
Rinse mouth with plenty of water.
Eye:
Wash with running water (15 mins). Medical attention.
Skin:
Remove contaminated clothing. Wash with water and soap.
Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.
Advice to Doctor:
Airway problems100% O2. Treat burns as thermal.
Retract eyelids - irrigate 30 mins.
Fire Fighting:
Keep surrounding area cool. Water spray/fog.
Spills & Disposal:
Prevent from entering drains.
Contain spillage by any means.
Absorb with dry agent.
Neutralize with soda ash/ lime.
Stop leak if safe to do so.
Take off immediately all contaminated clothing.
To clean the floor and all objects contaminated by this material, use water.

Issue Date: 28/3/2005 Print Date: 21/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 4557-30 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. 1300 550 081

ORICA SULFURIC ACID BATTERY GRADES (33.3%-50.1%)

INGREDIENTS	CAS No	%	TWA
sulfuric acid	7664-93-9	15-51	
water	7732-18-5	49-85	

CORROSIVE
8

UN No: 2796
Hazchem Code: 2R
DG Class: 8
Subsidiary Risk: None

PROPERTIES

Liquid.
Mixes with water.
Corrosive.
Acid.
Toxic or noxious vapours/gas.
Does not burn.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Toxic by inhalation.
Causes severe burns.
Risk of serious damage to eyes.
Chronic Health Effects:
Possible cancer-causing agent following repeated inhalation*.
* (limited evidence).

PRECAUTIONS FOR USE

Engineering Controls:
Mechanical Exhaust recommended.
Glasses:
Safety Glasses.
Chemical goggles.
Full face- shield.
Gloves:
1.NEOPRENE 2.NATURALRUBBER 3.
Respirator:
Type E-P Filter of sufficient capacity
Storage & Transport:
Keep locked up.
Keep container tightly closed.
Keep container in a well ventilated place.
Keep away from food, drink and animal feeding stuffs.
Store in cool, dry, protected area.
Restrictions on Storage apply. Refer to Full Report.
Fire/Explosion Hazard:
Attacks metals to liberate hydrogen.

EMERGENCY

FIRST AID
Swallowed:
Contact doctor or Poisons Centre.
Give glass of water.
Eye:
Wash with running water (15 mins). Medical attention.
Skin:
Flood body with water. Remove contaminated clothing.
Wash with water & soap. MEDICAL ATTENTION.
Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.
Advice to Doctor:
Airway problems100% O2. Treat burns as thermal.
Retract eyelids - irrigate 30 mins.
Fire Fighting:
Keep surrounding area cool. Water spray/fog.
Spills & Disposal:
Absorb with dry agent.
Dilute with water.
Neutralize with soda ash/ lime.
Stop leak if safe to do so.
Take off immediately all contaminated clothing.
This material and its container must be disposed of in a safe way.
To clean the floor and all objects contaminated by this material, use water.

Issue Date: 18/3/2002 Print Date: 21/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 4915-21 - NOT CONSIDERED HAZARDOUS (OSHA) / DANGEROUS (EC). - Company Contact No. +61 7 5597 6622

NATIONWIDE OIL RB 12

INGREDIENTS	CAS No	%	TWA
sulfur	7704-34-9.	< 0.5	10 mg/m3
iron	7439-89-6		3 mg/m3
silicon	7440-21-3		5 mg/m3
potassium	7440-09-7		3 mg/m3

NOT REGULATED UNDER UN CODE
FOR TRANSPORT OF DANGEROUS GOODS

PROPERTIES

Liquid.
Does not mix with water.
Floats on water.
Combustible.

HEALTH HAZARD INFORMATION

Chronic Health Effects:
Cumulative effects may result following exposure*.
* (limited evidence).

EMERGENCY

FIRST AID

Swallowed:
Give water (if conscious). Seek medical advice.

Eye:
Wash with running water.

Skin:
Remove contaminated clothing. Wash with water and soap.

Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.

Advice to Doctor:
Emesis generally unnecessary. Debride for subcutaneous injection.

Fire Fighting:
Foam.

Spills & Disposal:
Eliminate ignition sources.
Absorb with dry agent.
Stop leak if safe to do so.

PRECAUTIONS FOR USE

Engineering Controls:
General Exhaust Ventilation adequate.

Glasses:
Not normally required.

Gloves:
When handling larger quantities:
PVC chemical resistant type.

Respirator:
Type -P2 Filter of sufficient capacity

Storage & Transport:
Store in cool, dry, protected area.

Fire/Explosion Hazard:
Vapours/ gas heavier than air.
Toxic smoke/fumes in a fire.

