Santos

Fitness for Purpose Report 2006

For Compliance with the Petroleum Act 2000
South Australia

29 September 2006.

Contents

1 Introduction

The South Australian PETROLEUM ACT 2000 (the "**Act**") and the Petroleum REGULATIONS 2000 under the Act (the "**Regulations"**).

Some of the objectives of the Act and the Regulations are to create an effective, efficient and flexible regulatory system for industries, to which the Act applies, to:

- Protect the public from risks,
- Minimise environmental damage and
- Ensure security of supply for users of natural gas.

Under this Act, Santos Limited ("Santos") is required to have granted, from the Minister, various licences to perform various regulated activities as defined by the Act.

In accordance with the Regulations, Santos, as a licence holder under the Act, is also required to provide the Minister with specific information and perform certain activities as defined by the Regulations.

This report is provided to the Minister for Primary Industries and Resources of South Australia (PIRSA). The report demonstrates how Santos is:

- Managing risk as part of its overall business activities.
- Complying with the requirement to carry out periodic **FITNESS FOR PURPOSE ASSESSMENTS**, for the facilities within **Santos' Production Licences**, as defined by Item 30. of the Regulations.

The report has been developed from the complete hazard identification and risk assessment review conducted by Santos as part of its on-going business management. This detailed report forms part of Santos' management obligation to its joint venture partners, its Directors, Shareholders and the community.

About the Company

Santos is a major Australian oil and gas exploration and production company with interests and operations in every major Australian petroleum province and in the United States, Indonesia, Papua New Guinea, Vietnam, Kyrgyzstan and Egypt. Founded in 1954, Santos has been active in the energy business for more than 50 years.

Santos made its first significant discovery of natural gas in the Cooper Basin with the Gidgealpa 2 well in 1963. The Moomba 1 discovery in 1966 confirmed this region as a major petroleum province. As a result of these discoveries, Santos had a commercially viable quantity of gas and entered into Gas Sales Agreements with the South Australian Gas Company, the Electricity Trust of South Australia and the Australian Gas Light Company. Gas supply commenced in 1969. The Cooper Basin, which Santos and its joint venture partners have developed, is Australia's largest onshore resources project.

Santos is now one of Australia's largest gas producers, supplying sales gas to all mainland Australian states and territories, ethane to Sydney, and oil and liquids to domestic and international customers.

At year end 2005, Santos had a total market capitalisation of approximately $7.9 billion, making it one of Australia's Top 40 companies.

Santos operates the gas and oil production facilities in the Cooper and Eromanga Basins on behalf of 11 Joint Venture Partners who are parties to the SA Cooper Basin Unit Agreement.

These Companies are:

- Santos
- Santos (BOL) Pty Ltd (a wholly owned subsidiary of Santos)
- Santos Petroleum Pty Ltd (a wholly owned subsidiary of Santos)
- Vamgas Pty Ltd (a wholly owned subsidiary of Santos)
- Reef Oil Pty Ltd (a wholly owned subsidiary of Santos)
- Origin Energy Resources Ltd
- Santos (NARNL COOPER) Pty Ltd (a wholly owned subsidiary of Santos)
- Delhi Petroleum Pty Ltd
- Bridge Oil Developments Pty Ltd (a wholly owned subsidiary of Santos)
- Basin Oil Pty Ltd (a wholly owned subsidiary of Santos)
- Alliance Petroleum Australia Pty Ltd (a wholly owned subsidiary of Santos).

Santos is the designated operator for activities conducted, pursuant to the South Australian Petroleum Act 2000, within the 192 Petroleum Production Licences (PPLs 6 to 199 inclusive and 206 but excluding PPLs 21, 62 and 168) within the South Australian sector of the Cooper and Eromanga Basins.

Santos' Operations function is responsible for these PPL operations.

At the time of preparing this report, a total of 1,126 wells are operated by Santos and the Joint Venture parties in the SACB. A summary of these wells is available in section 4.1 on page 16.

2 Executive Summary

Overview

The 'Fitness for Purpose' report demonstrates how Santos is:

- Managing risk as part of its overall business activities, and is
- Complying with the requirements of the Act, and the Regulations, as they relate to the facilities within the Petroleum Production Licences granted by PIRSA.

This report has been compiled to address the impacts of identified hazards and risks on:

- Public Health and Safety;
- Environment; and
- Reliability of supply of natural gas,

for the whole of the Santos production facilities in the Cooper and Eromanga Basins, SA.

Fitness for Purpose

Santos is satisfied that the status and condition of the facilities, including utility systems, and the management systems and procedures, are fit for the purpose of satisfying public health and safety, environment and reliability of production and supply of natural gas requirements of the Act and in particular, item 30 of the Regulations. Projects identified within this report will enhance the ongoing fitness for purpose.

Major Improvements since Last Report

In line with Santos' commitment for improvement, the following is a summary of the major improvements to its facilities and systems that have occurred, or have commenced implementation, within the last five years. These items demonstrate the continuing effort that is being directed to complying with the intent and spirit of the Act, and associated Regulations, and evolving regulatory and community expectations.

- A further six third-party reviews have been commissioned by Santos to identify opportunities to improve facility operations and extend its risk mitigation action plans. The six reviews add to the sixteen reported against in the 2001 FFP report and include:
  - Three separate integrity reviews by Shell Global Solutions,
  - A Whole of Plant Risk Assessment (WOPRA) study facilitated by GHD-Qest and included extensive across the board involvement by Santos employees,
  - A review of Moomba plant integrity (MIRP) by Aker-Kvaerner.
  - An Insurer survey by Swiss Re and Marsh Pty Ltd (combined).
- Introduction and implementation of the Environment, Health and Safety Management System (EHSMS) that sets the core values, guiding principles and standards for Santos operations and associated activities.
- Launching a Competency Based Training (CBT) system that requires demonstration of required competencies for operating and maintenance personnel.
- Updating Operator Manuals and Operating Procedures.
- Asset Integrity Management Systems (AIMS) and Integrity Management Plans (IMP) for the Moomba Plant.
- Sweet Gas Header replacement with inhibitor injection and corrosion monitoring probes installed.
- Installation of facilities for the removal and recovery of mercury in the raw gas streams entering the Moomba Plant.
- Moomba Corrosion Under Insulation (CUI) programme developed and commenced.
- Commitment to addressing the risks associated with Pig launchers and receivers throughout the whole operation through high integrity surveillance.
- Extensive upgrade of the Moomba Plant Instrument Air system to provide three 50% capacity electrically driven air compressors and a diesel-fuelled back-up compressor.

- Commissioning of a Two-stage Reverse Osmosis (RO) Plant that has been reliably producing water suitable for boiler steam production and hence increasing the reliability of the Boiler Feed Water (BFW) and steam utilities.
- In addition to the RO Plant, the following programmes have also aided the improved reliability of the BFW / Steam system:
  - A service contract with a specialist water treatment company to manage, monitor and control the BFW quality.
  - Improved condensate recovery through a steam trap survey and upgrade programme, throughout 2003-04, using a company that specialises in steam usage and condensate recovery.
  - Installation of corrosion inhibitor injection facilities and corrosion monitoring probes in the steam condensate header.
- Implementation of the Asset Control Enhancement (ACE) Project that provided:
  - An upgrade of the Moomba plant control systems,
  - A replacement Distributed Control System (DCS),
  - Upgraded emergency shutdown systems (programmable trip systems),
  - Upgraded boiler control and management,
  - Improved power generation,
  - Electrical load management,
  - Upgraded gas turbine control systems,
  - Upgrades to the Moomba central control room,
  - Upgrade management information system and control softwares.
  - Improved control systems on the Area 65 LRP refrigeration gas turbine driven compressor packages.
- The Heating, Ventilation and Air Conditioning (HVAC) project for the upgraded Operations Control Centre (OCC).
- Implementation of the Hazardous Area Remediation and Upgrade Project (HARUP) in conjunction with the ACE Project.
- Implementation of the High Voltage Upgrade Project.
- Implementation of the Moomba UPS and Battery Charger Upgrade Project.

Santos Facilities

Refer Item 30. (6) (a) of the Regulations.

Following application, Santos was granted approval by PIRSA in memo P Klaosen / B Goldstein dated 27 April 2004, to report in terms of the following grouping of facilities:

- Gathering systems between individual wells, satellites and the Moomba Plant.
- Gas and Oil Satellite facilities.
- Moomba Processing Plant and Utility systems.

Santos has also considered the Petroleum wells that are constructed, operated, maintained and abandoned by Santos when compiling this Fitness for Purpose report.

At the time of compiling this report, the gas gathering system transports raw gas from 512 dedicated raw gas wells through 12 gas satellite facilities. Similarly, the oil gathering system is providing crude oil from 134 oil wells through 10 oil satellite facilities. The outputs from the gas and oil satellites are directed to the Moomba processing plant via a network of trunklines.

Assumptions, Sensitivities and Gaps

Refer Item 30. (8) (d) and Item 30. (8) (c) of the Regulations.

The main assumptions and the associated sensitivities within the risk assessments conducted by Santos personnel or independent groups relate to the degrees of 'Consequence' and 'Likelihood' applied to the various risk scenarios assessed.

A two dimensional risk matrix (consequence and likelihood), which is based on Table T2 of standard AS 4360 (1999 version), was used for the risk assessment of the majority of risk scenarios addressed. Wherever possible, historical data has been used to quantify the extent of product disruption in determining the level of the consequence. Similarly, the probability of an event occurring has been supported by Santos records where available.

In the absence of historical data, best quantitative judgements have been made based on the experience of third party and/or Santos professional personnel. Use of data from similar industry and facilities has also been consulted where appropriate.

Santos has not identified any significant 'lack of relevant information' or significant degree of uncertainty at the time of preparing the 2006 Fitness for Purpose report.

Hazard Identification

Santos has been identifying, assessing and addressing hazards and risks associated with its operations since the Moomba facilities were commissioned in 1969. Santos has performed these tasks using both in-house resources and has also commissioned and accommodated external, independent, third party organisations to survey, review and report on its operations and facilities.

Santos, 'EHSMS 09 - Hazard Identification, Risk Assessment and Control' is a standard in place to ensure that in-house processes are established and maintained to systematically identify EH&S hazards and assess and control their level of risk.

Santos has benefited from twenty-two (22) separate risk based surveys by independent organisations, including insurer groups, since 1984:

- 6 insurance-based inspections since 1992.
- 3 preliminary risk assessment surveys for major, new projects during 1992 and 1994.
- 13 risk based surveys of operating facilities and systems since 1984.
  (Five of which have been conducted in the last 5 years).
- A further visit by Marsh Pty Ltd (Santos' insurance broker) is scheduled for the fourth quarter 2006.

The hazards, risks and improvement projects identified have been individually assessed. Significant risks and hazards have been addressed, while others have been allocated a priority for future follow-up or further assessment for implementation.

The independent organisations that have performed these surveys are respected, creditable organisations, including:

- ABB Power Generation (1 survey).
- ACARRE (2 surveys).
- Aker-Kvaerner (1).
- DNV Technica (2).
- GHD-Qest (1).
- ICIAE (2).
- Marsh & McLennan (1).
- Sedgwick Energy Ltd. (4).
- SHE Pacific (1).
- Shell Global Solutions (3).
- SMEC-HGM (3).
- Swiss Re and Marsh Pty Ltd (1).

Confidentiality

The various risk assessment reports prepared by Santos and independent third party organisations which are referred to in this report contain commercially confidential information. Reference is made to these reports within this *Fitness For Purpose* Report, but the various assessment reports will not be provided as part of this *Fitness For Purpose* Report.

Risk Assessment

Refer Item 30. (6) (c) of the Regulations.

The attention to hazard identification, risk assessment and risk control has been a continuous improvement process from the major efforts of the late eighties and early nineties to the Whole of Plant Risk Assessments (WOPRA) and significant improvements implemented with the development of a comprehensive corporate-wide EHSMS.

Santos and its customers have benefited from numerous reviews by external technical and insurance companies over a period of two decades. These independent companies have assessed specific risks associated with the facilities and operations.

The potential risks have been assessed for numerous potential incident scenarios and action plans have been developed based on the priorities assigned.

Over the last decade the higher ranked risk scenarios have included:

- Electrical System Load Capacity Shortfall;
- Electrical System Transient Load Instability;
- Shared Electrical Equipment Causes Blackout;
- Lack of Steam Boiler Capacity;
- Corrosion induced major events.

A significant number of risk reduction mechanisms have already been implemented by Santos, including ones to specifically address the scenarios above. Additional projects and systems are scheduled for implementation or are being considered or assessed. The extent and status of the major improvements are outlined in 'Risk Reduction Measures (ALARP)' on page 57.

Based on the reliability performance of the Santos facilities and the most recent independent risk assessment reviews, the areas identified as having the greatest collective potential to impact on the reliability of supply of natural gas, or the environment, have been grouped as follows:

- Liquids spill into a sensitive environment due to a pipeline failure.
- Major facility incident.
- Large local rain or flood impact leading to curtailment of gas development programme.
- Inadequate subsurface asset management.

Risk Reduction Measures

Refer Item 30. (9) of the Regulations.

Risk reduction measures, implemented or under review by Santos, have been in support of findings and recommendations from the following independent surveys:

- Sedgwick Energy Ltd., Underwriting reports, Aug 1995 and Oct 1997.
- ICIAE, Insurance Indemnity Review, March 1996.
- Marsh & McLennan, Insurance Assessment Report, Dec 1998.
- ABB Power Generation, Moomba Steam Generators, March 1999.
- SHE Pacific, Risk Review of Moomba Processing Plant, May 2000.
- SMEC-HGM, three reports on Moomba Power System facilities and asset management plus Moomba Utilities, May, Aug and Sept 2000.
- Aker-Kvaerner, Moomba plant integrity (MIRP), commenced in 2002.
- GHD-Qest, Whole of Plant Risk Assessment (WOPRA) studies:
  - 2002, for the Moomba Plant,
  - 2003, for the Moomba South Central Satellite.

- Swiss Re and Marsh Pty Ltd (combined), the Moomba Gas Plant, in 2004.
- Shell Global Solutions, three separate integrity reviews:
  - Static Equipment, February 2005.
  - Pipelines and Rotating Equipment, October 2005.
  - Electrical and Instrumentation, May 2006.

Several of the projects or systems implemented for the Moomba Plant, as a result of these surveys and findings, include:

- New 5 MW Gas Turbine Alternator (GTA2).
- An upgrade to the High Voltage (HV) distribution system.
- UPS and Battery Charger System Upgrades.
- Boiler Feedwater Upgrade Projects which included:
  - Boiler No.10 Overhaul, Monitoring and Inspection Programme,
  - A two-stage Reverse Osmosis RO) Plant for high quality boiler feed water.
- Emergency Isolation Valves (EIV) on critical trunklines and propane accumulators.
- The Asset Control Enhancement (ACE) project that provided.
  - An upgrade of the Moomba plant control systems,
  - A replacement Distributed Control System (DCS),
  - Upgraded emergency shutdown systems (programmable trip systems),
  - Upgraded boiler control and management,
  - Improved power generation,
  - Electrical load management,
  - Upgraded gas turbine control systems,
  - Upgrades to the Moomba central control room,
  - Upgrade management information system and control softwares,
  - Improved control systems on the Area 65 LRP refrigeration gas turbine driven compressor packages.

Other significant projects and systems that have been implemented as risk mitigation mechanisms in the last decade include:

- Asset Integrity Management Systems (AIMS) and Integrity Management Plans (IMP) for the Moomba Plant.
- Corrosion Control programme for pipelines, plant and equipment.
- Pipeline upgrades and replacements.
- Removal and recovery of mercury from raw gas streams entering the Moomba Plant.
- Sweet Gas Header replacement.
- Liquids Pumping Station reinstatement.
- Operational competencies based on Competency Based Training (CBT).
- Control and emergency system upgrades at Satellite facilities.
- Updated Operating Procedures and Operator Manuals.
- Sales Gas Back-up Line.
- Moomba Instrument Air System Upgrade.

Improvement projects that are currently being investigated, engineered or scoped and could possibly be considered in the next 5 years include:

- Upgrade of the Dew Point Control Units Area 55 Switching Valves.
- Upgrade of the HP Flare header including the installation of an additional HP flare knockout drum.
- Upgrade of the LRP cold drain and emergency depressuring system.
- Continuation of the UPS and battery charger system upgrades.
- Higher integrity surveillance of pig launchers and receivers.
- Refurbishment of the Tantanna to Gidgealpa Trunkline.
- Further BFW improvements.

The risk reduction measures and improvement projects implemented have reduced risks and enhanced the overall fitness for purpose of the facilities. The planned projects are directed at further enhancing the fitness for purpose.

Effectiveness of Management Systems

Refer Item 30. (3) (b) of the Regulations.

The Santos EH&S Management System (EHSMS) is compliant with Australian Standard (AS) 4801:2000 Occupational health and safety management systems and AS/NZS ISO 14001:1996 Environmental management systems. The EHSMS comprises 33 core management standards which apply to matters of environment, health, safety and security of production and to all business aspects of its operations.

The EHSMS also comprises detailed hazard standards for environment and health and safety separately. These standards address the key hazards present within Santos operations and documents the controls required to adequately manage these hazards. There are a total of 12 environmental and 26 health and safety standards.

The total set of standards defines expectations of what is required to ensure that environment health and safety risk is systematically managed. Employees and contractors are expected to work in accordance with the EHSMS.

It should be noted that the EHSMS is a true system with a very rigorous audit and assessment program to demonstrate internal conformance with the requirements of the standards. Each year EHSMS assessments are conducted by independent, external auditors who review progress of the implementation of the standards against document assessment protocols. Each site receives a score, out of a maximum of 100%, along with a report documenting good practices and improvement opportunities.

Therefore, in summary, Santos' management of Public Health and Safety, Environment and the Security of Production and Supply of Natural Gas can be specifically linked to the following Company systems:

- Environment and Health and Safety Policies.
- Santos EHSMS.
- EMSHS management standards.
- EHSMS hazard standards.
- Procedures and processes.
- Specifications, Guidelines and Work Instructions.
- Assessment and Auditing Programs.
- Regular performance reporting to senior management and the Santos Board.

These systems address Santos' practices that range from design, construction, procurement, operations, maintenance through to audits/inspection and emergency response.

Public Health and Safety

Refer Item 30. (2) (a) of the Regulations.

The Santos gas and oil facilities are located in the Central Australian desert approximately 800 Km north of Adelaide, remote from population.

The remoteness and low exposure to the public, the use of International, National, and accepted Industry Standards and ongoing monitoring and inspection programs result in the assessed risks associated with public health and safety from the facilities and activities being regarded as low to negligible. This is supported by the fact that there have been no instances of adverse impact to public health and safety by Santos production operations in 37 years of operations.

The policies, EH&S management system and procedures applied by Santos for the Occupational Health and Safety protection of employees and contractors, are equally applicable to Public Health and Safety protection.

Impact of Environment on Facilities

Refer Item 30. (3) (c) of the Regulations.

The potential impact of environmental conditions on the safety and integrity of Santos operating facilities is an integral part of facility and equipment design.

Due to the isolation of these Santos production facilities, the risk of pipeline or equipment damage due to external factors (eg. Collision, excavation etc.) is assessed as low.

Pipeline and equipment integrity are maintained and monitored in accordance with Australian Standard AS2885 and AS/NZS 3788.

The systems and mechanisms utilised by Santos to manage any corrosion impacts are outlined on page 37, 'Corrosion Control'.

All of the integrity programs employed by Santos are being integrated into the EHSMS. This work represents the first major revision of the EHSMS since its introduction in 2003. The changes will incorporate a major body of work titled process safety management which addresses the rare but high consequence loss of containment scenarios that could occur it Santos' operations.

Impact of Facilities on Environment

Refer Item 30. (2) (b) of the Regulations.

Santos provides PIRSA with separate documentation addressing:

- Section 97 of the Act and Item 10 of the Regulations;
  - Environmental Impact Report (EIR).
- Sections 99 and 100 of the Act and Items 12 and 13 of the Regulations;
  - Statement of Environmental Objectives (SEO).

EIRs identify potential hazards and consequences associated with Santos' operations. EIRs have been developed for:

- Geophysical operations.
- Drilling and work-over operations.
- Production and processing operations.
- Moomba to Port Bonython Liquids Line (PL2).
- Jena Waterflood Pilot Project.

The Statement of Environmental Objectives (SEO) sets objectives and progressive targets for managing the potential environmental risks.

Three SEOs have been produced by Santos, addressing general operations, rather than specific projects or operations. They cover:

- Geophysical operations.
- Drilling and work-over operations.
- Production and processing operations.

Broadly, each SEO details the following requirements:

- A list of environmental objectives to be used when assessing Santos' compliance.
- Assessment methods (including goal attainment scaling or GAS, scientific surveys and studies, photo monitoring).
- Assessment criteria (for each objective).
- Auditing and reporting (including audits by PIRSA, Santos and third parties as well as incident reporting).
- Document revision (when it will be reviewed and consultation).

Additional SEOs have been developed that cover specific projects.

The Santos EHSMS is the key tool for managing Santos' environmental responsibilities, issues and risks. Within this framework, a number of programs have been developed focusing on continuous improvement and minimising environmental impacts, including:

- Regulatory compliance audit program
- Oil spill reduction strategy
- Cultural heritage management
- Waste management plans development and implementation
- Development and use of soil health index
- Development and use of oil spill remediation end point criteria
- Seismic rehabilitation programs
- Moomba Land-farm management
- Improving sludge collection and treatment
- Manage and prevent failures on oil trunklines and gathering lines
- Satellite upgrades to improve environmental performance.

Adequacy of Utilities

Refer Item 30. (3) (e) of the Regulations.

Significant attention has been directed toward improving the reliability of the Moomba Plant utility systems over the last 10 years.