Issue Date: 21/2/2002 Print Date: 21/11/2005

WORK-PRACTICE DATA SHEET - THIS IS A SUMMARY ONLY - FULL REPORT AVAILABLE

Chemwatch 4617-91 - HAZARDOUS (OSHA) / DANGEROUS (EC) SUBSTANCE. - Company Contact No. 61 1 000 033 111

BLUE CIRCLE FLY ASH

INGREDIENTS	CAS No	%	TWA
fly ash - low quartz	68131-74-8	100	

NOT REGULATED UNDER UN CODE
FOR TRANSPORT OF DANGEROUS GOODS

PROPERTIES

Does not mix with water.
Sinks in water.
Does not burn.

HEALTH HAZARD INFORMATION

Acute Health Effects:
Irritating to eyes, respiratory system and skin.
Inhalation may produce health damage*.
* (limited evidence).

Chronic Health Effects:
Harmful: danger of serious damage to health by prolonged exposure through inhalation.
Cumulative effects may result following exposure*.
* (limited evidence).

PRECAUTIONS FOR USE

Engineering Controls:
Local Exhaust Ventilation recommended.

Glasses:
Chemical goggles.

Gloves:
PVC chemical resistant type.

Respirator:
Particulate

Storage & Transport:
Keep container in a well ventilated place.
Keep away from food, drink and animal feeding stuffs.
Store in cool, dry, protected area.

EMERGENCY

FIRST AID

Swallowed:
Rinse mouth with water.

Eye:
Wash with running water.

Skin:
Remove contaminated clothing. Wash with water and soap.

Inhaled:
Fresh air. Rest, keep warm. If breathing shallow, give oxygen. Medical attention.

Advice to Doctor:
Treat symptomatically.

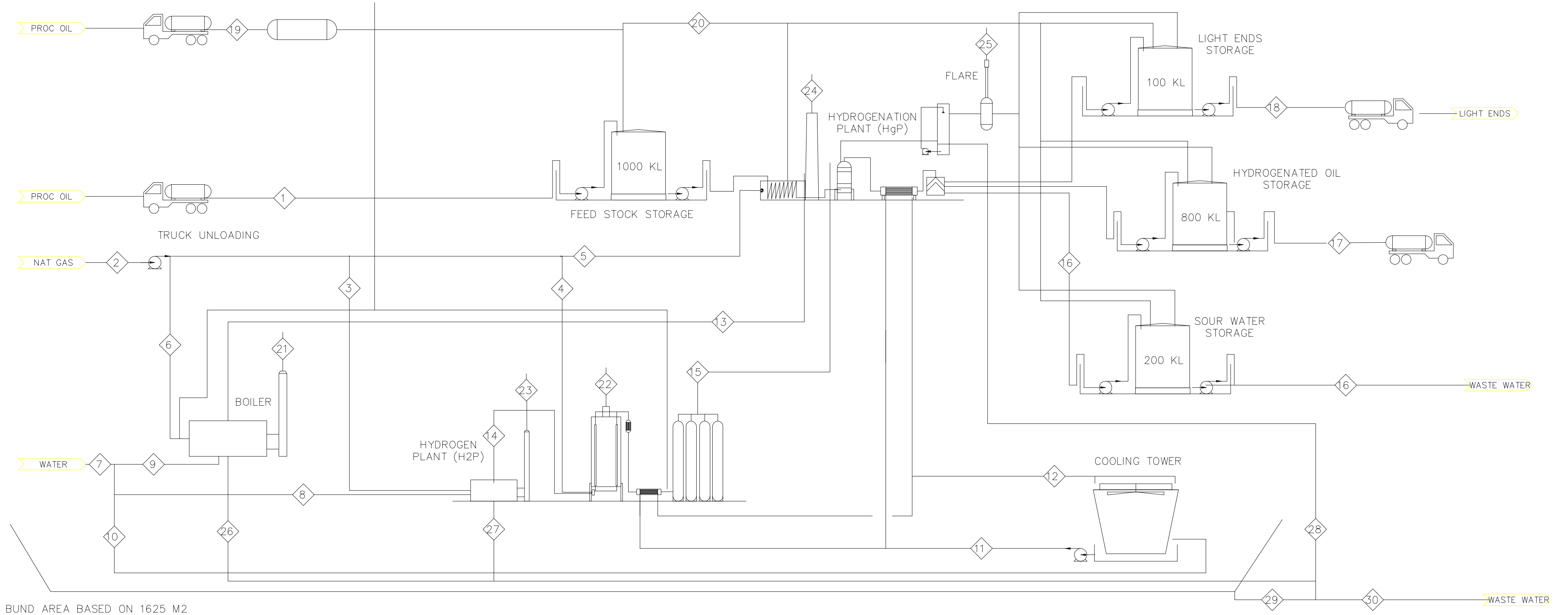
Fire Fighting:
Keep surrounding area cool. Water spray/fog.

Spills & Disposal:
Take off immediately all contaminated clothing.
To clean the floor and all objects contaminated by this material, use water and detergent.