Specific risk reduction projects or operating practices have been implemented or are continually being engineered for assessment and consideration as a result of historical performance investigations and corrective actions plus third party and internal operational reviews. The most significant operational assessments and recommendations for the utility systems have been provided by:

- Internal Santos operations, eg. 'Moomba Utilities Review - Study Report,
- ABB Power Generation,
- SHE Pacific,
- Snowy Mountains Engineering Corporation (SMEC-HGM Pty Ltd), and
- Shell Global Solutions, Electrical and Instrumentation, May 2006.

These projects and practices include:

- Installation of a new 5MW Gas Turbine Alternator (GTA2) at the Moomba plant.
- Upgraded Uninterrupted Power Supply (UPS), battery charger systems and switchgear trip circuit supervisory systems.
- Boiler Feed Water (BFW) treatment.
- New instrument air compressors and associated systems.
- An upgrade to the High Voltage (HV) distribution system.
- The Asset Control Enhancement (ACE) project that provided;
  - Upgraded emergency shutdown systems (programmable trip systems),
  - Upgraded boiler control and management,
  - Improved power generation,
  - Electrical load management,
  - Upgraded gas turbine control systems,
- The BFW projects that have been implemented.
- The overhaul and the recent reliable performance and the subsequent inspection of No.10 Boiler.
- Operating philosophy of maintaining one boiler on-line, incremental to satisfying steam demand.

Refer to Section 12 on page 54 for complete details of this subject.

Emergency Procedures

Refer Item 31. of the Regulations.

A summary of emergency procedures that are applicable to the Moomba production facilities in South Australia is outlined below:

- South Australia Emergency Management Plan.
- Moomba Emergency Response Plan.
- Moomba Aerodrome Emergency Response Plan.
- Moomba Contingency Pre-plan.
- Moomba Security Plan
- Moomba Plant and Utilities failure.
- Cooper Basin Field Contingency Pre-plan
- An overview of plans, mustering requirements is detailed during the mandatory induction.

Over thirty exercises were conducted during 2005 with forty two exercises scheduled for 2006.

Physical Condition of the Facilities

Refer Item 30. (3) (a) of the Regulations.

Santos' operations extend from the gas and oil wells through to the output from the Moomba Processing Plant.

Santos has regularly inspected the facilities and systems operated by Santos in the Cooper/Eromanga Basins of South Australia and found them to be sound and fit for purpose.

Santos makes this statement based on:

- Santos EHSMS ensures policies, standards and procedures are in place, continually reviewed and updated.
- Pipelines are designed, constructed and operated in accordance with Australian Standard AS2885 "Pipelines – Gas and Liquid Petroleum".
- Pressure vessels are inspected in accordance with AS/NZS 3788 "Pressure Equipment – In-Service Inspection".
- The company's use of independent third party surveys, specifically:
  - 6 insurance-based inspections since 1992.
  - 3 preliminary risk assessment surveys for major, new projects during 1992 and 1994.
  - 13 risk based surveys of operating facilities and systems since 1984. (Five of which have been conducted in the last 5 years).
- Identified risks, hazards and improvement projects have been assessed. Significant risks and hazards have been or are being implemented while the remainder have been prioritised.

Current and Expected Fitness for Purpose

Refer Item 30. (6) (d) of the Regulations.

In addition to the assessment of the current 'Physical Condition of Facilities', it is Santos' view that the facilities and systems operated by Santos in the Cooper and Eromanga Basins are considered sound and fit for ongoing purpose for at least the next 5 years.

Samples of specific items that support this belief include (Refer to Section 15.2 on page 69 for a full listing of initiatives over the last five years)15.3 on page 70:

- A further six third-party reviews to identify opportunities to improve facility operations and extend its risk mitigation action plans.
- Introduction and implementation of the Santos Environment, Health and Safety Management System (EHSMS).
- A Competency Based Training (CBT) system that requires demonstration of required competencies for operating and maintenance personnel.
- Continued updating of Operator Manuals and Operating Procedures.

- Asset Integrity Management Systems (AIMS) and Integrity Management Plans (IMP) for the Moomba Plant.
- Implementation of the Asset Control Enhancement (ACE) Project.
- Implementation of the Hazardous Area Remediation and Upgrade Project (HARUP) in conjunction with the ACE Project.
- Implementation of the High Voltage Upgrade Project.
- Implementation of the Moomba UPS and Battery Charger Upgrade Project.
- Sweet Gas Header replacement with inhibitor injection and corrosion monitoring probes installed.
- Installation of facilities for the removal and recovery of mercury in the raw gas streams entering the Moomba Plant.
- Moomba Corrosion Under Insulation (CUI) programme developed and commenced.
- Extensive upgrade of the Moomba Plant Instrument Air system to provide three 50% capacity electrically driven air compressors.
- Commissioning of a Two-stage Reverse Osmosis (RO) Plant that has provided reliable quality Boiler Feed Water (BFW) and reliable steam utilities.
- A service contract with a specialist water treatment company to manage, monitor and control the BFW quality.

In addition to the improved systems and the improvement facility projects, over the last five years, which have enhanced the fitness for purpose of Santos operations, the reliability of gas supply is also enhanced by:

- being able to switch to an operating mode referred to as Dewpoint Control Mode (DPCM) to maximise sales gas supply during periods of certain plant disruptions, and
- the plans for recovering from a significant emergency have been enhanced to further accommodate the unlikely event of an Estimated Maximum Loss (EML) incident.

Expected ongoing improvements in facilities and systems over the next five years will be supported by:

- Ongoing commitment to Santos' EHSMS.
- Continued support for the corrosion monitoring and control programme.
- Continued internal auditing, incident management and risk control mechanisms.
- Independent surveys.
- Ongoing review, monitoring and maintenance of wellbores, well operations and conducting of well workovers.
- Approved projects that are planned for implementation to further enhance fitness for purpose, including:
  - Upgrade of the Dew Point Control Units Area 55 Switching Valves.
  - Upgrade of the HP Flare header including the installation of an additional HP flare knockout drum.
  - Upgrade of the LRP cold drain and emergency depressuring system.
  - Continuation of the UPS and battery charger system upgrades.
  - Higher integrity surveillance of pig launchers and receivers.
  - Refurbishment of the Tantanna to Gidgealpa Trunkline.
- Ongoing attention to and assessment of the equipment and control systems for the Moomba Plant utility facilities, namely compressed air, power generation / distribution and steam availability.
- Other projects that will be identified, investigated, engineered or scoped as a result of Santos' continual review of equipment and systems to improve their operations.

Based on the above, Santos is of the view that there are no significant known or relevant operational or environmental hazards and associated risks that have not been identified and assessed at the time of preparing the 2006 Fitness for Purpose report.

Security of Production and Supply

Refer Item 30. (2) (c) of the Regulations.

Due to the extensive number of gas wells (approximately 500), feeding into 12 individual gas satellite facilities, which are connected to the Moomba plant through 9 separate trunklines, the risk of significant interruption to production of raw gas supply to the Moomba plant, for any significant period, is considered negligible.

Reliability of sales gas supply to purchasers of gas from SACBJV depends on the Moomba processing plant continuing to deliver sales gas in situations when sections of the processing plant are unavailable. These situations include outage of individual equipment items, common mode failures or major incidents.

The scenario, potentially having the most serious consequence to reliability of natural gas supply, has been identified as a vapour cloud explosion (VCE) in the Liquids Recovery Plant (LRP). Such a VCE may potentially terminate sales gas supply from Moomba for an extended period.

The risks of a VCE have been reviewed. These risks have been reduced as far as is reasonably practicable by the installation of:

- Upgraded plant control via the ACE project,
- Emergency Shutdown Systems (ESD) and critical function testing of ESD systems,
- Critical Operating Procedures (COPs),
- Integrity Management Plans (IMP),
- Specific projects as identified as per the Whole of Plant Risk Assessment (WOPRA),
- Gas detection and alarm systems,
- Closed circuit TV,
- Emergency Isolation Valves (EIVs) on large petroleum liquid inventories, and
- Installed fire water systems.

Additional reliability of gas supply from the Moomba plant is assisted by:

- Strategic equipment redundancy.
- Onsite spares holding.
- Underground gas storage back-up to raw gas production.
- An emergency response plan.
- Development of strategies for recovering from an emergency that may interrupt gas supply.
- Onsite, fully trained Emergency Response personnel.

A strategy to resume the supply of gas would be a component of the overall emergency response plan, designed to facilitate the prompt resumption of gas production and supply in the event of a major emergency.

To enable the underground gas storage system to be operable, independent of the Moomba plant, a back-up sales gas line was installed in 1999 to enable early resumption of sales gas supply. This line is routed away from the major VCE sources.

Potential for Serious Incidents

Refer Item 30. (3) (d) of the Regulations.

The Santos Production Facilities handle highly flammable liquids and gases at elevated temperatures and pressures. Consequently, there is potential for vapour cloud explosions, pool fires and gas fires.

Santos' current assessment of the potential for serious incidents is low. The current assessment of the incidents with the greatest combined potential to impact on the reliability of supply of natural gas or the environment are listed below:

- Liquids spill into a sensitive environment due to a pipeline failure.
- Major facility incident.
- Large local rain or flood impact leading to curtailment of gas development programme.
- Inadequate subsurface asset management.

The potential for a serious incident has resulted in the development of risk control and management systems to prevent or minimise the likelihood or consequence of their impact.

The control mechanisms Santos has in place to manage the potential for serious incidents are listed as follows:

- 'Safety Features and Systems' on page 26.
- 'Pipeline and Plant Integrity' on page 36.
- 'Management System Effectiveness' on page 40.
- 'Addressing Reliability of Utility Operations' on page 54.
- 'Risk Reduction Measures (ALARP)' on page 57.
- 'Emergency Procedures' on page 67.
- 'Security of Production and Supply' on page 71.

The most significant public risk is associated with vehicle accidents. Accordingly, Santos has strict requirements associated with vehicle operation designed into its Land Transportation Standard (part of the EHSMS). Requirements include competency based training for drivers, set speed limits and vehicle standards. Information is also provided to the general public, by the use of signs and the distribution of information, to enhance their knowledge of the risks and hazards.

The potential for serious incidents in the production and processing facilities is considered low. Projects recently completed and those planned are directed at further reducing the risk for serious incidents and enhancing the fitness for purpose.

3 Preparation of Fitness for Purpose Report

The 'Fitness for Purpose' report has been compiled in accordance with the Act 2000 from information, reports audits and inspections undertaken over a number of years. The report addresses the impacts of identified hazards and risks on:

- Public Health and Safety,
- Environment and
- Reliability of supply of natural gas,

for the whole of the Santos production facilities in the Cooper and Eromanga Basins, South Australia, as defined by the coverage of the Act and Item 30. of the Regulations.

This report does not cover:

- 'transmission pipelines' that are operated or managed by third party Companies,
- pipelines located outside the State of South Australia,
- the processing plant at Port Bonython.

3.1 Grouping of Facilities

The Santos operations considered in this report extend from the gas and oil wells through to the output from the Moomba Processing Plant.

In order to assess the 'fitness for purpose' of this entire production process, the facilities have been grouped and considered as follows:

- Gathering systems between individual wells, satellites and the Moomba Plant.
- Gas and Oil Satellite facilities.
- Moomba Processing Plant and Utility systems.

Approval for grouping of Santos facilities, in accord with item 30 (7) of the Regulations was advised in Santos memorandum (B. Goldstein / P Klaosen) dated 15 April 2004. The Director of the Petroleum Group, PIRSA granted approval, in memo P Klaosen / B Goldstein dated 27 April 2004.

Santos has also considered the Petroleum wells that are constructed, operated, maintained and abandoned by Santos when compiling this Fitness for Purpose report.

At the time of compiling this report the gas gathering system is providing raw gas from approximately 500 gas wells through to 12 gas satellite facilities. Similarly, the oil gathering system is providing crude oil from approximately 195 oil wells through to 10 oil satellite facilities. The outputs from the gas and oil satellites are directed to the Moomba processing plant via a network of trunklines. The trunklines form part of the total pipeline network known as the gathering system.

For descriptions of the 'grouped' facilities, refer to 'Description of Facilities' on page 16.

4 Description of Facilities

Refer Item 30. (6) (a) of the Regulations.

The Santos gas and oil production facilities, in the Cooper and Eromanga Basins of South Australia, consist of:

- Petroleum wells constructed, operated, maintained and abandoned by Santos.
- Gathering systems between individual wells, satellites and the Moomba Plant.
- Gas and Oil Satellite facilities.
- Moomba Processing Plant and Utility systems.

4.1 Wells

At the time of preparing this report, a total of 1,126 wells are operated by Santos and the Joint Venture parties in the SACB. These wells fall into the following categories, with the number of wells in each category shown:

Cased and Suspended (C & S)	104
In Production	679
Abandoned	11

The remaining 332 wells are shut in and suspended long term (not in production).

4.1.1 General Description

The key components of a typical well, as shown in the attached downhole diagrams, consist of some or all of the following components:

- Surface Casing
- Production Casing
- Casing Cement
- Tubing
- Wellhead
- Perforations
- Packer.

The diagrams include a typical downhole well completion for conventional and monobore wells. A copy of a typical gas wellhead is also attached.

Wells are generically split into two main types: monobore and conventional designs. Both well types incorporate surface casing installations in addition to production casings.

Conventional wells are lined with production casing which is cemented in place. Hydrocarbons from the producing zones are brought to the surface in a separate, smaller piping system (tubing) that is installed inside the production casing.

In monobore wells, the production casing is cemented in the ground in a similar fashion as in conventional wells, however, the one size (mono) casing, generally of a smaller diameter than in conventional wells, is installed. This pipe system is also used as the producing conduit. No separate tubing is run in these wells.

Santos gas wells use both conventional completion and monobore completion designs, depending primarily on the expected production rates and the expected production life of the individual well. The flexibility to modify or change the construction of the completion is generally reduced with a monobore construction when compared to a conventional well.

Santos oil wells almost exclusively are of the conventional design. Oil wells generally require a form of artificial lift to increase or maintain the production rates at optimum levels. Conventional well designs provide a much better degree of flexibility in the choice of artificial lift that can be installed.

4.1.2 Well Design

Well design is undertaken by professionally qualified, experienced engineers. Santos well design, including the casing and cementing systems, are based on internationally recognised Standards, and industry practice, including the American Petroleum Institute (API) Standards.

Modification to typical well design have been incorporated into Santos wells where experience and knowledge has identified improvements which are considered to be better, in terms of safety, operability and fitness for purpose, than the relevant Standard.

Strict change management practices have been adopted. These practices require detailed review and approval of any change to drilling or completion programs prior to the change being approved for implementation.

4.1.3 Drilling Program

A specific “Drilling Program” is developed for each well to be drilled. This program identifies:

- the targeted horizons for the well,
- the mud program,
- casing depths and cementing programs, with due consideration of zonal isolation,
- coring and sampling programs,
- electric line logging and drillstem testing programs,
- time versus depth curves,
- abandonment procedures.

4.1.4 Well Construction

Surface Location Selection

The well construction process commences with the analyses of geological information and modelling to target potential sub-surface hydrocarbon resources. This sub-surface information is used to determine the preferred location of the well on the surface and once identified, the surface location for the well is reviewed with due consideration to features such as drainage channels, vegetation, surface infrastructure and environmental and other considerations. The well surface location may be moved within defined parameters to allow the most appropriate location to be used.

Access to the Wellsite

Following surface location selection, access to the location is then developed. Access normally consists of the construction of a basic, narrow road to allow trucks to carry the drilling rig to the location. The access route is selected to provide appropriate access with consideration of distance, topographical features and terrain, minimisation of vegetation clearance and to prevent impact to aspects of Aboriginal and other heritage.

Wellsite Preparation

A pad is constructed at the well location upon which the drilling rig is established. This pad also allows the storage of wellbore tubulars, water and fuel supplies and other equipment and materials necessary for the drilling of the well.

A water supply is provided for the rig site. Water is used primarily for drilling mud, consisting of materials mixed in water which is circulated continuously through the drill string. The purpose of the mud includes,

- cooling and lubrication of the drill bit
- carrying drill cuttings to the surface
- providing a hydraulic “head” for well control purposes.

Drilling Operations

When the drilling rig is established on the chosen site, drilling operations commence in accordance with the predetermined program.

Santos utilises drilling rigs and equipment contracted from recognised and experienced well drilling contractors. Particular attention is paid to the rigs and equipment to ensure they:

- satisfy all relevant safety requirements,
- are fit for purpose,
- reduce safety risks to as low as reasonably practicable.

In the event the well encounters hydrocarbons, a decision is made to either case and suspend or complete the well. In the event that non-commercial quantities or no hydrocarbons are encountered, the well is likely to be plugged and abandoned (P&A).

Cementing Programs

Cementing programs are specifically designed to secure the wellbore casing and provide isolation of aquifers and hydrocarbon reservoirs to prevent undesirable crossflow and contamination.

In P&A wells, cement plugs are strategically located to isolate hydrocarbon zones and hydraulically separate water producing intervals. The shoe of the last casing string in the well is also covered with a plug which is “tagged” with a work string after the cement has set up to confirm the plug location and integrity.

Cements used in well cementing operations, including well abandonment, meet internationally recognised standards, and are also laboratory tested to confirm suitability.

4.1.5 Well Operations

Production wells are operated by Santos personnel.

Gas wells may be remotely monitored from the main Control Room in the Moomba Plant. Information in relation to rate, pressure and temperature is provided to the Control Room operator.

Information provided by a data collection system is reviewed by Petroleum Engineers to monitor well performance.

4.2 Gathering Systems

4.2.1 General

‘Gathering Systems’ are the gas and oil production wells plus the networks of pipelines that transport gas and oil from the production wells to Satellite facilities.

A gathering system may consist of several pipeline networks from different gas or oil fields. Each well in each field can be individually operated or isolated depending on production demand and other requirements.

Raw gas or crude oil enters a satellite through one or more headers, which can be individually operated or isolated.

This individual control adds to the integrity of production in case of individual well, pipeline, network or satellite problems.

The main gathering lines that direct gas and oil from the satellites to the Moomba Processing Plant are known as gas or oil trunklines.

The gathering and trunkline systems are generally equipped with ‘pig’ launching and receiving facilities.

4.2.2 Gas and Oil Wellheads

Raw gas, from each gas reservoir, is directed into its flow-line via a combination of down-hole pipes and an above-ground wellhead (‘Christmas Tree’). Immediately downstream of the wellhead is a safety shutdown valve (HiLo) and a wellhead production measurement skid.

The gas wellhead skid may include any or all of the following equipment:

- an auto controlled choke,
- a Pressure Safety Valve (PSV) to protect the flow-line,
- a meter run and flow recording device,
- corrosion inhibitor injection facilities,
- telemetry transmission for relay of wellhead pressure, flow, temperature and choke position to remote control and monitoring locations.

Crude oil from the subsurface oil reservoir is directed to the surface wellhead through tubing via the aid of down-hole pumps (jet, electric submersible and barrel/rod type pumps). Wellheads vary in configuration depending on the down-hole lift mechanism.

Wellheads have manual shutoff valves. PSVs are also installed unless wellhead pressure is sufficiently lower than the flowline pressure rating. The downstream flowline is connected directly to the wellhead.

4.2.3 Sales Gas and Ethane Storage Wells

Designated Moomba gas wells are used to store processed Sales Gas and Ethane from the Moomba Plant. The storage area for the Sales Gas and Ethane re-injection is known as the Lower Daralingie Bed (LDB) storage area.

These wells are located in the southern region of the Moomba field. The Sales Gas is transferred from Moomba Plant via a sales gas re-injection pipeline. Satellite compressors are used to re-inject the sales gas into these wells.

The sales gas can be withdrawn from the storage wells and returned to the Moomba Plant through the same re-injection pipeline.

Several designated gas wells are used for the storage of excess ethane that has been produced at the Moomba processing plant. A dedicated ethane injection line runs from the Moomba Plant to the field wells. If ethane withdrawal is required, the ethane can be withdrawn with sales gas or with raw gas via the raw gas gathering system.

4.3 Satellite Facilities

There are two types of satellite facilities, namely:

- Gas Satellites.
- Oil Satellites.

The satellites are fenced facilities that are generally only manned during the day. These facilities are secured and locked at night with the operations remotely monitored from the Moomba Control Centre. If there is a need, personnel can be mobilised within one hour.

4.3.1 Gas Satellites

A gas satellite delivers pressure boosted raw gas from field wells, and nodal compressors, to the Moomba Processing Plant.

Raw gas enters a gas Satellite where it is separated into three component phases;- gas, hydrocarbon liquid (condensate) and water, in separator vessels.

Separated gas is compressed. The compressed gas is cooled in after-coolers and condensed hydrocarbon liquid (condensate) is recovered in discharge separators.
The gas stream flows to the discharge header and onto the Moomba plant via a trunkline.

Condensed hydrocarbon liquids are further separated from water. The hydrocarbon condensate is re-injected into the discharge header with the gas stream. The two-phase hydrocarbon mixture is sent to the Moomba Plant via trunkline.

Recovered water passes to a drain system, through an Interceptor Pond (where any entrained hydrocarbons are recovered) and into an evaporation pond.

A gas satellite has its own fuel gas system. Electrical power is either supplied from Moomba or generated at the satellite.

A flare system is provided for plant venting and emergency relief.

A typical gas satellite incorporates:

- a gathering and manifold system from the gas wells,
- an inlet header system for raw gas,
- gas, liquid hydrocarbon (condensate) and water separation facilities,
- gas compression and cooling systems,
- condensate handling facilities,
- telemetry and communications system,
- emergency shutdown and control systems
- utility facilities, including fuel gas system, fire detection, instrument air, evaporative coolers, emergency power generation and wash-down water,
- waste water treatment and disposal systems,
- a flare system and vent facilities,
- a discharge header to a gas trunkline,
- perimeter fencing.

4.3.2 Oil Satellites

Oil satellite facilities receive fluids from oil producing wells, separate any gas and water from the oil, dispose of the water and then transfer the oil to the Moomba processing plant via an oil trunkline.

Processed oil is accumulated in storage tanks until sufficient is available for batch pumping to the Moomba Plant.

The separated water is processed to achieve oil in water content:

- less than 30 parts per million (ppm) if the water is being disposed of through ‘fenced’ evaporation ponds, or
- less than 10 ppm if the water is being directed to ‘free-form’ evaporation ponds or being reinjected into an aquifer.

Where available, the separated gas is used to supply the fuel gas requirements for the Oil satellite facility.

Electrical power for the satellite and the nearby oil fields is provided by electrical generation equipment at the satellite.

A typical Oil Satellite involves:

- a gathering and manifold system from the oil wells,
- an inlet manifold system,
- dewatering tanks,
- processed oil storage tanks,
- oil transfer pumps,
- utilities (instrument air, electric power generation, fuel gas and fuel oil systems),
- telemetry and communications system,
- emergency shutdown and control systems,
- waste water treatment facilities, including surface evaporation ponds,
- quality testing facilities,
- chemical injection system for corrosion prevention and emulsion breaking,
- pipeline connection to an oil trunkline,
- perimeter fencing.

4.4 Moomba Plant

4.4.1 Process Facilities

The Santos gas and oil facilities are located approximately 800 km north of Adelaide, in the Central Australian desert, well distanced from any public, residential or other industrial environs. The Plant receives raw gas, hydrocarbon condensate and crude oil from the gas and oil fields in the Cooper and Eromanga Basins. Raw gas is also supplied from South West Queensland via the Ballera pipeline.

There are nine gas trunklines feeding raw gas into the plant, including the Sales Gas reinjection / withdrawal line. The trunklines provide gas directly from wells, from gas satellite plants, including withdrawal sales gas and ethane that has been reinjected into selected underground storage formations. Liquid hydrocarbon condensate also enters the Moomba plant through the gas trunklines as a two-phase flow mixture with raw gasses.

The raw gas is processed in the following order:

- Water/condensate separation.
- Carbon dioxide (CO_2) removal.
- Dehydration (includes mercury removal and recovery).
- Gas Liquids recovery and separation.
- Gas metering and distribution.

The condensate/water separation is achieved by simple gravity separation. CO_2 Removal is achieved by a continuous hot potassium carbonate wash, where the potassium carbonate absorbs CO_2. This reaction is readily reversible. The CO_2 is released to atmosphere, allowing the hot potassium carbonate solution to be reused.

The dehydration of the gas is necessary to allow the subsequent intense cooling of the gas stream. Dehydration is achieved using beds of molecular sieve, a solid desiccant. The sieve is regenerated using hot gas.

The Moomba liquid recovery facilities can be operated in two modes:

- Normal Mode of operation that produces;
  - a Sales Gas stream, which is mostly methane,
  - an Ethane stream and
  - a Propane+ liquids stream (Natural Gas Liquids).
- Dew Point Control Mode (DPCM) that produces;
  - a Sales Gas stream of mixed methane, ethane, propane and butane,

During periods of low customer demand, Sales Gas and Ethane can be reinjected into the LDB for storage. During periods of high demand, the reinjected gases are withdrawn from the LDB to supplement processed sales gas.

Sales Gas leaves the site by pipelines and is sold at the exit flange from the Moomba Plant. The pipelines are owned and operated by third party operators. Sales gas customers are located in South Australia, Victoria and New South Wales.

Ethane leaves the site by a separate pipeline to Sydney, under similar sales arrangements.

Crude oil is pumped to the Moomba facilities through four oil trunklines.

Crude and Natural Gas Liquids leave the site by a single pipeline to the Santos liquids processing plant at Port Bonython. This pipeline is owned by the SACB JV and is operated and maintained under contract by EPIC Energy.

The plant is self-sufficient in the production of utilities. There is a single, main control room for the Process Areas and utility functions.

A hydrocarbon liquid Storage Area contains two crude oil tanks within individual bunds.

A Pressure Storage Area contains a propane refrigerant bullet, which is sited within an individual earthen bund, and two natural gas liquid vessels that are in a common bund. Pumps are located outside the bund.

4.4.2 Plant Layout

Overall layout drawings of the site are included in:

- Attachment 4 Plot Plan – Greater Moomba Area on page 81.
- Attachment 5 Plot Plan – Moomba Processing Plant on page 82.

Note: There are three separate sets of firewater facilities strategically located around the Moomba Plant. Each firewater facility consists of separate water storage and firewater pumps connecting into the plant fire-water distribution systems.

4.4.3 Gas Processing

Incoming raw gas streams are directed to the Inlet Separation section of the Moomba Plant, which provides three-phase separation of gas, hydrocarbon-condensate and water.

The facilities include the Raw Gas Inlet Header, Slugcatchers, Condensate/Water Coalescer, SWQ receiving facilities and the HP Separators.

The separated gas is transferred from the HP Separators to the Benfield Plants for carbon dioxide removal, while the condensate is further processed in the Crude Stabilisation Plant. The separated water is sent to the Oily Water System for treatment.

The purpose of the Benfield Plants (or CO_2 Removal Plant) is to remove carbon dioxide (CO_2) and hydrogen sulphide (H_2S) from the natural gas using the 'Benfield Process'. The CO_2 Removal Plant consists of seven parallel Benfield Trains, six of which are operational and one that was moth-balled in 2005. The six operating CO_2 Trains have sufficient CO_2 removal capacity to process the current and projected raw gas production required to be processed at the Moomba Plant.

The gas leaving the CO_2 Removal Plant, called sweet-gas, contains less than 3.0% CO_2 and less than 1 ppm H_2S. This gas is fed to the Liquids Recovery Plant via dehydration facilities.

The CO_2 is removed from the gas to ensure the Sales Gas meets contractual quality specifications.

The purpose of the Liquids Recovery Plant (LRP) is to recover liquid hydrocarbons from the Moomba plant gas feed. This is accomplished by cryogenic distillation that separates ethane and heavier hydrocarbons.

Dehydration facilities are located upstream of the LRP to:

- reduce the moisture content of the feed gas to a level such that ice will not form in the cryogenic sections of the LRP, and
- remove mercury from the gas stream to protect the aluminium cold box exchangers.

Moisture and mercury removal is accomplished by a process of cooling and Molecular Sieve absorption in the Dew Point Control (DPCU) vessels, before the gas passes into the Liquids Recovery Plant (LRP).

After passing through the LRP, the residue gas (Demethaniser overheads) is recompressed prior to entering the sales gas pipelines to Adelaide and Sydney.

Subsequent distillation of the liquid stream, from the LRP Demethaniser, separates ethane from heavier components. The remaining liquids from this distillation (mainly propane and butane) are mixed with stabilised crude and condensate and are transferred to the Port Bonython Fractionation Plant.

Because of the high priority of maintaining continuous gas product production, the plant can be switched to a much simplified flow scheme should the cryogenic distillation plant be unavailable. In this flow arrangement minimum liquid hydrocarbon is recovered by condensation using refrigeration to decrease the hydrocarbon dew point of the gas product to

a level that meets sales gas specification. This operating mode is referred to as Dewpoint Control Mode (DPCM).

Ethane from the LRP Deethaniser is fed to the Ethane Treatment Plant, (ETP), which reduces the ethane CO_2 content to <200 ppm, as a suitable quality for Petrochemical Feedstock. The ethane from the LRP can also be directed to Sales Gas or re-injected into underground storage for future processing.

The ETP utilises an Amine process for CO_2 removal and a Molecular Sieve Dehydration Unit.

4.4.4 Liquid Processing

Liquid hydrocarbons at the Moomba Plant are recovered from the raw gas or pumped to Moomba from the Oil Satellites. Crude oil is produced either stabilised sufficiently to store in tankage, or it requires processing through the Crude Stabilisation Plant (CSP), to remove volatile fractions before it can be stored. The stored block oil is directed to the CSP or the Distillate Plant for processing, as required.

The CSP removes volatile hydrocarbons and water from the crude oil feedstocks and from the liquid hydrocarbons (Condensate) recovered from the raw gas.

The CSP comprises a distillation column with the overhead fractions compressed and recombined with the raw gas for processing.

The ‘reduced’ or ‘stabilised’ crude from the CSP is stored in tankage prior to pumping, with Natural Gas Liquids (NGL) from the LRP, to the Port Bonython Fractionation Plant.

The Tank Farm consists of:

- Oil tanks for receiving piped and trucked oil.
- Facilities for the storage and shipping of stabilised crude from the CSP.
- The necessary pumps, pipework, valving and instrumentation for the unloading of road tankers.

The Distillate Plant at Moomba was shutdown in, and has not operated since, 2001. This was a commercial operation introduced at the Moomba Plant and has no impact on the processing, supply and distribution of sales gas from the plant.

4.5 Moomba Plant - Utilities

The Moomba plant is self-sufficient in the production of:

- Potable and Boiler Feedwater quality water.
- Fuel gas.
- Compressed air.
- Steam.
- Electric power.

4.5.1 Water

Water is essential to Santos operations. Water is required for:

- Steam generation.
- Process requirements.
- Domestic purposes for Cooper Basin Camps.

Raw water is provided by an above ground pipeline from artesian bores at Gidgealpa, 27 kilometres north-west of the Moomba camp. This water is purified using a Reverse Osmosis (RO) Plant, providing potable and process water to meet required quality standards.

The Flash Evaporation Units were shutdown early in 2004 once the RO Unit had been upgraded.

4.5.2 Fuel Gas

Fuel gas is provided from the sales gas produced and is used to provide energy for:

- Steam generation.
- Electric power generation.
- Fired process facilities.
- Process turbines and compressors.
- Domestic camp gas.

4.5.3 Compressed Air

Compressed air is primarily required as 'instrument' air to drive pneumatic actuators on control valves.

The instrument air system consists of:

- Three electrically driven, 50% capacity, screw compressors that provide spare capacity and normally operate with two on-line and one in stand-by.
- One portable diesel driven compressor (for emergency back-up).
- Two air dryer units and various air receivers.
  The dryers are desiccant units that can be regenerated in-situ.

The current system is able to deliver approximately 3,400 Sm^3/hr of instrument air. This system was upgraded in early 2002.

4.5.4 Boilers and Steam

The Moomba facility has seven gas-fired boilers and two waste heat boilers producing high-pressure super-heated steam. The steam is used to drive process steam turbines and to produce electric power via four turbo-alternators.

The combined capacity of the operating boilers at Moomba is 430 tonne/hr (MCR) of high pressure (HP) steam. The normal operating demand for steam is approximately 260 tonne/hr (Summer) and 300 tonne/hr (Winter).

Steam is used as a medium for transferring energy around the Moomba plant. The H.P. steam generated in the boilers is let-down to a low pressure (L.P) steam system as it is used in the plant process.

Condensed steam is returned as boiler feedwater service via a condensate recovery system.

4.5.5 Electric Power

Moomba has four steam turbine driven alternators (STAs) and two gas turbine driven alternators (GTAs).

Following the installation and commissioning of a second Gas Turbine Alternator (GTA) in January 2001, the electrical generation capacity for Moomba is rated at 22.7 MWs. The second GTA has its own 400kW black-start diesel-fuelled alternator.

The Moomba power distribution system was reconfigured in 2003 so that all generation is connected at 11kV to a ring main system.

New turbine and generation control systems were installed on the 4 STAs and GTA #1 as part of the ACE Project in 2003-04.

Electrical power is provided for the operation of the Moomba Processing Plant and associated facilities (camp, amenities, contractor facilities etc.).

A 400 kW diesel-fuelled alternator is located near the Operations Control Centre (OCC) to provide back-up service for the control systems. The main camp has a dedicated 400kW emergency diesel alternator.

Electric power is also distributed to two nearby Satellite plants via a 33kV overhead power-line.

4.6 Major Hydrocarbon Inventories

Listed below are the maximum quantities of liquid hydrocarbons that may be stored at the Moomba plant. Liquid hydrocarbon inventories in a gas satellite would normally be less than 10m^3. Oil satellites may hold up to 1,000 m^3 of crude oil.

Table 1 LPG Storage

Circuit	No. of units	Material	Max. Amount	Temp (ºC)
Area 65 Refrigeration Accumulator	2	Propane	28.5 m^3	35
Area 75 Propane Refrigeration Accumulator	1	Propane	40.2 m^3	38
Plant Propane Storage Drum	1	Propane	65 tonne	30

Table 2 Crude/Condensate Storage

Tank ID	Service	No. of units	Max. Capacity (m^3)
TK-1000	Stabilised hydrocarbon liquid	1	15,890
TK-3000	Stabilised hydrocarbon liquid	1	47,690
TK-4570	Stabilised hydrocarbon liquid	1	1,590
Pipeline Feed Drums	Liquid at process conditions	2	190 m^3 (1)

(1) Normal operating inventory is approximately 60 m^3 per drum

5 Safety Features and Systems

5.1 General

The policies, systems and procedures applied by Santos for the Occupational Health and Safety of employees and contractors, are also relevant for Public Health and Safety protection. Safety, health and environmental protection are the highest operational priorities for Santos.

The policies, standards, and procedures that flow from the environment health and safety management system (EHSMS), and are applied by Santos for the Occupational Health and Safety of employees and contractors, are also relevant for Public Health and Safety protection. Safety, health and environmental protection are the highest operational priorities for Santos.

Equally, these systems are fundamental to the prevention or management of incidents that have the potential to:

- Damage equipment and processes.
- Interrupt production or supply of natural gas.
- Impact on recovery following an incident.

Safety features and systems include:

- Fully documented embedded EH&S Management System (EHSMS) into day to day operations.
- Equipment and facilities designed in accordance with recognised standards and codes.
- Equipment operated and maintained in accordance with manufacturer's recommendations and recognised condition monitoring practices.
- Plant and facility control and shutdown systems, including;
  - equipment designed to shutdown in a safe condition,
  - emergency shutdown systems (ESD): - integrated, programmable and manual,
  - uninterrupted power supply (UPS) for selected critical equipment,
  - PSVs on pressurised systems,
  - emergency shutdown valves strategically positioned to isolate and contain the supply of flammable and pressurised materials,
  - flare systems for the safe disposal of vented hydrocarbons,
  - emergency isolation valves (EIVs) on gas trunklines and large hydrocarbon inventories.
- Fire protection, detection and control systems, including;
  - fusible plug loop systems,
  - combustion gas, smoke, ultraviolet, infra-red and thermal detectors connected in circuit groups to fire indicator panels,
  - electrical equipment either suitable for hazardous area duty or positioned outside of hazardous areas,
  - fire indicator panels that provide outputs for local and remote (via telemetry) indication,
  - automatic release of fire suppressant agent, NAF S-111, into critical equipment and structures,
  - fixed and mobile fire-fighting systems and equipment (eg. Firewater mains, deluge and foam systems).
- Critical function testing of safety devices.
  - Eg. fire detection systems are designed for testing while plant is operational.
- Training (refer to Operational Competency on page 65.
- Up-to-date Operator Manuals for the Moomba Process Plant, Gas Satellites, Gas Nodal Facilities and Oil Satellites.

- Safe operating procedures for;
  - Critical safety interlocks,
  - Permit to work system,
  - Isolation and lockout,
  - Operating systems,
  - Maintenance systems,
  - Management of change requirements.
- Plant and facility surveillance:
  - Vessel/Equipment and Facility Inspection programme,
  - Development and use of On-Line Inspection techniques.
- Emergency Response Plans and Procedures:
  - installed Emergency Response facilities,
  - dedicated, trained Emergency Response Teams,
  - dedicated emergency response vehicles and equipment,
  - Emergency Response Exercises.
- Preventive maintenance programme.
  - Santos has been granted self-inspection status with respect to the statutory requirements for pressure vessel inspections.
- Accident, incident, non-conformance and near miss reporting systems.

5.2 Moomba Plant Features

Following are some of the specific safety and protection features that are included within the Moomba Plant:

- Concrete fireproofing.
- Active protection systems including firewater systems and mobile equipment.
- Three separate water storage and firewater pump systems connecting into the plant, fire-water distribution systems.
- Hydrocarbon gas detectors and UV/IR fire detection systems in critical areas.
- Automatic control systems.
- Hard-wired emergency shutdown systems.
- Fixed condition monitoring and machine based shutdown systems on the main compressor sets.
- High integrity pump seals.
- Heat detection systems that are integrated with Emergency Isolation Valves (EIVs) in the suction systems of selected pumps.
- EIVs on designated major trunklines into the plant.
- EIVs on major propane accumulator vessels.
- Emergency shutdown system on boilers.
- Deluge system on selected, critical equipment.
- Fixed foam systems for the crude and condensate storage tanks.
- Leak detection systems.
- CCTV surveillance of critical operating locations.
- Pressure relief systems (Eg. PSVs and rupture discs).
- High pressure, low pressure and low temperature flare systems.

6 Assumptions and Sensitivities

Refer Item 30. (8) (d) of the Regulations.

This report specifically addresses the Fitness for Purpose of Santos production facilities in South Australia as defined by the Act and the Regulations, Item 30. Consequently, the report does not cover:

- 'Transmission pipelines' that are operated or managed by third party Companies.
- Pipelines located outside the State of South Australia.
- The Santos processing plant at Port Bonython.

Certain assumptions are made by Santos.

1. The main assumptions and the associated sensitivities within the risk assessments conducted by Santos personnel or independent groups relate to the degrees of 'Consequence' and 'Likelihood' applied to the various risk scenarios assessed.
   - A two dimensional risk matrix (consequence and likelihood), which is based on Table T2 of standard AS 4360 (1999 version), was used for the risk assessment of the majority of risk scenarios addressed. Wherever possible, historical data has been used to quantify the extent of product disruption in determining the level of the consequence. Similarly the probability of an event occurring has been supported by Santos records where available.
   - In the absence of historical data, best quantitative judgements have been made based on the experience of the independents and/or Santos personnel. Use of data from similar industry and facilities has also been consulted in some instances.
2. An Estimated Maximum Loss (EML) approach has historically been used by Insurance Underwriters and Brokers for assessing Santos production facilities in the Cooper and Eromanga Basins. A catastrophic EML scenario has been quantified into overpressure circles and continues to be used as the benchmark scenario for worst case evaluations to business interruption and for recovery planning.
   - An EML scenario considers the largest loss that could result from a single incident. It assumes that the initial incident is so large that the active protection systems are rendered inoperative, and only the passive protection facilities, such as spacing and fireproofing, are effective.
   - The Business Interruptions (BI) are those that flow from the EML scenarios. In addition to the specific shutdowns of the Units impacted by the EML it is assumed, following such an incident, the entire site would be shutdown for a period of up to a month. The shutdown would be required whilst investigations are carried out and repairs are made to the major pipe-rack that runs north-south through the site.
3. Sedgwick Energy Ltd. has assessed two levels of EML for underwriting purposes. A 'Normal EML' and a 'Catastrophic EML'.
   - A 'Normal EML' is defined as "the likely maximum estimated loss that could be sustained in a single fire and/or explosion incident after due consideration for mitigating and aggravating features of the assigned target area".
   - A 'Catastrophic EML' is defined as "the loss that could be sustained under abnormal conditions with the failure of multiple protective systems". The initiating events have a remote probability of occurring. Eg. A full diameter pipe failure with rapid propane leakage and a subsequent Vapour Cloud Explosion (VCE) from one or more of the propane accumulators in the Liquids Recovery Plant.

4. Specific assumptions made by ICI Australia Engineering (ICIAE) in evaluating the impact and recovery requirements associated with an EML are:
   - Primary damage due to a VCE blast is based on "Effects of Overpressure on Plant Equipment". Equipment damage is assessed according to its location in the over-pressure areas.
   - Secondary damage is associated with subsequent fire, torching, structural collapse, and failure of utilities eg. electricity and air. These scenarios have not been analytically addressed, but have been extrapolated based on evidence from similar incidents.
   - It is assumed that available Santos resources would be directed to the short-term minimisation of business interruption losses.
   - Failure behaviour of steel structures, buildings and equipment foundations has not been assessed.
   - Structures and buildings would be rebuilt to the original 1982 designs. Approval to rebuild to codes in force at that time is assumed.
   - It has been assumed that control and electrical system rebuild would not be time critical.
   - Existing engineering documentation in the Moomba planning office, engineering office and control room is not affected by the incident.
   - The risk of equipment supply and repair lead-time may be increased as a result of supplier reorganisation or relocation. However, no change to the current level of activity in the engineering industry is assumed.
   - Future levels of gas and liquids demand, known reserves, and plant technology do not materially change the fundamental plant processes or its basic configuration.
   - Government and/or coronial investigations of the incident would be held promptly, and approval given to commence demolition and the recovery plan within one month of the blast.
5. The survey and assessment of the Tirrawarra Satellite by DNV Technica in 1984, is the adopted standard for Santos satellite facilities in the Cooper and Eromanga Basins. In addition, any improvements, HAZOP, incident analyses/recommendations and changes in standards have been applied across satellite facilities since the time of the DNV survey. No other third party surveys have been conducted at satellite facilities.
6. Moomba utility requirements. It is recognised that the utility systems must be capable of delivering required outputs during operating conditions that represent the greatest demands on the Moomba utilities. These conditions are assumed to be:
   - Design gas production rates at an ambient temperature of 35°C.
   - 90% of design rate on very hot days that are defined as 12 hours at an ambient temperature of 45°C followed by 12 hours at an ambient temperature of 35°C.
7. Raw gas production rates, gas demand, reserves, ethane balance and the proposed capital projects are consistent with the annual plans provided to PIRSA. The most recent data, namely the “2006 Development Plan and Operational Overview”, was presented to PIRSA on 7 April, 2006.
8. Whole of Plant Risk Assessments (WOPRA) carried out on Moomba Plant and Moomba South Central Satellite, and the Moomba Integrity Review Project (MIRP), are structured reviews aimed at identifying significant high consequence low frequency risks. Assumptions and associated sensitivities are as described in point 1 above.

7 Gap Analysis

Refer Item 30. (8) (c) of the Regulations. 'Areas with Lack of Relevant Information'.