Issue Date: 2/11/2004 Print Date: 21/11/2005

Appendix C

Piping and Instrument Diagrams



** BUND AREA BASED ON 1625 M2

Stream	PRE-TREATED OIL		NATURAL GAS (88% Methane)					RAW WATER				COOLING WATER	
Stream Number	1	1	2	3	4	5	6	7	8	9	10	11	12
Source	TRUCK UNLOAD	TRUCK UNLOAD	MAIN SUPPLY	GAS COMPR.	GAS COMPR.	GAS COMPR.		RAW SUPPLY	WATER SUPPLY	WATER SUPPLY	WATER SUPPLY	COOLING TOWER	H2P HgP
Destination	TK-1/2/3 TK-4/5/6	TK-1/2/3/ TK-4/5/6	GAS COMPR	H2P STM GENER.	H2P	HgP, FLARE PILOT BURNER, BOILER		COMB. FLOW	H2 STM GENER.	BOILER	COOLING TOWER	H2P HgP	COOLING TOWER
Concentration Oil (%)	99	99	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Flow	4 T/Hr	36000 T/Y	>360	11 GJ/Hr	5 GJ/Hr	6 GJ/Hr		4500 L/Hr	250 L/Hr	1250 L/Hr	3000 L/Hr	210 M3/Hr	210 M3/Hr
Pressure (kPag)	<500	< 500	35 – 100	1800	1800	1800		600	600	600	600	<700	< 500
Temperature (˚ C)	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT	AMBIENT		AMBIENT	<100	100	AMB.	28.5	36.5
KW	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	2000	2000
S02	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
C02	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
N2	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
H20	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
02	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Sulphur	.024 T/Hr	74 T/Y	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A

Stream	STEAM		H2	SOUR WATER	BASE OIL	LIGHT ENDS	NITROG.	NITROG.	AIR EMISSIONS				
Stream Number	13	14	15	16	17	18	19	20	21	22	23	24	25
Source	BOILER	H2P STM GENER.	H2P STM GENER.	TK-10	TK-5/6/7 TK-8/9	TK-11	SUPPLIER	STORAGE	BOILER	H2P REFORMER	H2P STM GENER.	HgP HEATER	FLARE
Destination	HYDROG. PLANT	H2 PROD.	HYDROG. PLANT	WATER TREAT.	TRUCK LOAD	HYDROG. PLANT	STORAGE	PURGES	ATMOSPH.	ATMOSPH.	ATMOSPH.	ATMOSPH.	ATMOSPH.
Concentration Oil (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flow	2000 KG/H	250 KG/H	250 NCMH	3283 T/Y	33436 T/Y	2000 T/Y	60.48 T/Y	60.48 T/Y	1443 AM3/Hr	>10 M/S	>10 M/S	1546 AM3/Hr	4912 AM3/Hr
Pressure (kPag)	1000	1800	1379	<500	<500	<500	1500	0.6	ATMOSPH	ATMOSPH	ATMOSPH	ATMOSPH	ATMOSPH
Temperature (˚ C)	178	210	38	<40	<40	<40	<0	25	~240	~1010	~240	~240	~200
KW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7 G/Nm3	5 G/Nm3
C02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	158 G/Nm3	158 G/Nm3	158 G/Nm3	149 G/Nm3	96 G/Nm3
N2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	919 G/Nm3	919 G/Nm3	919 G/Nm3	917 G/Nm3	77 G/Nm3
H20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	117 G/Nm3	117 G/Nm3	117 G/Nm3	120 G/Nm3	943 G/Nm3
02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	55 G/Nm3	55 G/Nm3	55 G/Nm3	55 G/Nm3	141 G/Nm3
Sulphur	N/A	N/A	N/A	0.43 kg/Hr	N/A	N/A	N/A	N/A					

Stream	EFFLUENT WATER				
Stream Number	26	27	28	29	30
Source	BOILER	H2P GENER.	STRIPPER COND.	BUNDS**	COMB FLOW
Destination	W/WATER	W/WATER	W/WATER	W/WATER	W/WATER
Concentration Oil (%)	0	0	<1%	<1%	<1%
Flow	100 L/Hr	15 L/Hr	1 kL/Hr	185 L/Hr	1.3 kL/Hr
Pressure (kPag)	<500	< 500	< 500	<650	<650

DRAWING No.
REFERENCE DRAWINGS

TRANSPACIFIC INDUSTRIES PTY LTD
CORONATION DRIVE
MILTON, QLD
Telephone (07) 33677800

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	RNM	8/05	EIS DRAFT- N2 ADDED		
A	RNM	8/05	EIS DRAFT		

	BY	DATE
PROJ. APP.		
DESIGN APP.		
DESIGNED		
CHECKED		
DRAWN	RNM	08/05

CLIENT
TRANSPACIFIC INDUSTRIES PTY LTD

SIZE A1
SCALE NTS
CAD FILE No. 10F8003

TITLE
RUTHERFORD PROJECT
HYDROGENATION FLOW SHEET

REV. No. 1 2
DRAWING No.
TPI-10-F-8001