7.1 Operational

It is Santos' view that there are no significant known or relevant hazards and associated risks that have not been identified and assessed at the time of preparing the 2006 Fitness for Purpose report, to significantly affect the fitness-for-purpose of the facilities.

Santos makes this assessment in good faith based on the following supporting factors:

- Third party, independent surveys and reports have been conducted for Santos facilities by at least twelve different organisations over the last two decades.
- Twenty-two separate independent surveys, reports and their associated recommendations have been considered by Santos in the preparation the 2006 Fitness for Purpose report.
- The 2006 Fitness for Purpose report has been compiled by an independent consultant, on behalf of Santos, using internal and independent reports and data.
- An independent consultant has facilitated a desk-top exercise with Santos representatives to brain-storm and identify potential scenarios or hazards that may exist after the currently identified and scheduled risk reduction measures had been addressed. Identified risk scenarios have subsequently been included as part of the assessed risks in this report.
- The Santos EH&S Management System (EHSMS) provides for ongoing hazard identification, risk assessment, incident reporting and investigation, action tracking and close-out.
- HAZOP studies are conducted at the pre-implementation stage for projects and modifications to ensure associated hazards are identified and risk reduction measures are put in place to achieve an acceptable level of risk.
- Active dialog is maintained between Santos and PIRSA with PIRSA being kept appraised of events and any follow-up actions, as any events occur.
  The Santos / PIRSA Quarterly Compliance meetings provide PIRSA with the opportunity to raise matters with Santos on a regular basis.

7.2 Procedural

In addition to the hazard identification and risk assessment techniques used by external groups, which have been commissioned by Santos, Santos also has its own formalised system for managing this area of its business on a day-to-day basis.

This is achieved using one of the Environmental, Health and Safety Management System (EHSMS) standards, 'EHSMS 09 - Hazard Identification, Risk Assessment and Control'.

The purpose of this standard is to ensure processes are established and maintained to systematically identify EH&S hazards and asses and control their level of risk.

Refer to Hazard Identification and Risk Assessment on page 31.

8 Hazard Identification and Risk Assessment

Refer Item 30. (6) (c) of the Regulations.

Santos Health and Safety Policy and Environmental Policy

The Health and Safety Policy (Attachment 1 Santos Health & Safety Policy on page 78) and Environmental Policy (Attachment 2 Santos Environmental Policy on page 79) provide the overall standard for hazard identification and risk assessment by requiring that Santos:

"Proactively pursue the identification of all hazards and eliminate or, if not possible, manage the risk to as low as reasonably possible" and "Apply a systematic approach to identifying hazards and managing environmental risks to reduce these to as low as reasonably practicable."

Santos' Environmental, Health and Safety Management System (EHSMS) standard, 'EHSMS 09 - Hazard Identification, Risk Assessment and Control' is a standard in place to ensure that processes are established and maintained to systematically identify EH&S hazards and assess and control their level of risk. This standard applies to Santos operations and activities including existing operations, modifications and new projects to address potential hazards and risks to personnel, facilities, the public and the environment. Risk assessments are performed by competent personnel including, where appropriate, expertise from outside the immediate site.

Further procedures and standards are in place to meet the requirements of EHSMS09 and the Santos Policies. These include:

- Job Hazard Analysis and Stepback.
- Workplace Inspections.
- Incident and Non-conformance Investigation, Corrective and Preventative Action.
- Hazard and Operability Studies (HAZOPS).
- Workplace Inspections.
- Work Permits.
- Management of Change.

Identification and assessment of hazards is undertaken both internally and using external (independent) organisations.

8.1 Formal Risk Assessments

8.1.1 Overview

The attention to hazard identification, risk assessment and risk control has been a continuous improvement process from the major efforts of the late eighties and early nineties to the Whole of Plant Risk Assessments (WOPRA) and significant improvements implemented with the development of a comprehensive corporate-wide EHSMS.

Many of the previous improvement activities were associated with the construction of a Liquids Recovery Plant (LRP), installation of the #7 Benfield train (CO_2 removal), the Moomba Hazard Risk Audit conducted by ICIAE in 1996/1988 and the audit of the Tirrawarra Satellite by DNV Technica in 1984.

Consequently, the following potential risks to facility integrity and reliability of supply have been, or are being, addressed at the Company's production facilities in the Cooper and Eromanga Basins, South Australia.

- A dedicated flare system to address potential low temperature embrittlement.
- Pressure relief and blowdown upgrades.
- Improved corrosion monitoring and control, particularly in the Benfield trains.
- Emergency shutdown(ESD) system reviews and upgrades, specifically;
  - emergency isolation valves on critical equipment,
  - alarm and interlock reviews,
  - on-line critical function testing,
  - ESD upgrades at the major satellite facilities.
- Fire system upgrades including;
  - gas and UV/IR detection,
  - automatic fire sprays and deluge systems,
  - incremental fire hydrants and monitors.
- Remote isolation of satellite and unit feed lines from the Moomba control room.
- Fireproofing of pipe-bridge columns and designated supports and vessels.
- Installation of new cold boxes and mercury removal and recovery facilities in LRP Trains A and B.
- Upgrade of the Dew Point Control Units Area 55 Switching Valves (DPCU Nos. 6, 7, 8 and 9) to provide greater reliability of moisture and mercury removal upstream of the LRP Trains. This project is scheduled for implementation in 2006 - 2007.
- Upgrade of the HP Flare header including the installation of an additional HP flare knockout drum. This project is to protect against hydraulic loading of the HP Flare safety system and is scheduled during a planned plant shutdown in 2007.
- Upgrade of the LRP cold drain and emergency depressuring system. This project addresses the hazard of low temperature impact on materials of construction and is also planned to be implemented in 2007.
- Continuation of the UPS and battery charger system upgrades.
- Higher integrity surveillance of pig launchers and receivers.
- Refurbishment of the Tantanna to Gidgealpa Trunkline.
- Further BFW improvements.

In more recent years Santos has methodically progressed the identification of remaining hazards and associated risks that have the potential to impact on its Cooper Basin facilities.

The process has involved:

- Internal evaluations by Santos professional staff.
- Reviews and assessments by several, independent companies.
- Prioritised action plans to address improvement recommendations.
- Preventative actions arising from incident reports and investigations.
- Risk mitigation activities involving capital projects and procedural, system changes.
- High level management review.

Independent, third party reviews or studies have been conducted by:

- SMEC-HGM.
  Three separate assessments addressing specific reliability aspects of the Moomba Plant utility facilities.
- SHE Pacific.
  Consolidation and extension of ABB Power and ICIAE reports. Qualitative Risk Assessment of incremental potential hazard scenarios. Addressing the next level of potential threats beyond the Major Incident scenarios previously addressed in other studies.
- ABB Power Generation.
  Reviews and recommendations provided for Water Management, Boiler Plant, Controls and Instrumentation at Moomba Plant Utilities.
- Marsh & McLennan.
  Insurance Assessment of the Moomba Plant. Addressed site facilities, management systems and protection facilities. Considers impacts of estimated maximum loss (EML) scenarios as well as major perils.
- Swiss Re
  Insurance Assessment of Santos' operations including the Moomba plant. Addressed site facilities, management systems including procedures and protection systems.
- ICIAE.
  Reviews the recovery plan for a Moomba Plant EML incident. Provides quantitative overpressure circles and recovery recommendations.
- Sedgwick Energy Ltd.
  Four separate Insurance Underwriter reports from 1992 to 1997. Include EML assessments and risk mitigation recommendations.
- Australia Centre of Advanced Risk & Reliability Engineering (ACARRE).
  Ethane Project – Preliminary Risk Assessment & Fire Safety Study.
- Shell Global Solutions
  'Focussed Asset Integrity Reviews' have been undertaken to assess integrity of pressure vessels, pipelines, machinery and power and control systems.

Approximately 50 different scenarios have been addressed within the following categories:

- Fire and Explosion Scenarios
- Plant Equipment Scenarios
- Operational Risk Scenarios

Hazard and Operability Studies (HAZOPS) are conducted for new projects and plant/equipment modifications. For significant capital projects third party risk assessment studies are generally commissioned by Santos.

Examples of assessments commissioned for major projects include:

- Preliminary risk assessment and fire safety study (by ACARRE), addressing impacts of the new Ethane Treatment Plant to produce ethane at petrochemical feedstock quality for supply into Sydney.
- Preliminary risk assessments of the (then) proposed Ballera natural gas pipeline from Queensland to Moomba Plant (by ACARRE).
- Assessment of pipeline failure rate and ignition probability for Ballera gas pipeline from Queensland into the Moomba Plant (by DNV Technica).
- Semi-quantitative risk assessment for LRP trains A and B prior to recommissioning in 2004.
- Fire Safety Study for the SWQ 'End of Line (EOL)' facilities.

The findings and recommendations from these assessments were then reviewed and considered for incorporation into the final design, construction and commissioning of these projects.

The Ethane Treatment Plant was commissioned in 1996 and the Ballera Pipeline in 1994.

8.1.2 SHE Pacific Recommendations

The SHE Pacific study of 1999 concluded that there was no longer an appropriate level of standby and redundant capacity at the Moomba processing plant as a result of:

- the carbon dioxide content in the raw gas having risen, and
- the sales gas output demand having increased.

It also concluded that much of the risk to gas interruption was associated with shortcomings of the site utilities.

SHE Pacific identified that the above conclusions could be remedied by installing:

- Another CO_2 removal train.
- Another 5MW alternator.
- Another 70 to 110t/hr steam boiler.

Santos concurred that another power generator was necessary and a new 5MW gas turbine alternator was commissioned in January 2001. Furthermore, Santos commissioned SMEC-HGM to provide specific recommendations for improved power distribution and reliability.

As a result, the following projects have been implemented to further improve the reliability of the power system at Moomba and linked satellite stations:

- 'Power Generation' on page 63.
- 'UPS and Battery Charger Systems' on page 64.
- 'High Voltage Distribution Upgrade' on page 64.
- 'Asset Control Enhancement (ACE)' on page 62.

Santos reviewed the need for additional capacity for CO_2 removal and steam generation and reached the conclusion that neither of the proposals were required at that point of time. Subsequently, in 2005, CO_2 Train 2 was mothballed based on sufficient capacity being available from other trains.

These conclusions were based on factors including:

- Declining raw gas production.
- Forecast of sales gas demand was marginally lower.
- Extensive improvements to the quality of boiler feedwater, including condensate returns, which has been identified as the major cause of past steam generator unreliability. Improvements include;
  - Installation of a Reverse Osmosis potable water plant,
  - Modifications to prevent contamination of steam condensate returns,
  - Inspection, cleaning and lining repairs to the five demineralised water storage tanks
  - Re-tubing the dump condensers,
  - Elimination of No.4 Deaerator bypassing.
- Extensive upgrades to the steam generators and in particular the 130 T/hr No.10 Boiler. The upgrades included:
  - No.10 Boiler Upgrade 2000 – replacement of tubes, acid cleaning and comprehensive inspection/overhaul,
  - No.10 Boiler follow-up inspections.
- Improved boiler control by replacement of the Boiler Control and Burner Management systems as part of the ACE Project in 2004.

Improvements that can be further assessed to improve steam generation and/or CO_2 removal reliability, if required in the future, include:

- Replacement of the electric black-start BFW pumps,
- Elimination of vacuum and air ingress in the dump condensers,
- Conductivity and turbidity monitoring system for steam condensate return and BFW,
- Automatic steam and BFW dosing systems.

Refer to 'Steam Generating Capability' on page 55, in the section titled 'Adequacy and Reliability of Utilities', for more detail on the steam generation improvements.

8.1.3 Whole of Plant Risk Assessment (WOPRA)

Commencing in 2002 and 2003 respectively, Whole of Plant Risk Assessments were undertaken on the Moomba plant and Moomba South Central Satellite.

These detailed reviews, facilitated by Qest Consulting Group, identified the significant hazards associated with the operation of the above plants and subsequently, through a semi-quantitative risk assessment approach, characterised each of those hazards. This exercise included significant involvement of the Santos workforce. Actions to further address hazards to reduce overall risk have been undertaken and indeed this process is approaching completion during the second half of 2006.

Final closeout of the WOPRA activities will take the form of risk acceptance workshops to be undertaken in accordance with the requirements of EHSMS09 Hazard Identification, Risk Assessment & Control.

The Whole of Plant Risk Assessment is a rigorous and structured process which can be considered a form of the more generic Process Hazard Analysis, of which HAZOP, Fault Tree Analysis and Failure Mode and Effect Analysis are other examples. The WOPRAs which have been undertaken have involved cross functional teams from initial hazard identification through to risk assessment and actions to address hazards. Particular focus is on higher consequence, lower frequency events.

The ten greatest hazards identified for the **Moomba Plant**, representing 80% of identified risk, were:

- Release from a Moomba plant gas inlet pig receiver.
- Release from A train while B train in a LRP turnaround (or vice versa).
- Gas leak from CO_2 trains 5, 6 or 7.
- Gas leak from CO_2 trains 1, 2, 3 or 4.
- Collapse of vessel internals during internal inspection.
- Large dropped object from mobile lifting equipment (plant wide).
- Falls from handrail and ladder cage areas (plant wide).
- Switchboard fire or explosion (plant wide).
- Analyser hut gas release.
- Solution leak from CO_2 trains 1, 2, 3 or 4.

All actions from the Moomba Plant WOPRA have been closed out.

The five greatest hazards identified to date for **Moomba South Central (MSC)**, representing 90% of identified risk, were:

- Loss of Containment of HP Compression (closed out).
- Driving to and from wells (closed out).
- Venomous strike from snakes and spiders (site wide) (no specific WOPRA actions)
- Loss of containment in gas well head (closed out).
- Loss of containment in lube oil/ seal oil system (closed out).

A final review of the MSC WOPRA has commenced as part of the formal close-out of the WOPRA Project.

Actions recommended by the above Whole of Plant Risk Assessments were varied and include:

- Installation of Emergency Isolation Valves on incoming gas trunklines.
- Improved procedures and controls for pigging operations.
- Improvements to the corrosion management programme.
- Upgrade to fire management system.
- Review and development of plant shutdown procedures.
- Improved vibration monitoring and management.
- Improved procedures, training etc for lifting equipment (eg cranes).

8.1.4 Liquids Recovery Plant (LRP) Risk Reduction

Following the LRP A Train Incident on 1 January 2004, a detailed risk review was undertaken to ensure hazards and risks were appropriately managed prior to and following repair and start-up. In excess of 140 actions were identified from this process for action prior to start-up of A and B trains; a further 33 actions were identified for action following start-up of which 28 have been closed out to date. Four of the remaining actions are due to be completed in the second half of 2006, with the last action due for completion in the 2nd Quarter 2007.

8.1.5 Moomba Integrity Review Programme (MIRP)

Commencing in 2002, the MIRP study reviewed potential integrity and reliability issues in the Moomba plant that may arise from:

- process temperatures being lower than Minimum Allowable Temperature (MAT), and
- electrical supply and instrumentation control.

Santos commissioned Aker-Kvaerner to undertake the study work and field assessment for the Moomba Gas Plant as part of MIRP.

Actions which were recommended by MIRP and subsequently implemented include:

- installation of Critical Operating Parameter (COP) alarms
- implementation of critical operating procedures
- replacement of some carbon steel piping with stainless steel for improved low temperature embrittlement control
- review of adequacy of some pressure relief devices.

Of 55 actions identified, all actions have been closed out.

8.1.6 Swiss Re Safety Management Audit

In 2004, Swiss Re undertook a site visit of the Moomba Gas Plant to evaluate the operation for insurance/ underwriting purposes. In addition to their evaluation, a number of recommendations were made to Santos regarding opportunities to reduce risk. These recommendations were divided into three timeframes for completion being end January 2006, end 2006 and end 2007.

Santos is progressively implementing the recommendations in line with the required time frame, or where implementation of the recommendation has not been considered appropriate, Swiss Re is advised accordingly.

8.2 Pipeline and Plant Integrity

8.2.1 Pipelines

Santos and its JV Partners have a significant pipeline network installed in the Cooper and Eromanga Basins of South Australia. To ensure integrity, pipelines are constructed and maintained consistent with Australian Standard AS2885 “Pipelines – Gas and Liquid Petroleum”. The intent and requirements of this standard are reflected in the relevant Santos Specifications, Guides and Procedures.

On a day-to-day basis the health of the pipeline network is maintained by a field-based corrosion group who monitor the effectiveness of the corrosion mitigation measures. Adelaide based engineers provide long term direction and specialist engineering support.

8.2.2 Pressure Equipment

Santos operates some 2000 pressure vessels and associated piping. Equipment integrity is maintained through the application of the appropriate Australian standards for design, maintenance and inspection. AS/NZS 3788 “Pressure Equipment – In-Service Inspection” forms the basis of the inspection programme.

Field based personnel provide the inspection resource, and conduct specific corrosion control programs. These programs are based on the corrosion mechanism, severity of service and hazard levels (consistent with AS4343). Adelaide based engineers provide specialist support and long term direction.

8.2.3 Corrosion Control

The corrosion monitoring and control programme addresses aspects of Plant, Pipeline and Equipment Integrity. The goal is to achieve zero leaks or failures.

In order to achieve a goal of zero failures, the degradation mechanisms that can lead to equipment failure are addressed. These degradation mechanisms fall into a number of categories, as follows:

- Internal corrosion resulting from the presence of carbon dioxide or hydrogen sulphide and / or excessive fluid velocities.
- Microbiological corrosion caused by bacteria, which take two main forms sulphate reducing bacteria (SRB) and acid producing bacteria (APB).
- External corrosion/Cracking caused by defects in the pipeline coating and / or cathodic protection (CP) systems.
- Under Insulation Corrosion (UIC) caused by water trapped under insulation.
- Cyclic Fatigue caused by temperature and/or pressure fluctuations.
- Third party damage, mainly where the pipeline encroaches on populated urban areas and intensely farmed land.
- Natural land-shifts caused by extreme weather conditions.
- Environmentally induced cracking, eg. liquid metal embrittlement and stress corrosion cracking.

Corrosion control is a major focus within Santos and integrity initiatives include:

- Application of AS3788 to pressure equipment inspection.
- A Pipeline Integrity Management System (PIMS) to improve the collection, storage and retrieval of design information. In addition it provides the central corrosion database for corrosion monitoring data.
- Microbiological Influenced Corrosion (MIC) study.
- Development of Pipeline Re-lifing Assessment Model for the Santos pipeline gathering network.
- Development of a Corrosion Management system.
- Intelligent pig surveys of major trunklines.
- Annual coating defect surveys and repairs to improve external pipeline protection levels.
- Annual audits of the effectiveness of the Cathodic Protection system.
- Ongoing monitoring of the effectiveness of inhibitor injection through water sampling.

Santos Pipeline and Pressure Equipment is considered sound and fit for purpose. The application of the above programs ensures the risk associated with operating this equipment is kept as low as reasonably practicable.

8.3 Wells

8.3.1 Risk Identification

Significant risks associated with well construction are managed to as low as reasonably practicable by a variety of means.

Where unacceptable risks in well construction are identified, remedial operations are conducted to reduce the risk to acceptable levels. An example of such a risk reduction activity involved the conversion of wellbore tubing to a high chromium content tubing where elevated amounts of CO_2 in the gas stream resulted in accelerated levels of tubing corrosion.

8.3.2 Risk Assessments

Assessments as the Fitness For Purpose of well construction are reviewed at various times on an ongoing basis. These assessments include the following:

- Corrosion logs of the wellbore tubulars.
- Pressure monitoring of wellbores.
- Detailed review of any equipment failure and corrective actions.
- Application of corrosion inhibitors and testing of fluid streams to monitor and manage corrosion.

For any problematic well, a specific well repair or abandonment program is developed for individual risk assessment. Approval of the final program is then sought from PIRSA, prior to the abandonment activity taking place.

During the latter part of 2001, a review was made of zonal isolation and well abandonment practices for inclusion in a Downhole Environment Impact Report for the review of a Statement of Environmental Objectives for well operations. The review consisted of a literature search and identification and comparison of practices and procedures from various internationally recognised standards and organisations.

These organisations included:

- American Petroleum Institute
- Alberta (Canada) Energy and Utilities Board
- University of NSW.

This review identified that Santos cementing practices meet, and in many instances exceed the requirements, of the Standards, practices and procedures reviewed.

8.4 Assessment Overview

Refer Item 30. (6) (c) of the Regulations.

The areas identified as having the greatest collective potential to impact on the reliability of supply of natural gas, or the environment are:

1. Liquids spills into a sensitive environment due to a pipeline failure.
   Extensive controls are in place including:
   - Pipeline standards and risk assessments.
   - Operating procedures.
   - In-line inspection and standard pigging programmes.
   - Mass balance of transfers.
   - Dedicated pipeline integrity engineer.
   - Pipeline re-lifing programme.
   - Cathodic protection.
2. Major facility incident resulting in lost or deferred production and contracted gas nominations not being met.
   Controls in place include:
   - Integrity inspection programs and condition monitoring.
   - Routine preventive maintenance.
   - Plant operating standards.
   - Pressure equipment standards.
   - Whole of Plant Risk Assessments (WOPRA).
   - EH&S management system and assessments.
   - Operating procedures and manuals, and Competency Based Training (CBT).
   - Emergency and shutdown procedures.
   - Defined operating envelopes.
   - Gas storage management policy.
   - Alternative gas supply sources.
   - Critical spares management.
   - Process risk assessments.
3. Large local rain or flood impact in Cooper Basin leading to curtailment of gas development programme.
   Controls in place include:
   - Gas storage.
   - Backup outside sources of deliverability/ gas purchases.
   - Appropriate acceleration of development work in flood prone areas.
   - Active weather monitoring and daily monitoring of flood front.
4. Inadequate Gas subsurface asset management.
   Controls in place include:
   - Field development and appraisal training
   - Subsurface data and understanding
   - Peer and Vice-President reviews
   - Evaluation and probabilistic techniques
   - Continuous improvement focus and formalised look-back
   - Reserve review guidelines
   - Independent Reserve Review process audit
   - Watch list of 2P reserves at risk
   - Employee development and cross training
   - Consistent and auditable models.

9 Management System Effectiveness

Refer Item 30. (3) (b) of the Regulations.

The Santos EH&S Management System (EHSMS) is compliant with Australian Standard (AS) 4801:2000 Occupational health and safety management systems and AS/NZS ISO 14001:1996 Environmental management systems. The EHSMS comprises 33 core management standards which apply to matters of environment, health, safety and security of production and to all business aspects of its operations.

The EHSMS also comprises detailed hazard standards for environment and health and safety separately. These standards address the key hazards present within Santos operations and documents the controls required to adequately manage these hazards. There are a total of 12 environmental and 26 health and safety standards.

The total set of standards define expectations of what is required to ensure that environment health and safety risk is systematically managed. Employees and contractors are expected to work in accordance with the EHSMS.

It should be noted that the EHSMS is a true system with a very rigorous audit and assessment program to demonstrate internal conformance with the requirements of the standards. Each year EHSMS assessments are conducted by independent, external auditors who review progress of the implementation of the standards against document assessment protocols. Each site receives a score, out of a maximum of 100%, along with a report documenting good practices and improvement opportunities.

Therefore in summary, Santos' management of Public Health and Safety, Environment and the Security of Production and Supply of Natural Gas can be specifically linked to the following Company systems:

- Environment and Health and Safety Policies;
- Santos EHSMS;
- EMSHS management standards;
- EHSMS hazard standards;
- Procedures and processes;
- Specifications, Guidelines and Work Instructions;
- Assessment and Auditing Programs; and
- Regular performance reporting to senior management and the Santos Board.

These systems address Santos' practices that range from design, construction, procurement, operations, maintenance through to audits/inspection and emergency response.

9.1 Commitment Statement

The Environmental and Health and Safety Policies detail the commitment of Santos towards achieving environment health and safety excellence in exploring developing, producing and marketing of hydrocarbon resources.

The Santos safety vision is "We will all go home from work without injury or illness" and outlines a number of key beliefs which apply to all aspect of Santos' operations:

- No business objective will take priority over health and safety.
- All injuries are preventable.
- No task is so important or urgent that it cannot be done safely.
- Without diminishing management's obligations, the responsibility and accountability for health and safety rests with every individual.

Santos has documented it's commitment to conducting business in a manner that prevents injury or illness to employees, contractors, customers and the public who may be affected by our work activities. We encourage best practice in health and safety management within this wider Santos community.

To achieve this, Santos:

- Proactively pursues the identification of all hazards and eliminates or, if not possible, manages the risk to as low as reasonably practicable.
- Consults with and promotes active participation of employees in the management of their own and others' health and safety.
- Requires that companies providing contract services to Santos manage their health and safety in line with this Policy.
- Provides resources to achieve a systematic approach to health and safety management to ensure continuous performance improvement.
- Identifies performance measures, sets improvement targets, measures and reports performance at all levels.
- Complies with or exceeds all relevant legislation and standards.
- Develops a culture where all employees and contractors are constantly aware of hazards around them and act accordingly at, and away, from work.
- Includes health and safety performance in the appraisal of employees and contractors and recognise accordingly.

9.2 EHSMS Standards

There are 33 Management Standards that define expectations of all employees and contractors to meet the Environmental, Safety and Health Policies. Santos' approach to Public Health and Safety is covered by the same principles it applies to Occupation Health and Safety.

The EHSMS Management Standards address the following:

- EHSMS 01 Environment, Health and Safety Policies
- EHSMS 02 Legal and Other Obligations
- EHSMS 03 Objectives and Targets
- EHSMS 04 Environment, Health and Safety Improvement Plans
- EHSMS 05 Responsibility and Accountability
- EHSMS 06 Training and Competency
- EHSMS 07 Consultation and Communication
- EHSMS 08 Document and Records Management
- EHSMS 09 Hazard Identification, Risk Assessment and Control;
  - 09.1 Job Hazard Analysis (JHA) and Stepback
  - 09.2 Hazard Studies
  - 09.3 Workplace Inspections
  - 09.4 Behavioural Improvement
  - 09.5 Environmental Impact Assessment and Approvals.
- EHSMS 10 Contractor and Supplier Management
- EHSMS 11 Santos Operations;
  - 11.1 Operated by Others
  - 11.2 Design and Handover of Operating Facilities and Decommissioning and Abandonment
  - 11.3 Pipeline Management
  - 11.4 Onshore Well Suspension and Abandonment.
- EHSMS 12 Management of Change;
  - 12.1 Piping and Instrument Diagram (P&ID) and Control System Change
  - 12.2 Change Management for Operating and Maintenance Procedures
  - 12.3 Disablement of Protective Devices (Bridging)
  - 12.4 Substitution of Materials and Equipment Components
  - 12.5 Acquisition and Divestment of Assets.
- EHSMS 13 Emergency Preparedness;
  - 13.1 First-Aid and Medical Facilities.

- EHSMS 14 Monitoring, Measurement and Reporting
- EHSMS 15 Incident and Non-Conformance Investigation, Corrective and Preventative Action;
  - 15.1 Injury Management.
- EHSMS 16 Management System Audit and Assessment
- EHSMS 17 Management Review.

The EHSMS is supported by:

- 26 Health and Safety Hazard Standards (HSHS), and
- 12 Environmental Hazard Standards (EHS).

The Heath and Safety Hazard Standards are outlined below:

- HSHS 01 Fire Hazard Management
- HSHS 02 Land Transportation
- HSHS 03 Air Transportation
- HSHS 04 Health and Wellbeing
- HSHS 05 Working in Hot Environments
- HSHS 06 Electrical Safety
- HSHS 07 Working at Heights
- HSHS 08 Chemical Management and Dangerous Goods;
  - 08.1 Asbestos
  - 08.2 Synthetic Mineral Fibre
  - 08.3 Benzene
  - 08.4 Mercury
  - 08.5 Vanadium
  - 08.6 Nitrogen
  - 08.7 Hydrogen Sulphide.
- HSHS 09 Radiation
- HSHS 10 Food Safety
- HSHS 11 Manual Handling and Ergonomics
- HSHS 12 Occupational Noise
- HSHS 13 Working Alone in Remote Locations
- HSHS 14 Personnel Security
- HSHS 15 Lifting Equipment
- HSHS 16 Personal Protective Equipment
- HSHS 17 Entry to Confined Spaces
- HSHS 18 Excavations.

The Environmental Hazard Standards are:

- EHS 01 Land Disturbance.
- EHS 02 Underground and Secondary Containment Systems.
- EHS 03 Produced Water Management.
- EHS 04 Waste Management.
- EHS 05 Air Emissions.
- EHS 06 Greenhouse Gas Management.
- EHS 07 Energy Conversation.
- EHS 08 Contaminated Land Management.
- EHS 09 Weed and Pest Animal Control.
- EHS 10 Water Resource Management.
- EHS 11 Cultural Heritage.
- EHS 12 Noise Emissions.

9.3 Design

Santos has well-developed internal standards, specifications, guides and procedures that relate to the design of its equipment and facilities. The systems are administered and checked by qualified professionals both internally to Santos and, on many occasions, external to the Company. Santos internal systems supplement nominated national and international industry standards. Santos also participates in reviews of key national and international standards.

The national and internal design standards and Santos' specifications, procedures and work instructions are maintained on the Santos electronic network and are subject to reviews, updates and auditing in line with Santos quality management processes.

These measures assure that Santos' Design Standards are fit for purpose.

9.4 Operations

EHSMS Standard - Santos Operations

Purpose
Operations are to be conducted within established parameters and regulations. This requires effective systems, procedures and qualified personnel who consistently execute these procedures and practices.

Summary of Key Requirements

- Processes shall be in place to plan and discuss operational activities to ensure EH&S risks are managed (eg Job Hazard Analysis, toolbox meetings and Stepback).
- Procedures shall be developed, implemented and maintained by a nominated custodian for routine tasks.
- Procedures are classified as critical, standard or work aid, determined by the risk and complexity of the task.
- Critical procedures shall undergo a relevant technical and management review before being approved.
- Personnel shall be trained in the procedures and follow the requirements of the procedure.
- A handover process shall be in place to enable the effective handover of ongoing operations.
- A Work Permit System shall be developed and maintained for the planning, coordination, authorisation and control of specified work activity to ensure that the work is conducted
- Safely and efficiently and that personnel, the environment and facilities are protected.

EHSMS 11.1 Operated by Others

Purpose
To outline the Santos requirements for stewarding EH&S performance of Joint Venture activities operated by others.

EHSMS 11.2 Design, Commissioning and Abandonment

Purpose
To ensure that EH&S risks associated with the design, commissioning and handover of operating facilities and the decommissioning and abandonment of plant and equipment are effectively managed.

EHSMS 11.3 Pipeline Management

Purpose
Pipelines are consistently designed, operated and maintained in a manner which reduces EH&S risks to as low as reasonably practicable.

EHSMS 11.4 Onshore Well Suspension and Abandonment

Purpose
Oil and gas wells that are no longer economic can be suspended and abandoned in a manner that leaves the well, field or area as near as practical to their original environmental condition.

9.5 Maintenance

Systems of work shall be in place to ensure the health and safety of people and the protection of the environment.

Hazards shall be identified and their consequent risks shall be reduced to as low as reasonably practicable. Monitoring programs on existing controls will demonstrate safe and healthy working conditions, safe behaviour and effective protection of the environment.

Similar to Operations, Maintenance functions have specific procedures, job plans and technical instructions for dedicated activities. Procedures, job plan and technical instructions are subject to reviews, updates and auditing in line with the Santos management system processes.

9.6 Change Management

EHSMS Standard

Purpose
Processes are required to ensure that changes in organisational structure, operations, procedures, standards, facilities or personnel, are evaluated and managed so that EH&S risks arising from these changes remain at an acceptable level.

Summary of Key Requirements

- A structured process using Change Request (CR) forms shall be used to make changes to:
  - control systems
  - piping and instrumentation diagrams
  - operating and maintenance procedures
  - temporarily disable protective devices
  - materials or equipment components.

The initiator of a CR form shall provide sufficient details to enable the change to be assessed. Proposed changes shall be assessed by the relevant Supervisor or Superintendent to ensure that the proposal is merited, funds are allocated and an appropriate response is developed.

An appropriate technical review of detailed aspects of the proposal shall be undertaken. The developer of the change shall undertake the required definition and design to allow implementation of the proposed change, including cost estimation, and coordinate the appropriate hazard and technical reviews; eg Hazard Studies.

Endorsed and developed CRs shall be forwarded to the change coordinator, who will:

- check the completeness of the change documentation provided
- allocate a unique CR Number
- register the CR in the Change Register
- complete the distribution section of the CR and circulate
- file a copy of the endorsed CR for reference.

Approval levels shall relate to the classification of the CR and the residual risk of the change, taking into account the controls to be implemented. The change shall be implemented and documentation updates completed by a nominated implementer. The implementer shall conduct pre-commissioning checks of the change and ensure that the change has been completed and is safe to bring into service.

A review of the change (Completion Review) shall be completed by the completion auditor within 3 months of implementation. The objective of the Completion Review is to:

- check and record if the intentions of the change have been achieved after a period of operation;
- confirm that all planned actions/changes have been completed;
- confirm that no unplanned action/changes have been made that would warrant a new CR number;
- ensure that all affected documentation has been updated to 'as built'.

Nearly all of the systems and procedures that are applicable to managing the design of Santos facilities and processes are equally applicable to Change Management.
Refer to 'Design' on page 43.

Some policies and procedures associated with Managing Change include:

- Engineering Change Control (No.05.01 Rev 1).
- Santos Operations - Work Permit Procedures (No.3.5.1 Rev 5).
- P&ID and Control System Revision (No.3.3.1).
- Preparation and Control of Management Systems Policies, Procedures and Work Instructions (No.2.04 Rev 4).

Procedures and work instructions are subject to reviews, updates and auditing in line with the Santos management system processes. These are considered fit for purpose.

10 Public Health and Safety

Refer Item 30. (2) (a) of the Regulations.

The Santos gas and oil facilities are located remote from population. Security fencing surrounds the Moomba Plant and Satellite facilities. In the case of satellites, gates are locked when the facility is unattended. The Moomba plant is manned 24 hours per day.

The remoteness of the facilities and low exposure to the public assist in the assessed risks associated with public health and safety from the facilities and activities being regarded as low to negligible. Other factors which support this low risk include:

- The provision of information and publications to the public.
- The use of warning signs at and near facilities.
- Company personnel required to advise, assist or direct members of the public if the need arises.

This is supported by the fact that there have been no instances of adverse impact to public health and safety by Santos production operations during 32 years of operations.

The most significant risk to the public and to the company's workforce is in the area of road accidents. Santos has addressed this risk by the provision of driver training and adoption of policies and procedures for vehicle operation. The engagement of the public in recognising the risk associated with driving in this environment, including driving in dust, is sought through sign-posting and the direct provision of information.

The policies, systems and procedures applied by Santos for the Occupational Health and Safety protection of employees and contractors, are equally applicable to Public Health and Safety protection.

Refer 'Safety Features and Systems' on page 26 for specific features that are in place.

Santos recognises the potential hazards and risks of transportation and road-use associated with its business in the Cooper and Eromanga Basins.

The following mechanisms have been put in place to minimise such risks and impact on the public as well as employees and contractors.

- Land Transportation Standard.
- Land Transportation Procedure Audit Checklist.
- Work Zone Traffic Management training course.
- Weekly Vehicle Inspection Checklist.
- Daily Vehicle inspection Checklist.
- Driver Training Competency Standard.
- Signs.
- Specific Public Information

These are considered to have lowered the risk to as low as reasonably practicable and are considered fit for purpose.

11 Environmental Risks

11.1 Facilities on Environment

Refer Item 30. (2) (b) of the Regulations.

Santos has provided PIRSA with separate documentation addressing:

- Environmental impact report (Section 97 of the Act and Item 10 of the Regulations)
- Statement of Environmental Objectives (Sections 99 and 100 of the Act and Items 12 and 13 of the Regulations).

11.1.1 Environmental Impact Report

In 2000, an EIR covering production and processing operations was developed. This EIR has been reviewed. In addition, four other EIRs have been released. EIRs cover the following operations:

- Geophysical operations.
- Drilling and work-over operations.
- Production and processing operations.
- Moomba to Port Bonython Liquids Line (PL2).
- Jena Waterflood Pilot Project.

Generally, the EIRs provide a description of the following:

- Description of environment in which Santos operates.
- Legislative framework.
- Description of relevant operations.
- Description of existing environment (physical, biological and social).
- Consultation process.
- Identifies hazards, potential consequences and risk minimisation strategies.
- The risk assessment process its application (includes mitigation, monitoring and training strategies to manage environmental impacts).
- Overview of Santos' environmental performance.

The EIR identifies potential hazards and consequences associated with petroleum production and processing operations in the Santos South Australian Cooper and Eromanga Basin licence areas. Environmental hazards associated with production and processing operations include:

- Storage and disposal of process wastes (eg. PFW and oil sludge).
- Accidental spills or leaks associated with pipeline rupture or storage of oil, fuels and chemicals.
- Disposal of domestic and chemical waste and contaminated soil;
- Air emissions vented from satellites and the Moomba processing plant.
- Earthworks associated with pipeline, road construction and borrow pits.

11.1.2 Statement of Environmental Objectives

Following the release of an interim Statement of Environmental Objectives (SEO) by PIRSA in 2000, three SEOs have been produced by Santos, addressing general operations, rather than specific projects or operations. They cover:

- Geophysical operations.
- Drilling and work-over operations.
- Production and processing operations.

Broadly, each SEO details the following requirements:

- A list of environmental objectives to be used when assessing Santos' compliance.
- Assessment methods (including goal attainment scaling or GAS, scientific surveys and studies, photo monitoring).
- Assessment criteria (for each objective).

- Auditing and reporting (including audits by PIRSA, Santos and third parties as well as incident reporting).
- Document revision (when it will be reviewed and consultation).

Each SEO will be reviewed at least once every 5 years, as per Part 3(14) of the Regulations.

Geophysical Operations SEO

Activities associated with geophysical operations that are covered by the SEO are:

- Cultural heritage clearance
- Line and access track preparation
- Line surveying
- Recording
- Campsites and associated activities
- Uphole drilling and logging
- Monitoring and auditing of selected locations
- Line access track and camp site restoration where required.

Environmental objectives for geophysical operations are:

1. Conserve soil resources by minimising disturbance and avoiding contamination
2. Reduce disturbance to drainage patterns and avoid contamination of surface waters and shallow groundwater resources.
3. Avoid disturbance to sites of cultural and heritage significance.
4. Conserve natural environment habitats by minimising disturbance to native vegetation and reducing risks to native fauna.
5. Avoid or minimise the visual impact of operations, including litter.
6. Avoid or minimise disturbance to livestock, pastoral infrastructure and landholders.
7. Optimise waste reduction and recovery.
8. Remediate and rehabilitate operational areas to agreed standards.
9. Avoid the introduction or spread of exotic species and implement control measures as necessary.

Drilling and Work-over Operations SEO

Activities associated with drilling and work-over operations that are covered by the SEO are:

- Well site and access track construction.
- Well site and access track abandonment.
- Drilling.
- Well completions and work-overs.
- Gas and oil systems on well leases.
- Well and zonal abandonment.
- Waterflood or water injection activities.

Environmental objectives for drilling and work-over operations are:

1. Minimise the risk to the public and other third parties.
2. Minimise disturbance and avoiding contamination to soil.
3. Avoid the introduction or spread of pest plants and animals and implement control measures as necessary.
4. Minimise disturbance to drainage patterns and avoid contamination of surface waters and shallow groundwater resources.
5. Avoid disturbance to sites of known cultural and heritage significance.
6. Minimise loss of aquifer pressure and avoid aquifer contamination.
7. Minimise disturbance to native vegetation and native fauna.
8. Minimise air pollution and greenhouse gas emissions.
9. Maintain and enhance partnerships with the Cooper Basin community.

10. Avoid or minimise disturbance to stakeholders and/or associated infrastructure.
11. Optimise waste reduction and recovery.
12. Remediate and rehabilitate operational areas to agreed standards.
13. Minimise as far as reasonably practicable interruptions to natural gas supply.

Production and Processing Operations SEO

Activities associated with production and processing operations that are covered by the SEO are:

- Pipeline, trunkline and flowline construction, operation and abandonment
- Plant and satellite construction, operation, maintenance and abandonment
- Produced formation water disposal operations
- Road construction, maintenance and restoration
- Waste management operations
- Moomba airport operations
- Fire training.

Environmental objectives for production and processing operations are the same as for drilling and work-over operations (refer Section 2.2 above).

Other SEOs

Additional SEOs have been developed that cover specific projects. These cover the following:

- Ballera to Moomba Gas Pipeline (PL5)
- Moomba to Port Bonython Liquids Line (PL2)
- Stokes to Mettika Gas Pipeline (PL9)
- Jena Waterflood Pilot Project

Although the Production and Processing SEO addressed pipelines, additional SEOs are required to cover pipelines that cross land outside PEL114. The first three SEOs listed above are for this.

The Drilling and Work-over SEO covers the general requirements of waterflood activities. However, the Jena Waterflood Pilot Project SEO was developed to ensure that the environmental issues specific to this project were addressed, as due to its location and operation, it had potential to significantly impact on the local environment.

11.1.3 Santos Environmental Policy

As part of the ongoing improvement program within the EHSMS, in 2004 the Santos Environmental Policy was updated (refer to Attachment 2 Santos Environmental Policy on page 79). The Policy has incorporated the following:

- Santos' expansion into international operations;
- consistency with AS/NZS ISO 14001:1996 Environmental management systems – Specification with guidance for use;
- inclusion of sustainable development; and
- an explicit reference to the Santos EHSMS, which continues to include:
  - commitment to continuous improvement;
  - training of employees; and
  - working with the community.

Refer to Section 9, Management System Effectiveness on page 40 for further information about the Santos EHSMS.

11.1.4 Regulatory Compliance Audits

The regulatory compliance audit conducted at Moomba in 2005 revealed that activities were at a high level of compliance with required licences and standards. A number of improvement opportunities have been identified for bunding, waste management and tracking, with actions

included in the Santos Audit and Inspection Manager (AIM). Longer-term actions are also included in the relevant EH&S Improvement Plan.

A further regulatory compliance audit is planned for the fourth quarter 2006.

11.1.5 Oil Spill Reduction Strategy

In 2002, an Oil Spill Reduction Strategy was developed to address those areas found to have high frequency and/or severity incidents; in particular oil pipelines and satellites. A pipeline inspection and repair program and satellite upgrade program (tank-farm upgrades and skimming facility upgrades) formed major parts of the program. The volume of uncontained hydrocarbon has reduced significantly since 2001.

In 2006, another review of oil spill location and frequency is underway to ensure existing programs adequately address those areas of concern. The top 5 spill sources are:

- Pipeline leaks.
- Drains and sump overflows.
- Tank leaks.
- Tank overflows.
- Pump leaks.

11.1.6 Cultural Heritage

In 2002, an Indigenous Land Use Agreement was negotiated with the Traditional Owners of land in PEL114, the Yandruwandha-Yawarrawarrka. Since that time, exploration clearances have been undertaken in consultation with them.

In 2005, a comprehensive review of cultural heritage records, procedures and administrative practices was undertaken against statutory requirements and obligations. As a result revisions to procedures and processes relating to site identification and recording, statutory recording obligations, contractor and staff inductions and field clearance procedures have been made. These changes are now being implemented.

11.1.7 Waste Management Plans

In accordance with waste management requirements in the Santos EHSMS, waste management plans have been developed and implemented for onshore Australian operations, including the Cooper Basin. Issues covered include:

- Waste transportation and receipt.
- Materials handling and separation.
- Litter and fire management.
- Complaints management.
- Records management.

11.1.8 Soil Health Index (SHI)

In 2000 Santos initiated the development of site specific remediation criteria for produced formation water disposal ponds for its Cooper Basin Operations to identify environmentally responsible and cost effective remediation endpoints or criteria for impacted soil/sediment.

Since that time, the following reports have been produced:

- Method Statement for Soil Health Index Approach for Managing Ecological Risks from Produced Formation Water Sediments and Land-farm Soils (2002).
- Results of Soil Health Index Tests, Moomba Evaporation Pond Sediments and Land-farm Soils (2003).
- Results of Biological Impact Testing (Using Soil Health Index Method), Mudlalee #1 Well Site, Cooper Basin, SA (2004).
- Results of Bio-treatability Tests Mudlalee and Big Lake Sites, Trial Remediation of Sediment from Mudlalee and Big Lake Interceptor Pits (2004).

- Comparison of costs of rehabilitation and closure of Produced Formation Water facilities based on the SHI Approach and the “tailings” approach (2005)

The final reports on the remediation trials are due in late 2006.

The assessment method developed uses a rating system to compare test results from the potentially contaminated sites’ soils to background soils using a scale from 1 to 5, with 1 indicating poor biological response (poor soil health) and 5 an ideal response (good soil health).

The findings so far show that PFW soil/sediment are typically lower, poorer soil health, than the background soils (eg. soil/sediment SHI = 3 and background SHI = 5). Typically results of SHI greater than 4.0 indicate that no rehabilitation/remediation is likely to be required. Areas of concern identified included:

- Flare pit sediments.
- Interceptor pit sediments.
- Evaporation pond sediments.

Some natural soils had SHIs of 3.5, in particular those in free-form evaporation ponds and some larger bunded evaporation ponds. This has been attributed to the effects of salinity associated with PFW, and no rehabilitation/remediation is likely to be required.

It is anticipated that these findings will be incorporated into abandonment and rehabilitation procedures shortly.

11.1.9 Oil Spill Remediation End Point Criteria

In 2001, a study was undertaken to determine end-point criteria for remediated oil spills in the South Australian sector of the Cooper and Eromanga Basins. End point criteria (or screening criteria) are defined as ‘maximum allowable concentrations of contaminants’. A number of remediation studies were examined, including bioremediation at a test site at Big Lake. Three receptor groups were considered: human, stock, and ecological.

Criteria were determined for each group that cover heavy metals, simple aromatics and TPH fractions. In addition, spill response protocols and an oil spill site monitoring and sampling program were proposed.

The outcomes have been incorporated into the Santos EHSMS, in particular into the SEO for production and processing operations.

11.1.10 Seismic Rehabilitation

In 2005 South Australian Cooper Basin Joint Venture (JV) parties and PIRSA finalised a Deed of Arrangement addressing the rehabilitation requirements for seismic lines in the Merninie Ranges north of Innamincka. The Deed addresses matters associated with the relinquishment of the petroleum exploration licences and is a good result for the JV. Small scale environmental projects within the Innamincka regional reserve will be implemented in lieu of substantial restoration work.

11.1.11 Moomba Land-farm Management

In 2001, land-farm management techniques were reviewed. A number of findings were presented including: improved irrigation and aeration and investigate alternative disposal for sludges (but consider continued use of land-farm for heavily contaminated oil spills).

From 2003, further investigation was undertaken into how landfill-treated soil could be disposed of properly, including if treated soil could be used as intermediate (daily) landfill cover at the Moomba Waste Depot landfill. It is intended to present this disposal proposal to the EPA in late 2006 for endorsement. Following the disposal of land-farm soils, subject to EPA approval, Santos intend to reduce the land-farm operating area and implement a management plan for land-farm operation.

11.1.12 Sludge Collection and Treatment

A successful on-site trial to treat hydrocarbon sludge was undertaken in 2002 at Moomba.

This was followed-up in 2005 with approximately 3,000 m^3 of sludge being processed using the mobile centrifuge and over 6,500 m^3 of crude oil was recovered from interceptor ponds and the sludge treatment process.

In late 2005, a study was commissioned that investigated opportunities to reduce sludge generated in the field. In addition to this, changes to emulsion breaker formulas have resulted in improved separation and thus less sludge generation.

Further review of the opportunities for reducing sludge generation (such as from the above report) and improving sludge harvesting and treatment processes are continuing.

11.1.13 Oil Trunklines and Gathering Lines

The main activities being progressed to manage and prevent failures are:

- A bacteria management process is being revised to improve MIC related corrosion issues, which involves the installation of pulse injection systems, tank cleaning program and a pipeline pigging and dosing schedule.
- Above ground pipelines are visually monitored and inspected to identify corrosion concerns and damaged pipe supports.
- A review team that considers pipeline integrity. The brief for the team is to review design, operating and maintenance practices to highlight high-risk pipelines in order to develop the appropriate mitigation strategies.

11.1.14 Satellite Upgrades

There is an ongoing program to upgrade satellite facilities to improve environmental performance. Areas of focus include interceptor pit skimming facility and tank-farm upgrades.

Satellites that have been upgraded (or are in the process of being upgraded) include:

- Moomba South Oil Facility,
- Moomba Oil Facility,
- Strzelecki Satellite,
- Merrimelia Oil Satellite and
- Tirrawarra Gas Satellite.

In addition, there has been an increased focus on housekeeping, with regular inspections addressing issues such as weeds, spills and leaks, rubbish and appropriate signage.

11.2 Environment on Facilities

Refer Item 30. (3) (c) of the Regulations.

The potential impact of environmental conditions on the safety and integrity of Santos operating facilities is an integral part of facility and equipment design and operation. Santos design guides and codes of practice are accompanied by design, construction and operating HAZOP studies. Refer to the 'Design' section on page 43.

Due to the isolation of the Santos production facilities in the Cooper/Eromanga Basins, the risk of pipeline or equipment damage due to third party influence (eg. Collision, excavation etc.) is assessed as low.

In addition, independent reviews by Santos Insurance Underwriters and Brokers have recognised and made assessments regarding the importance of considering the potential impacts of external factors on the facilities they are insuring.

The first survey conducted by newly appointed Insurance Broker, J&H Marsh & McLennan, during September and October 1998, addressed the following issues as part of their review into 'Consideration Of Major Perils':

- Fire and explosion.
- Lightning.
- Wind storms.
- Climate.
- Earthquake.
- Flood.
- Subsidence.
- Collision.
- Riots/strikes/malicious damage.

There was only one minor recommendation, generated by Marsh & McLennan, which related to any of the above environmental matters. The recommendation related to a review of the over-voltage system in case of a lightning strike.

In 2001, earthing systems at Santos facilities (plant and field) were tested for integrity and repaired or upgraded as necessary. An on-going test procedure has been put in place.

11.3 Summary

It is Santos' view that the Statements of Environmental Objectives and the environmental systems and procedures, which are in a state of ongoing development / continuous improvement, are fit for purpose.

12 Adequacy and Reliability of Utilities

Refer Item 30. (3) (e) of the Regulations.

The improvement programmes and projects referenced in the 2001 FFP report have been implemented, resulting in improvements in the reliability of the Moomba Plant utilities. The improvements addressed those issues raised in the following reports:

- ABB Power Generation, March 1999.
- SHE Pacific, May 1999.
- "Moomba Utilities Review - Study Report" of May 1999.
- Snowy Mountains Engineering Corporation (SMEC-HGM Pty Ltd), three specific reviews in May, August and September 2000.

The focus for maintaining utilities reliability and achieving on-going continuous improvement is being addressed through a number of mechanisms including:

- Shell FAIR reviews and follow-up actions.
- A "Critical Equipment Review Meeting" each week to review and prioritise operational/reliability issues. The meeting is attended by cross-functional team members, including Process, Instrument/Electrical, Mechanical, Maintenance and Engineering & Reliability.
- The Reliability Improvement Team that are implementing:
  - Reliability Management Plans (RMP).
  - Root Cause Analysis (RCA) investigations and action plans.

12.1 Addressing Reliability of Utility Operations

The collective process of reviews, assessments and recommendations by:

- ABB Power Generation,
- SHE Pacific,
- Santos 'Moomba Utilities Review - Study Report', and
- Snowy Mountains Engineering Corporation (SMEC-HGM Pty Ltd),

led to specific risk reduction projects being implemented.

These projects included:

- Installation of a new 5MW Gas Turbine Alternator (GTA2) at the Moomba plant.
- Upgraded Uninterrupted Power Supply (UPS), battery charger systems and switchgear trip circuit supervisory systems.
- New instrument air compressors and system.
- An upgrade to the High Voltage (HV) distribution system.
- The Asset Control Enhancement (ACE) project that provided;
  - An upgrade of the Moomba plant control systems,
  - A replacement Distributed Control System (DCS),
  - Upgraded emergency shutdown systems (programmable trip systems),
  - Upgraded boiler control and management,
  - Improved power generation,
  - Electrical load management,
  - Upgraded gas turbine control systems,
  - Upgrades to the Moomba central control room,
  - Upgrade management information system and control softwares.

Refer to 'Risk Reduction Measures (ALARP)' on page on page 57 for more details.

12.1.1 Steam Generating Capability

The total steam generating capacity at the Moomba plant is 430 tonne/hr (MCR) of high-pressure (HP) steam. The normal operating demand for steam is about 260 tonne/hr (Summer) and 300 tonne/hr (Winter). The steam generators therefore have sufficient capacity to satisfy year-round steam requirements.

However, due to historical unreliable performance of the steam generators, considerable review and effort has been directed at the Moomba steam generation reliability and capacity.

Historically, the main reasons for poor reliability were identified as:

- Unacceptable Boiler Feed Water (BFW) quality excursions.
- Resultant internal fouling and damage to steam generators and in particular No.10 Boiler.
- Control issues associated with boilers and steam generation/reliability.

To address these issues the following actions have been implemented:

- Installation of a new two-stage Reverse Osmosis (RO) water plant.
- Tighter quality testing and control of BFW and condensate return quality.
- Extensive overhaul of No.10 Boiler including:
  - Complete replacement of screen and sloping wall tubes,
  - Replacement of 6 superheater tubes,
  - Comprehensive acid clean,
  - Independent inspection before and after the acid clean.
- Replacement of shells on Nos. 3, 4 and 5 Flash Evaporator plants.
- Modifications to prevent contamination of condensate returns.
  - Eg. Redirection of the CO_2 Train flash steam vents.
- Replacement of superheaters in Nos. 4 and 6 Boilers.
- Re-tubing of the Dump Condensers, Nos.2, 3, 4 and 5.
- Elimination of Deaerator bypassing (Deaerator No.4).
- The ACE Project, which upgraded the Moomba plant and utility control systems, was completed in 2005 and included:
  - the main Distributed Control System (DCS),
  - emergency shutdown systems (programmable trip systems),
  - boiler management systems,
  - burner management systems,
  - power generation control systems.
- Updating Operator Manuals and Operating Procedures.
- Competency Based Training (CBT) for operating and maintenance personnel.

Since 2001 statutory inspections have been carried out on the Moomba Plant boilers and no major repairs have been necessary. This has reinforced the improvements achieved over the last five years.

Further work being considered and reviewed for the boiler feedwater / condensate system includes:

- Replacement of LRP condensate return header, scheduled for 2007.
- Automatic steam and BFW dosing systems.

Santos has deemed it an acceptable commercial risk not to increase steam-generating capacity based on:

- The plant now operates at only approximately 75% of its steam generating capacity.
- Reliable operation of the two-stage RO plant.
- The BFW projects that have been implemented.
- The overhaul, the ongoing reliable performance and the acceptable 12 month inspection of No.10 Boiler.
- Satisfactory outcomes from the statutory boiler inspections over the last five years.

- Ongoing attention and improvements to BFW quality control.
- Forecast processing rates are lower and hence the steam demand will be lower.
- Improved utilities control resulting from the ACE project.

Steam generation is based on having one boiler on-line, additional to demand, to support reliability of gas supply. This is in line with normal operating practice for utility companies.

The utility systems in the Moomba plant are considered fit for purpose. Improvement projects identified in this report will enhance both the reliability and fitness for purpose into the foreseeable future.

12.1.2 Instrument Air Reliability

The Instrument Air facilities at the Moomba Plant underwent a major upgrade in 2002. Refer to the section on Moomba Instrument Air System Upgrade on page 64.

As a result of the upgrade, the instrument air system has been operating reliably for a number of years.

An instrument air outage in July 2006 is being investigated by a Santos team using a TapRoot® structured root cause analysis process, consistent with the requirements of the Santos EHSMS09, ‘Incident and Non-conformance Investigation, Corrective and Preventative Action’. The results of this investigation will be communicated separately to PIRSA.

13 Risk Reduction Measures (ALARP)

Refer Item 30. (9) of the Regulations.

Outlined in this section are the recent major activities undertaken by Santos to minimise the identified and assessed risks, to its production operations, in the Moomba area consistent with the objective of reducing risk to as-low-as-reasonably-practicable (ALARP). The majority of activity is directed at ensuring the integrity and reliability of its facilities and ensuring reliability of supply to its customers.

The implementation of these major projects will address many of the recommendations proposed by third party risk assessment reports over the last decade.

In particular, the Company reports that have been addressed are:

- Sedgwick Energy Ltd., Underwriting reports, August 1995 and October 1997.
- ICIAE, Insurance Indemnity Review, March 1996.
- Marsh & McLennan, Insurance Assessment Report, December 1998.
- ABB Power Generation, Moomba Steam Generators, March 1999.
- SHE Pacific, Risk Review of Moomba Processing Plant, May 2000.
- SMEC-HGM, three reports on Moomba Power System facilities and asset management plus Moomba Utilities, May, August and September 2000.
- QEST Consulting Engineers Pty Ltd, Whole of Plant Risk Assessment- Moomba Plant, March 2003.
- QEST Consulting Engineers Pty Ltd, Moomba South Whole of Plant Risk Assessment, March 2005.
- Aker-Kvaerner, Moomba Integrity Review Project, December 2003.
- Shell Global Solutions International BV, Santos Focused Asset Integrity Review [Static Equipment], February 2005.
- Shell Global Solutions, Santos Focused Asset Integrity Review [Pipelines and Rotating Equipment], October 2005.
- Shell Global Solutions, Santos Focused Asset Integrity Review [Electrical and Instrumentation], May 2006.

The projects identified in this section of the report enhance the reliability, operability and performance of the Moomba Plant and reduce the risk of unplanned events. Many of these projects enhance the fitness for purpose of the utility systems.

13.1 Asset Integrity Management System

Santos is currently finalising the development and implementation of an Asset Integrity Management System (AIMS) to integrate and improve existing systems. AIMS shall provide a structured management framework which describes how the integrity of Santos oil and gas facilities, power and control systems and pipelines are managed and assured. It enhances effective through-life integrity management of assets to meet operational availability and technical integrity goals set by Asset Value Plans.

Implementation of AIMS will contribute towards achieving the following:

- Statutory or Corporate compliance with Environmental, Health and Safety policies.
- Managing the frequency and severity of loss of containment events.
- Increased plant availability.
- Reduction in unplanned maintenance.
- Reduction in deferment costs.

The above will be achieved by ensuring:

- Integrity failures are anticipated wherever possible before they occur.
- The scope and responsibilities of integrity management activities are clear.
- A structured framework exists for identification of risks associated with integrity management and systems.
- Deterioration mechanisms are understood, rates are predicted or measured and risks reported to management.
- Risk control measures are developed and corrosion mitigation, monitoring and inspection methodologies are employed.
- Any anomalies found to be outside the pre-defined acceptance levels are assessed and actioned by relevant personnel.
- Integrity and Corrosion monitoring and inspection records are analysed to ensure ongoing efficiency and effectiveness of integrity programmes.
- Periodic auditing of technical practices is undertaken and corrective measures are tracked and closed out.

AIMS provides a guideline for managing the following elements:

- Santos integrity organisation and key responsibilities
- How compliance is defined and managed
- How audits are conducted and at what frequency
- Key integrity performance indicators
- Developing 5 Year integrity plans and identifying resource requirements
- Developing and managing Integrity Management Plans
- Defining how inspections are carried out
- Assessment and management of risks
- Identification and management of integrity competency requirements
- Identification, assessment and management of non-conformances
- How integrity is assured during operation of assets
- How and when Fitness for Service assessments are carried out
- Managing deferment of inspections
- Managing repairs and improvements to assets
- Managing out-of-service equipment
- Identifying and managing key integrity records
- Ensuring that integrity is established during the development of new assets and modification to existing
- How materials are managed to ensure integrity of our assets
- Creating and managing performance measures to ensure that Key Integrity Performance Indicators are achieved.

Implementing AIMS will help to focus and align a number of key integrity related initiatives, in particular:

- Development of Integrity Management Plans.
  - Integrity Management Plans are being developed for all critical assets and equipment. The objective is to provide a more proactive and structured process for the management of integrity failure mechanisms and increasing the opportunity for maximising the potential life of assets. The key aspect of IMPs focuses on formalising this structured process for identifying and managing possible failure mechanisms and is not just a documented plan.
- Integration of Inspection, NDT and Asset Integrity Management Services:
  - In October 2005 Santos established a contract for Inspection and NDT activities. One of the main advantages of this contract has been to increase flexibility of resources resulting in the ability to focus inspection activities into key priority areas. The introduction of this inspection contract also enhances the independence of the inspection findings.

- The contract with the Service Provider is being progressively expanded into an alliance partnership, with the Service Provider increasingly carrying out a wider range of integrity activities, both through provision of specialist services to help improve systems and procedures, and also by assisting Santos to develop Integrity Management Plans for all critical assets. The Service Provider's growing capability to support a wider range of integrity activities will again increase Santos's flexibility and ability to improve integrity management across all assets in a cost effective manner.

13.2 Corrosion Control Program

The corrosion programme aims to address all corrosion aspects of Pipelines, Plant and Equipment Integrity. The goal is to achieve zero leaks or failures.

Corrosion control is a major focus within Santos and recent integrity initiatives include:

- Introduction of the Asset Integrity Management System (AIMS) and the development of Integrity Management Plans (IMPs) for all Santos pressure containing assets.
- Installation of corrosion resistant glass reinforced epoxy (GRE) pipelines for oil service in some, critical, locations.
- Development of Pipeline Damage Mechanism Models and Re-lifing Assessment Tool for the Santos pipeline gathering network.
- Mothballing of the retired Keleary trunkline.
- Engagement of specialist consultants to study microbiological influenced corrosion (MIC) study.
- Installation of biocide injection systems at critical trunkline locations to control MIC.
- Introduction of batch biocide treatments to control MIC.
- Introduction of pipe supports to combat external corrosion of surface laid piping.
- Development of a Pipeline Corrosion Management system.
- Continued extensive use of Fusion Bonded Epoxy (FBE) coating system on carbon steel pipelines.
- Intelligent pig surveys of major trunklines.
- Development of Pipeline 'Direct Assessment' methodology as a method of evaluating the likelihood of active corrosion (eg. SCC) and for prioritising pipeline inspection (inspection scope and location).
- Optimisation of pigging frequency and corrosion inhibitor treatments of pipelines that can be pigged.
- Ongoing corrosion inhibitor injection and batch treatment programs
- Annual audits of the effectiveness of the Cathodic Protection system.
- Ongoing monitoring of the effectiveness of inhibitor injection through water sampling.
- Annual coating defect surveys and repairs to improve external pipeline protection levels.
- Installation of solar powered chemical injection and transformer rectifier units to improve cathodic protection and chemical injection performance.
- Moomba Corrosion Under Insulation (CUI) programme developed and commenced.
- Moomba Sweet Gas Header and some LRP piping replacement. Installation of inhibitor injection and corrosion monitoring probes.
- Development of a mercury management plan, which has included replacement of the Moomba LRP cold boxes with mercury tolerant design, monitoring mercury in process streams, etc.

13.3 Wells

Risk reduction and management of the wells and their associated operations is based on the ongoing review, monitoring and maintenance of wellbores, well operations and conduct of well workovers, with particular attention to:

- construction materials, methods and equipment, and
- practices and procedures, associated with:
  - design and construction,
  - operations,
  - monitoring,
  - well maintenance
  - modification, and
  - abandonment.

13.4 Pipeline Gathering Network Improvements

13.4.1 Embarka Swamp Flowline Replacements

The Tirrawarra Embarka Swamp area is one of the most environmentally sensitive areas of the Cooper Basin. It becomes inundated approximately once every 3 years due to flooding from the Cooper Creek. The objective of this project was to improve the integrity of the oil gathering system in the Tirrawarra Embarka Swamp by the replacement of several oil flow lines with new glass reinforced epoxy (GRE) lines. This allows the system to be operated with a decreased risk of environmental contamination in times of flood.

13.4.2 Limestone Creek to Strzelecki Trunkline Replacement

This project involved the replacement of the 15year old, 100mmNB, surface laid, 45km trunkline between Limestone Creek (LSC) and Strzelecki. The old trunkline has had external and internal corrosion issues in the past resulting in pinhole leaks and associated oil spills. The conversion of the pipeline to GRE is the most cost effective means of addressing long term integrity and capacity issues in accordance with standards and good environmental practice.

13.4.3 Tirrawarra Oil Trunkline

The original Tirrawarra Oil Trunkline has been retired and the better conditioned pipeline that was used for Ethane Oil Recovery (EOR) is now used to transport oil from the Tirrawarra Satellite to the Moomba Processing Plant.

Following its revised service, in 2003, this oil pipeline has been successfully inspected using an inline inspection tool. The analysis is currently underway with the refurbishment strategy expect for the pipeline in the second half 2006.

13.5 Ballera Pipeline

The Ballera pipeline connects the gas fields and processing plant in South West Queensland to the Moomba Plant. It was built and commissioned in 1993 to supply incremental raw gas into the Moomba Plant for processing. It is a raw gas trunkline into Moomba and hence reinforces reliability of supply in South Australia.

The Ballera line, which is a Licensed Pipeline (PL #5) subject to a separate report, is also a factor that can be considered in plans for recovery from an emergency that may interrupt gas supply. Sales gas, if available from the Ballera Plant, could supplement natural gas into South Australia in certain circumstances.

For this to occur, certain criteria and issues would need to be addressed, including:

- A critical unavailability of gas in South Australia.
- A logistical review of the gas balance in Queensland.
- The lead times and operational/technical issues.

13.6 Control System Upgrades - Gas Satellites

Extensive control system upgrades have been conducted at several gas and oil satellite facilities.

The major upgrade of the control system at Moomba South-Central gas satellite is a significant factor for ensuring reliability of withdrawing sales gas and ethane from underground storage.

Other satellites that have undergone control system upgrades are:

- Big Lake gas satellite.
- Tirrawarra gas and oil satellite.
- Merrimelia oil satellite.
- Strzelecki oil satellite.

13.7 Pig Launchers and Receivers

The risks, associated with the Pig Receivers on the raw gas trunklines, which were identified in the SHE Pacific Report (May 1999), were initially addressed by the following equipment improvements:

- Emergency Isolation Valves (EIV) installed upstream of the pig receivers on four of the major gas trunklines entering the Moomba Plant.
- Pig-receiver isolation valves upgraded to high integrity expanding-type gate valves on three of the major gas trunklines.

The above actions, flowing from the SHE Pacific Report, were designed to manage the risk by minimising the 'consequence' of a failure.

A more recent risk assessment review has identified the need to minimise the risk of failure of a Pig Receiver (or Launcher) as opposed to focussing on the consequences associated with a failure. To this end Santos is introducing an increased surveillance programme for pig receivers and launchers throughout its operation as a more proactive means of risk mitigation.

This approach has developed from one of the Shell FAIR reviews and the surveillance programme will form part of the Integrity Management Plan.

13.8 Sales Gas Back-up Line

A VCE in the Liquids Recovery Plant (LRP) may render the normal sales gas pipeline in the Moomba plant inoperable, thereby terminating sales gas supply from the plant for an extended period.

A back-up sales gas line, which runs outside the VCE overpressure circles (particularly the >20 kPa areas), was installed in 1999. The bypass line assists early resumption of sales gas supply. Such a line is predicted to survive a VCE in the LRP with little or minimal damage. The line runs from Dew Point Control Units #1 and #2 (DPCU #1/#2), along the eastern boundary fence of the Moomba plant, to the sales gas meter stations.

The sales gas back-up line is an essential part of the recovery plan. It will enable a combination or raw gas, withdrawal sales gas, withdrawal ethane and Ballera gas, which can be processed through surviving DPCUs and CO_2 Trains, to be routed to the Sales Gas discharge header for distribution to customers.

Refer to 'Security of Production and Supply' on page 71 for a description of the Recovery Plan and details of available sales gas following an EML type incident at the Moomba Plant.

13.9 Mercury in Raw Gas

After 20 years of operation the Cold Box section of LRP Train 'A' experienced material failure at the start of 2004. The failure was attributed to 'Liquid Metal Embrittlement' (EML) of the aluminium material.

An extensive risk management process resulted in the following improvements to manage the risks associated with mercury in raw gas:

- New Cold Boxes installed with improved design and specialist third party verifications and inspections.
- Mercury removal molecular sieve installed in the Dew Point Control Units (DPCU) to achieve <0.1ug/Sm^3 in gas entering the LRP.
- Addition of a Mercury Removal Unit (MRU) to remove mercury from the DPCU regeneration gas.
- A mercury monitoring, sampling and inspection programme established.

13.10 Asset Control Enhancement (ACE)

The ACE Project was completed in 2005 and included:

- Upgrading the Moomba plant control and safety systems;
  - the main Distributed Control System (DCS),
  - emergency shutdown systems (programmable trip systems),
  - boiler management systems,
  - burner management systems
  - power generation control systems,
  - control systems on the Area 65 LRP refrigeration gas turbine driven compressor packages.
- Refurbishing the Main Control room to create the Operations Control Centre and centralising the Plant and Field control in the one room.
- Providing data historian for plant data allowing for better management of the plant and for plant control system performance optimisation.

The ACE project was also enhanced by the Heating, Ventilation and Air Conditioning (HVAC) project for the upgraded Operations Control Centre (OCC).

13.11 Sweet Gas Header Replacement

Planned inspections revealed levels of corrosion that led to the scheduled replacement of the Sweet Gas Header and the upgrade of corrosion inhibitor, and corrosion probe monitoring facilities, in 2003. The corrosion mechanism was attributed to acid gas attack. The Sweet Gas Header transports 100% of Moomba's gas production.

Work scope included:

- Replacement of 250 m of high pressure header and its connecting branches, which were located within the existing main pipe-rack.
- Sizes ranged 250 mm to 600 mm diameter with design pressure 8,300 kPag at 120°C.
- Work completed in stages, achieving reliability of gas supply during tie-in to seven CO_2 and two LRP trains.
- Corrosion inhibitor facilities upgraded to mitigate further corrosion in the sweet gas header and post Benfield coolers.

13.12 Liquids Pumping Station Re-instatement

A fire at the Liquids Pumping Station in 2001 led to an upgraded re-instatement of this facility that pumps liquids from the Moomba Plant to the Processing Plant at Port Bonython.

Risk mitigation upgrades / modifications were made to the operating plant in the following key areas:

- Control systems.
- Process liquid isolation valves changed to fail-closed air-operated valves.
- Addition 'blinding' facilities installed.
- Installation of a new high integrity relay based Emergency Shutdown System (ESD).
- Upgraded services including lighting.

13.13 Propane Inventory Isolation at Moomba Plant

The technical risk review carried out by SHE Pacific in 1999 identified potential propane leakage, from the three refrigerant accumulators in the Liquids Recovery Plant (LRP), as a significant risk scenario. This scenario could result in a major interruption of gas supply from Moomba, caused by serious damage to the LRP arising from a propane fire and/or vapour cloud explosion. Such a situation has been identified as an 'Expected Maximum Loss (EML)' scenario for maximum loss of product supply and maximum business interruption.

By installing emergency isolation valves on the inlets and outlets of these accumulators, the scale of such an incident could be reduced by restricting the quantity of propane discharged in a leak scenario.

EIVs were installed on the three Propane Accumulators in 2002-03.

13.14 Steam Generation and Boiler Feedwater Improvements

The reliability and performance of the steam generating equipment and the associated water systems have been improved by the installation of the two-stage Reverse Osmosis Plant that is reliably providing potable and demineralised water (for BFW).

The main causes of steam generating deficiencies have historically been the availability of, and quality excursions for, Boiler Feed-Water (BFW).

In addition to the commissioning of the two-stage RO Plant, the following programmes have also aided the improved reliability of the BFW system:

- A service contract with a specialist water treatment company to manage, monitor and control the BFW quality.
- Improved condensate recovery through a steam trap survey and upgrade programme, throughout 2003-04, using a company that specialises in steam usage and condensate recovery.
- Installation and operation of corrosion inhibitor injection facilities and corrosion monitoring probes in the steam condensate header.

13.15 Power Generation

Internal Santos reviews and studies by the SMEC-HGM Pty Ltd in 2000, identified reliability risks associated with the power generation system at the Moomba Plant. The risk assessment scenario addressed current power reliability and the need to ensure adequate generation capacity for the forecast load growth over the five-year period following the report.

Lack of spinning reserve generation meant the chance failure of one of the 5MW generators, while one of the remaining generators is off-line, may result in an interruption to the supply of power to the Plant and Moomba environs and associated loss of production. Similarly, lack of generating capacity did not allow for access to existing plant for operational and long-term maintenance requirements.

The power generating capacity and reliability at the Moomba Plant has been improved with the installation of a new Gas Turbine Alternator (GTA). The additional alternator, of 5MW capacity, was commissioned in 1Q 2001.

Operating Manuals, Operator proficiency training and High Voltage Switching procedures/training were updated for the operation of the additional GTA in conjunction with the existing system.

The Moomba Power Generation System now comprises four Steam Turbine Alternators (STA) and two GTAs which address risks and recommendations raised in the assessment reviews conducted by SMEC-HGM during 2000.

The installation of the new GTA as a base load generator provides an additional major advantage by introducing greater flexibility for the plant's steam-driven power generation system.

13.16 UPS and Battery Charger Systems

As a result of the SHE Pacific assessments performed in 1999, a project was implemented and completed in 2003 to upgrade the Moomba Un-interruptible Power Supplies (UPS) and Battery and Battery Charger systems providing power to the Moomba Plant control and safety systems.

The project addressed the following load centres within the Moomba plant:

- Marshalling Stations 1, 2, 3 and 4.
- Switchrooms 1, 2, 3 and 5.
- Central Control Room.

It also includes the Battery Systems at each of the following major satellite communications sites in the Cooper Basin, namely, Tirrawarra, Bookabourdie, Della, Dullingari, Toolachee, Big Lake, Moomba South Central, Gidgealpa and Daralingie.

The UPS and Battery systems installed at the Moomba Plant are required to provide secure power to critical / essential equipment for plant utilities and plant process control and safety systems. Similarly the communications site systems are required to provide secure power to critical / essential communications equipment for ongoing operations.

13.17 Moomba Instrument Air System Upgrade

The upgraded Moomba Plant instrument air system was commissioned in 2002 and involved:

- Replacing the existing instrument air compressors with the exception of the diesel driven emergency air compressor. Installing three screw compressors, each with a capacity of 1,700 Sm^3/hr. Each compressor was designed to deliver 50% of normal plant air requirements.
- Replacing the existing air drying equipment with an installation designed to handle the full range of weather conditions experienced at Moomba.
- Power supply for Train "A" Duty Compressors 8 and 9 is from Switchroom 5 Utilities MCC 'A' and 'B', respectively, while the power supply for Train "B" Emergency/stand-by Compressor 10 (including black-start Diesel Compressor) is from a new MCC tier extending Switchroom 5 Utilities MCC 'A'. The latter supply is aligned with the emergency power bus.
- A Programmable Logic Controller (PLC) controlled system to:
  - Manage the load distribution of the ‘duty’ compressor train and the ‘stand-by’ compressor train.
  - Control and monitor the humidryer sequences.

The system is designed to deliver total plant requirements with two compressors operating and the other in standby mode.

This project addressed recommendations from the SHE Pacific report.

Also refer to Instrument Air Reliability on page 56.

13.18 High Voltage Distribution Upgrade

The Moomba High Voltage Upgrade was completed in 2004 and included:-

- The removal of the 3.3kV Distribution System for the main process and production related power supply systems.
- The integration of the HV Distribution into a common 11kV ring main system for generation and distribution.
- An 11kV Bus Neutral-Earthing Scheme has been installed and is to be commissioned in 4Q 2006.
- The provision of back-up supplies to each HV switchboard section.
- Removal of HV equipment from congested Switchrooms.
- Replacement of existing oil filled 11kV breakers with vacuum breakers

- Replacement of existing 30-year-old 3.3kV transformers with new 11kV units.
- Replacement of electromechanical protection relays with electronic units integrated with the breakers.
- Integration of the generation and 11 kV power distribution systems with the new plant wide control system installed by the ACE Project.
- Provision of an integrated power system monitoring and data logging via the plant data historian installed by the ACE Project.
- Improvement in the reliability of power generation due to the increased availability of system information.

13.19 Operating Procedures and Documentation

Considerable effort has gone into upgrading operating manuals and procedures for the Moomba Plant and satellite facilities since the 1990's. This activity was re-emphasised with the introduction of Competency Based Training (CBT) and the Corporate Environment, Health and Safety Management Standards.

The upgrades have involved:

- Updates to Operating Manuals, including preparation of new manuals where required.
- Updates to Operating Procedures, including preparation of new procedures where required.
- Review and upgrading of the Standing Order system.
- Updating existing operating philosophies and guidelines, including preparation of new ones where required.
- Development and implementation of improvements to Competency Based Training, including use of Operating Manuals and Procedures as learner and assessor resources.
- Implementation of quality controlled document systems.
- Conversion into a common database (Technical and Information Management System, TIMS).

The programme is ongoing and the objective is to have up-to-date, quality controlled operating documentation that is available on-line to essential end users.

13.20 Operational Competency

Over the last 5 years Santos has invested significant energy, time and resources in the development of the following key initiatives to build operational competencies.

Competency based training framework for tradespeople and front line operational personnel. This has resulted in the direct alignment of the Santos training system to the:

- National industry training package, including the;
  - Chemical, Hydrocarbons and Oil Refining Training Package – PMA 02, and
  - Metals, Engineering and Manufacturing Training Package – MEM 05.

The approach to CBT results in the attainment, by Santos operational and maintenance personnel, of national recognised qualifications - Certificate 4 in the respective training packages and more recently Diploma level qualifications for maintenance personnel.

This system identifies the necessary core and site specific competencies required to safely and effectively carryout work at the various operating sites.

The system is underpinned by a learning management system which allows the employee and supervisor to manage and track competency achievement 'on – line' and enables effective auditing of skills, knowledge and competency possessed by relevant personnel.

This system is now being extended to encompass supervisory, professional (discipline engineering) and technical support roles.

Operating manuals, which underpin the safe and effective operation and maintenance of field equipment and systems, are directly aligned to the CBT system.

Standard operating procedures (SOPs) for standard and critical operating and maintenance activities.

The currency of Operating manuals and standard operating procedures are maintained via the Santos Management of Change (MOC) standard which ensures that SOPs remain current as changes to equipment specifications, operating parameters, introduction of new plant and equipment arise.

Training needs analysis processes for operating and maintenance personnel to ensure that such staff are equipped with the necessary skill, knowledge and competency to carry out their respective roles and to ensure qualifications remain current.

Recruitment processes have been improved to ensure that selection of suitably qualified and experienced personnel is achieved. These processes also address issues of candidate behaviour and attitude and targeted selection processes are engaged to determine if potential candidates exhibit the necessary regard for environment, health and safety, adherence to standard operating procedures and equipment reliability. Rigorous pre-employment checking is undertaken to support candidate selection.

Technical Competency Ladder framework has been developed and implemented to identify technical training needs of discipline engineers.

13.21 Work in Progress

The following projects are well advanced for implementation in the near future:

- Upgrade of the Dew Point Control Units Area 55 Switching Valves (DPCU Nos. 6, 7, 8 and 9) to provide greater reliability of moisture and mercury removal upstream of the LRP Trains.
  This will introduce greater reliability of moisture removal for meeting Sales Gas specifications and also greater protection for the low temperature sections of the LRP Trains. The project is scheduled for implementation in 2006 - 2007.
- Upgrade of the HP Flare header including the installation of an additional HP flare knockout drum.
  This project is to protect against hydraulic loading of the HP Flare safety system and is scheduled during a planned plant shutdown in 2007.
- Upgrade of the LRP cold drain and emergency depressuring system.
  This project mainly addresses the hazard of low temperature impact on materials of construction. A dedicated stainless steel, cold drain system will be constructed and feed into the specialised Low Temperature Flare system. It is also planned to be implemented in 2007.
  The project will also include new remotely operated drain points to empty operating liquid inventories from the LRP in case of emergency or planned shutdowns.

14 Emergency Procedures

Refer Item 31. of the Regulations.

General Standard:

EHSMS# 13 is the Management Standard that defines the requirements for Emergency Preparedness. This ensures that relevant emergency equipment and resources are readily available and personnel are able to effectively respond to emergency situations as to minimise the impacts on the health and safety of people, the environment, plant, property and other harm to Santos.

Santos has developed Emergency Plans and Procedures that have been regularly reviewed and updated.

14.1 Emergency Response Plans

A summary of emergency procedures that are applicable to the Moomba production facilities in South Australia is outlined below:

- Santos Incident Management Plan (SIMP).
- Moomba Emergency Response Plan.
- Moomba Aerodrome Emergency Response Plan.
- Moomba Contingency Pre-plan.
- Moomba Security Plan
- Moomba Plant and Utilities failure.
- Cooper Basin Field Contingency Pre-plan
- An overview of plans, mustering requirements is detailed during the mandatory induction.

14.2 Emergency Response Exercises

The Management Standard requires emergency scenarios to be regularly rehearsed. A schedule of exercises to be conducted is drawn up for each year.

Major exercises are conducted under the guidelines of Emergency Management Australia (EMA). Some exercises include participation or observation from outside agencies, including regulators and emergency authorities. For example the national counter terrorism exercise “Mercury 05” had participation and observation by Senior Police and ADF officers.

During 2005 there were twenty six exercises of various types conducted by Santos in the Cooper Basin. These ranged from table top / discussion through to the annual major exercise.

- Details of exercises are described in the annual SA Cooper Basin report to PIRSA.
- Forty two exercises are scheduled for 2006.

14.3 Emergency Response Exercise Follow Up

Exercises are followed by a debrief. In the case of the major exercises there may be four debrief sessions culminating in a final debrief. Exercises are recorded in the EH&S Toolbox. In the debrief Opportunities For Improvement (OFIs) may be identified. These are electronically assigned and tracked until closed out.

As a result of this ongoing development and continuous improvement, planned exercises, the emergency procedures are considered fit for purpose.

14.4 Security

The Moomba Security Plan was designed to strengthen the security posture especially at increased national threat levels.

As noted in 14.2 above, Moomba was involved in “Mercury 05” the national anti terrorism exercise. This resulted in a large contingent (approx 140) of Police and Australian Defence personnel being deployed to Moomba. These personnel were actively involved within the scenario on a 24H basis for 3 days. Santos was requested to supply their expertise into the exercise development and control.

15 Ongoing Fitness for Purpose

The following sections record the assessment of ongoing fitness for purpose for Santos facilities with regard to:

- Public Health and Safety.
- Environmental Impact.
- Reliability of supply of Natural Gas.

15.1 Physical Condition of Facilities

Refer Item 30. (3) (a) of the Regulations.

Santos' operations extend from the gas and oil wells through to the output from the Moomba Processing Plant.

The facilities incorporate equipment items such as wells, pipelines, pressure vessels and pipework, rotating machinery and storage facilities as well as operating systems including procedures, instrumentation and control systems, safety mechanisms and utility operations.

Santos has regularly inspected and audited the facilities outlined above and reviewed and audited the systems operated by Santos in the Cooper/Eromanga Basins and found them to be sound and fit for purpose. Should inspections or audits reveal deteriorating or unacceptable conditions or systems, corrective action plans are established to address any short-comings.

Santos makes this statement based on the supporting factors, outlined in this report:

- The Santos Management System (EHSMS) ensures policies and procedures are in place, including:
  - Risk Assessment and Management,
  - New Plant, Equipment and Process Design,
  - Management of Change,
  - Systems of Work for Operations, Maintenance and Inspection,
  - Audit Systems.
- To ensure integrity, pipelines are constructed and maintained to Australian Standard AS2885 "Pipelines – Gas and Liquid Petroleum".
- AS/NZS 3788 "Pressure Equipment – In-Service Inspection" forms the basis of the inspection programme.
- The company's use of independent third party surveys, specifically:
  - 6 insurance-based inspections since 1992.
  - 3 preliminary risk assessment surveys for major, new projects during 1992 and 1994.
  - 13 risk based surveys of operating facilities and systems since 1984. (Five of which have been conducted in the last 5 years).

15.2 Current

Refer Item 30. (6) (d) of the Regulations.

In addition to the preceding section on the 'Physical Condition of Facilities', other aspects that relate to the current 'fit for purpose' status of Santos' facilities and operations, include:

- Significant improvements to risk reduction in the last 5 years including:
  - A further six third-party reviews to identify opportunities to improve facility operations and extend its risk mitigation action plans.
    - Three separate integrity reviews by Shell Global Solutions,
    - A WOPRA study facilitated by GHD-Qest,
    - A review of Moomba plant integrity (MIRP) by Aker-Kvaerner.
    - An Insurer survey by Swiss Re and Marsh Pty Ltd (combined).
  - Introduction and implementation of the Santos Environment, Health and Safety Management System (EHSMS).

- A Competency Based Training (CBT) system that requires demonstration of required competencies for operating and maintenance personnel.
- Updating Operator Manuals and Operating Procedures.
- Asset Integrity Management Systems (AIMS) and Integrity Management Plans (IMP) for the Moomba Plant.
- Implementation of the Asset Control Enhancement (ACE) Project that provided.
  - An upgrade of the Moomba plant control systems,
  - A replacement Distributed Control System (DCS),
  - Upgraded emergency shutdown systems (programmable trip systems),
  - Upgraded boiler control and management,
  - Improved power generation,- Electrical load management,
  - Upgraded gas turbine control systems,
  - Upgrades to the Moomba central control room,
  - Upgrade management information system and control softwares.
  - Improved control systems on LRP refrigeration compressor packages.
- The Heating, Ventilation and Air Conditioning (HVAC) project for the upgraded Operations Control Centre (OCC).
- Implementation of the Hazardous Area Remediation and Upgrade Project (HARUP) in conjunction with the ACE Project.
- Implementation of the High Voltage Upgrade Project.
- Implementation of the Moomba UPS and Battery Charger Upgrade Project.
- Sweet Gas Header replacement with inhibitor injection and corrosion monitoring probes installed.
- Installation of facilities for the removal and recovery of mercury in the raw gas streams entering the Moomba Plant.
- Moomba Corrosion Under Insulation (CUI) programme developed and commenced.
- Commitment to addressing the risks associated with Pig launchers and receivers throughout the whole operation through high integrity surveillance.
- Extensive upgrade of the Moomba Plant Instrument Air system to provide three 50% capacity electrically driven air compressors.
- Commissioning of a Two-stage Reverse Osmosis (RO) Plant that has provided reliable quality Boiler Feed Water (BFW) and reliable steam utilities.
- A service contract with a specialist water treatment company to manage, monitor and control the BFW quality.
- Improved condensate recovery through a steam trap survey and upgrade programme, throughout 2003-04, using a company that specialises in steam usage and condensate recovery.
- Installation of corrosion inhibitor injection facilities and corrosion monitoring probes in the steam condensate header.

- Santos is of the view that there are no significant known or relevant hazards and associated risks that have not been identified and assessed at the time of preparing the 2006 Fitness for Purpose report.
- Santos is able to switch to an operating mode referred to as Dewpoint Control Mode (DPCM) to maximise sales gas supply during periods of certain plant disruptions.
- The plans for recovering from a significant emergency have been enhanced to further accommodate the unlikely event of an Estimated Maximum Loss (EML) incident.

15.3 Expected (Over Next 5 Years)

Refer Item 30. (6) (d) of the Regulations.

The factors outlined above that contribute to a healthy ‘fit for purpose’ state of the current operating facilities and operations, also extend into the future and will be supported by further improvements in facilities and systems.

- Ongoing commitment to the Santos EHSMS.

- Continued support for the corrosion monitoring and control programmes.
- Ongoing review, monitoring and maintenance of wellbores, well operations and conducting of well workovers.
- Actions arising from internal:
  - Auditing and assessments.
  - Incident and non-conformance reporting, investigating and tracking.
  - Hazard identification and risk reduction programs.
- Independent surveys as deemed necessary.
- Commitment to statutory requirements including the Petroleum Act and Regulations.
- Planned projects, including:
  - Upgrade of the Dew Point Control Units Area 55 Switching Valves.
  - Upgrade of the HP Flare header including the installation of an additional HP flare knockout drum.
  - Upgrade of the LRP cold drain and emergency depressuring system.
  - Continuation of the UPS and battery charger system upgrades.
  - Refurbishment of the Tantanna to Gidgealpa Trunkline.
- Ongoing attention to and assessment of the equipment and control systems for the Moomba Plant utility facilities, namely compressed air, power generation / distribution and steam availability.
- Other projects that will be identified, investigated, engineered or scoped as a result of Santos' continual review of equipment and systems to improve their operations.

15.4 Security of Production and Supply

Refer Item 30. (2) (c) of the Regulations.

15.4.1 Wells

The risks to "security of supply" posed by any individual gas well or group of wells is assessed as being low. This assessment results from two main aspects:

- the number of gas wells from which gas is produced and the widespread nature of the geographic location of these wells, which results in a very low risk of any "knock on effect", and
- the methods, materials, practices and procedures associated with well design and construction, operation and monitoring.

While the risk to "security of supply" are assessed as low, procedures are maintained, including direct access to international experts in well control, to enable any well problem to be quickly controlled.

15.4.2 Gathering and Production

The Santos raw gas gathering network system in the SA Cooper and Eromanga Basins consists of approximately 500 operating gas wells, feeding into 12 gas satellite facilities, which are connected into the Moomba Processing Plant through 9 separate trunklines.

One of these trunklines provides gas supply from the Ballera Plant in South-West Queensland to the Moomba Plant.

The risk of significant interruption to production of raw gas supply to the Moomba plant, for any significant period of time, is considered negligible.

15.4.3 Supply

In the event of a significant disruption to the supply of natural gas, Santos would instigate an emergency response plan to manage recovery from the incident. Part of an emergency response plan would involve the development and introduction of recovery strategies that would identify the various recovery steps, alternate processing procedures and options in order to continue performing critical business functions during and following an incident.

Reliability of sales gas supply to consumers depends on the Moomba processing plant continuing to deliver sales gas under situations when sections of the processing plant are unavailable. These situations include outage of individual equipment items, common mode failures or major incidents.

Reliability of gas supply from the Moomba plant is provided through strategic equipment redundancy and underground gas storage back-up to raw gas production.

The risk that was assessed as having the most serious consequence to reliability of natural gas supply from the Moomba processing plant, was a vapour cloud explosion (VCE) in the Liquids Recovery Plant (LRP). A VCE in the LRP has the potential to render the normal sales gas line inoperable, potentially terminating sales gas supply from the Moomba plant for an extended period.

Santos is committed to maintaining the ability to deliver sales gas from Moomba Plant and gas storage in case of such an emergency. This requires the underground gas storage system to be operable independently of the Moomba plant.

A back-up sales gas line was installed in 1999 to enable early resumption of sales gas supply. This line is expected to survive a VCE in the LRP with little or minimal damage. This separate line bypasses the LRP area of the plant.

A recovery plan may involve:

- Processing withdrawal gas through DPCU #1/#2. The silica gel provides for removal of liquid hydrocarbons as well as water.
- Directing the processed withdrawal gas to sales via the sales gas back-up line.
- Processing raw gas through any operable/repaired Benfield Units through DPCU #1/#2 and into the sales gas back-up line.
- In extreme circumstances, any available sales gas from Ballera could be considered for injection into the sales gas back-up line to supplement natural gas into South Australia.

Later, following the gradual repair and conversion of LRP molecular sieve dehydration units to silica gel duty, other Benfield units could be started up to supply the DPCUs and increase the availability of sales gas.

It is Santos' opinion that the installed facilities, systems and procedures, including the various emergency procedures are fit for purpose in satisfying reliability of supply.

15.5 Potential for Serious Incidents

Refer Item 30. (3) (d) of the Regulations.

The Santos Production Facilities handle flammable liquids and gases at elevated temperatures and pressures. Consequently, there is potential for vapour cloud explosions, pool fires and gas fires.

Potential incident scenarios (Hazards) and the associated risks have been assessed for:

- Pipelines.
- Utility systems.
- Estimated maximum loss incidents.
- Operating equipment.
- Safety protection systems.
- Process gases.
- Process liquids.
- Stored hazardous materials.
- Control systems.
- Corrosion failure.
- Flood, water inundation.
- Product quality.
- Management systems and resources.

The perceptions of the incidents with the greatest combined potential to impact on the reliability of supply of natural gas or the environment are listed below in descending order:

- Failures associated with the Moomba Plant utility systems, including:
  - Electric power generation and distribution.
  - Steam generation including boiler reliability.
  - Water treatment and steam condensate facilities.
  - Instrument air.
- Critical pipeline failures, specifically:
  - Trunkline pig receiver failure resulting in a jet fire scenario.
  - A major gas piping failure within the gas processing facilities.
- Corrosion of Pipelines and Plant as a result of:
  - Internal corrosion resulting from the presence of carbon dioxide and / or excessive fluid velocities.
  - Microbiological corrosion caused by bacteria, which take two main forms sulphate reducing bacteria (SRB) and acid producing bacteria (APB).
  - External corrosion and Stress Corrosion Cracking caused by defects in the pipeline coating and / or cathodic protection (CP) systems.
  - Under Insulation Corrosion caused by water trapped under insulation.
  - Cyclic Fatigue caused by temperature and/or pressure fluctuations.
  - Natural land-shifts caused by extreme weather conditions.

Refer to the section 'Pipeline and Plant Integrity' on page 36 for a description of corrosion risks and mitigation processes.

- An Estimated Maximum Loss (EML) incident involving a vapour cloud explosion (VCE) in the Liquids Recovery Plant (LRP).

Note: By definition, this catastrophic scenario can never be assessed as lower than a significant risk.
Refer to 'Security of Production and Supply' on page 71 for more specific details.

An Estimated Maximum Loss (EML) scenario considers the largest loss that could result from a single incident. It assumes that the initial incident is so large that the active protection systems are rendered inoperative, and only the passive protection facilities, such as spacing and fireproofing, are effective. Based on historical insurance surveys the estimated maximum loss scenario, for Material Damage only, is a vapour cloud explosion originating from the Propane Refrigeration Accumulator in the Liquids Recovery Plant (LRP). Following such an incident, it is estimated that the LRP would be shutdown for 24 months and that DPCU Nos. 8 and 9 would be shutdown for 3 months.

The potential for a serious incident does not exist in isolation without serious risk control and management systems being put in place to prevent or minimise the likelihood or consequence of their impact.

To appreciate the control mechanisms Santos has in place to manage the potential for serious incidents refer to:

- 'Safety Features and Systems' on page 26.
- 'Pipeline and Plant Integrity' on page 36.
- 'Management System Effectiveness' on page 40.
- 'Addressing Reliability of Utility Operations' on page 54.
- 'Risk Reduction Measures (ALARP)' on page 57.
- 'Emergency Procedures' on page 67.
- 'Security of Production and Supply' on page 71.

It is Santos opinion that the risks of a serious incident in the production and processing facilities is reduced to as low as reasonably practicable.

15.6 Commitment

Refer Item 30. (4) of the Regulations.

Based on the above, Santos is of the view that there are no significant known or relevant operational or environmental hazards and associated risks that have not been identified and assessed at the time of preparing the 2006 Fitness for Purpose report.

Santos is committed to continually reassessing and improving operations on a 'fit for purpose' basis. It is also committed to progressing and, where reasonably practicable, implementing improvement programs as referenced in this report.

Santos' commitment extends to working with agencies of the South Australia Government and in particular, PIRSA, to ensure ongoing improvement and compliance with the intent of the Petroleum Act 2000 and the associated Regulations.

Santos also recognises its obligation to review and report on the 'Fitness for Purpose' of its operating facilities in the SA Cooper and Eromanga Basins at least at 5 year intervals.

16 Definitions and Abbreviations

Term	Description
ACARRE	Australia Centre of Advanced Risk & Reliability Engineering
ACE	Asset Control Enhancement
Act	The South Australia Petroleum Act 2000
ADF	Australian Defence Forces
AIMS	Asset Integrity Management System
ALARP	As Low As Reasonably Practicable
APB	Acid Producing Bacteria
API	American Petroleum Institute
AS	Australian Standard
BFW	Boiler Feed Water
BI	Business Interruption
C&S	Cased and Suspended Well, where after drilling the wellbore is cased and cemented, but the well is not completed, and the various formations remain isolated from each other and from the wellbore.
CBT	Competency Based Training
CCTV	Closed Circuit Television
CO_2	Carbon Dioxide
Completion	The methods and procedures by which a flow path is established in a well that allows the production of fluids from or into one or more formations in a well.
Conventional Well	Construction of a well in which wellbore casing is cemented into a well after drilling and a separate wellbore piping system (tubing) is installed for the production of wellbore fluids.
COP	Critical Operating Procedure
CP	Cathodic Protection
CR	Change Request
Crude oil	Untreated oil from an oil production well
CSP	Crude Stabilisation Plant
CUI	Corrosion Under Insulation
DCS	Distributed Control System
DPCM	Dew Point Control Mode
DPCU	Dew Point Control Unit
EH&S	Environment, Health and Safety
EHS	Environmental Hazard Standard
EHSMS	Environment, Health and Safety Management System
EIR	Environmental Impact Report
EIV	Emergency Isolation Valve
EMA	Emergency Management Australia
EML	Estimated Maximum Loss
EOL	End of Line
EOR	Ethane Oil Recovery
EPA	Environment Protection Authority, South Australia

Term	Description
ESD	Emergency Shutdown
ETP	Ethane Treatment Plant
FFP	Fitness for Purpose
GAS	Goal Attainment Scaling
Gas condensate	Liquid hydrocarbon that is recovered during raw gas production
Gathering system	A network of hydrocarbon pipelines that relay raw gas, gas condensate and crude oil to satellite and Moomba processing plants
GRE	Glass Reinforced Epoxy (pipeline)
GTA	Gas-fuelled, turbine driven turbo-alternator
HARUP	Hazardous Area Remediation and Upgrade Project
HAZOP	Hazard and Operability study
HSHS	Health and Safety Hazard Standard
HV	High Voltage
HVAC	Heating, Ventilation, Air-Conditioning
IMP	Integrity Management Plan
IR	Infra-Red
JHA	Job Hazard Analysis
JV	Joint Venture
LDB	Lower Daralingie Bed (underground formation used for gas storage)
LPG	Liquefied Petroleum Gas
LRP	Liquids Recovery Plant
LSC	Limestone Creek Satellite
MAT	Maximum Allowable Temperature
MCR	Maximum Continuous Rating
MIC	Microbiological Influenced Corrosion
MIRP	Moomba Integrity Review Program
MOC	Management of Change
Monobore	A well in which a single casing string is run into the well and cemented, which serves to isolate the various productive zones and aquifers and also to allow the production of fluids to the surface.
MRU	Mercury Recovery Unit
MW	Mega Watt (energy unit)
NB	Nominal Bore (internal size of pipe)
NDT	Non-Destructive Testing
NGL	Natural Gas Liquids
OCC	Operations Control Centre (Moomba Plant)
OFI	Opportunity For Improvement
P & A	Plug and Abandon. Series of actions to isolate a well bore from productive zones. Abandonment achieved by setting cement plugs at strategic locations across the perforations and in the wellbore.
P&ID	Piping and Instrumentation Diagram
PEL	Petroleum Exploration Licence
Perforate	Activity undertaken to provide access to the wellbore of reservoir fluids. Generally undertaken with the use of shaped explosive charges in the wellbore which puncture the tubing and casing.

Term	Description
PFW	Produced Formation Water
PIMS	Pipeline Integrity Management System
PIRSA	Department of Primary Industries and Resources South Australia
PL	Pipeline Licence
PLC	Programmable Logic Controller
PPL	Petroleum Production Licence
Production facilities	Santos facilities within the Production Licences issued by PIRSA
PSV	Pressure Safety Valve
Raw gas	Untreated gas from a gas production well
RCA	Root Cause Analysis
Regs or Regulations	The South Australia Regulations under the Petroleum Act 2000
RMP	Reliability Management Plan
RO	Reverse Osmosis
SACB	South Australian Cooper Basin
SACBJV	South Australian Cooper Basin Joint Venture group
SAEMS	Santos Australia Environment Management System
Santos	Santos Ltd.
Satellite	An operating plant, remote from the main Moomba Plant, where raw gas or crude oil are processed prior to relay to the Moomba Plant
SCC	Stress-Crack Corrosion
SEO	Statement of Environmental Objectives
SHI	Soil Health Index
SIMP	Santos Incident Management Plan
SOP	Standard Operating Procedure
SRB	Sulphate Reducing Bacteria
STA	Steam turbine driven turbo-alternator
Steam condensate	Condensed steam
SWQ	South West Queensland
TIMS	Technical Information Management System (data storage)
TK	Tank
TPH	Total Petroleum Hydrocarbons
Trunkline	Refers to the major hydrocarbon pipelines that connect satellite facilities to the Moomba processing plant
UIC	Under Insulation Corrosion
UPS	Uninterrupted Power Supply
UV	Ultra-Violet
VCE	Vapour Cloud Explosion
WOPRA	Whole of Plant Risk Assessment

17 Attachments

Attachment 1 Santos Health & Safety Policy

Health & Safety Policy

Santos

Our Health and Safety Vision:

"We all go home from work without injury or illness"

We believe that:

- No business objective will take priority over health and safety.
- All injuries are preventable.
- No task is so important or urgent that it cannot be done safely.
- Without diminishing management's obligations, the responsibility and accountability for health and safety rests with every individual.

At Santos we are committed to conducting our business in a manner that prevents injury or illness to employees, contractors, customers and the public who may be affected by our work activities. We encourage best practice in health and safety management within this wider Santos community.

To achieve this we will:

- Proactively pursue the identification of all hazards and eliminate or, if not possible, manage the risk to as low as reasonably practicable.
- Consult with and promote active participation of employees in the management of their own and others' health and safety.
- Require that companies providing contract services to Santos manage their health and safety in line with this Policy.
- Provide resources to achieve a systematic approach to health and safety management to ensure continuous performance improvement.
- Identify performance measures, set improvement targets, measure and report performance at all levels.
- Comply with or exceed all relevant legislation and standards.
- Develop a culture where all employees and contractors are constantly aware of hazards around them and act accordingly at and away from work.
- Include health and safety performance in the appraisal of employees and contractors and recognise accordingly.

John Ellice-Flint
Managing Director
September 2004

Santos Ltd ABN 80 007 550 923 File No: POLICY P039

Attachment 2 Santos Environmental Policy

Environmental Policy

Santos

Our Environmental Vision:

"We will lighten the footprint of our activities"

Santos is an Australian energy company producing oil and natural gas in both onshore and offshore localities throughout Australia and overseas.

At Santos we are adopting the principles of sustainable development. We recognise our responsibility to meet community expectations and we are committed to the continuous improvement of our environmental performance. We believe that environmental stewardship is both a management obligation and the responsibility of every employee.

To achieve this we will:

- Maintain and continuously improve the Environment, Health and Safety Management System (EHSMS) across the organisation.
- Ensure that all personnel, contractors and consultants receive adequate training to fulfil their individual EHSMS responsibilities.
- Apply a systematic approach to identifying hazards and managing environmental risks to reduce these to as low as reasonably practicable.
- Develop annual environmental objectives and targets and implement programs to achieve them.
- Comply with relevant legal and other requirements, and where opportunities exist, participate in the development and review of legislation and guidelines.
- Ensure that we have the resources and skills necessary to achieve our environmental commitments.
- Incorporate environmental performance in the annual appraisal of employees and contractors, and recognise accordingly.
- Implement strategies to reduce and prevent pollution, manage waste effectively, use water efficiently and address relevant cultural heritage and biodiversity issues.
- Formally monitor, audit, review and report annually on our environmental performance against defined objectives.
- Review the environmental impact of goods and services being provided by our suppliers.

As the Managing Director, I am committed to working with Santos personnel to ensure that this policy is communicated, understood, accepted and successfully implemented by all employees and contractors.

John Ellice-Flint
Managing Director
September 2004

Santos Ltd ABN 80 007 550 923 File No: POLICY P040

Attachment 3 Santos Risk Assessment Record Form

Date:

Risk Assessment Team Members:

Purpose of Risk Assessment:

Description of the Unwanted Event Being Assessed:

Consequence Category Selected:

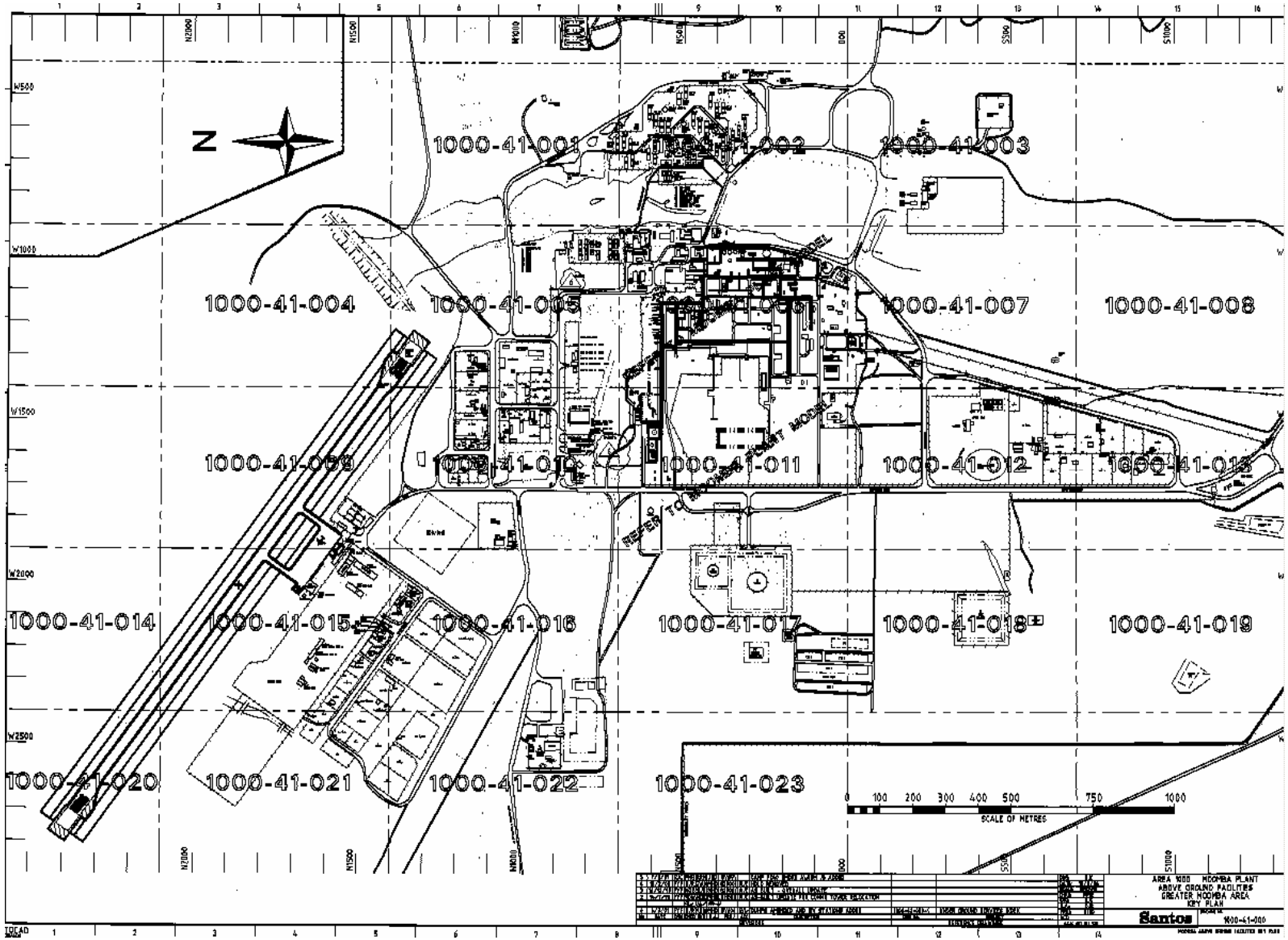
Health and Safety ☐ **Environment** ☐ **Reputation** ☐ **Financial** ☐

			Consequence				
			Negligible	Minor	Moderate	Major	Critical
			I	II	III	IV	V
Likelihood	Almost Certain	A	☐	☐	☐	☐	☐
	Likely	B	☐	☐	☐	☐	☐
	Possible	C	☐	☐	☐	☐	☐
	Unlikely	D	☐	☐	☐	☐	☐
	Remote	E	☐	☐	☐	☐	☐

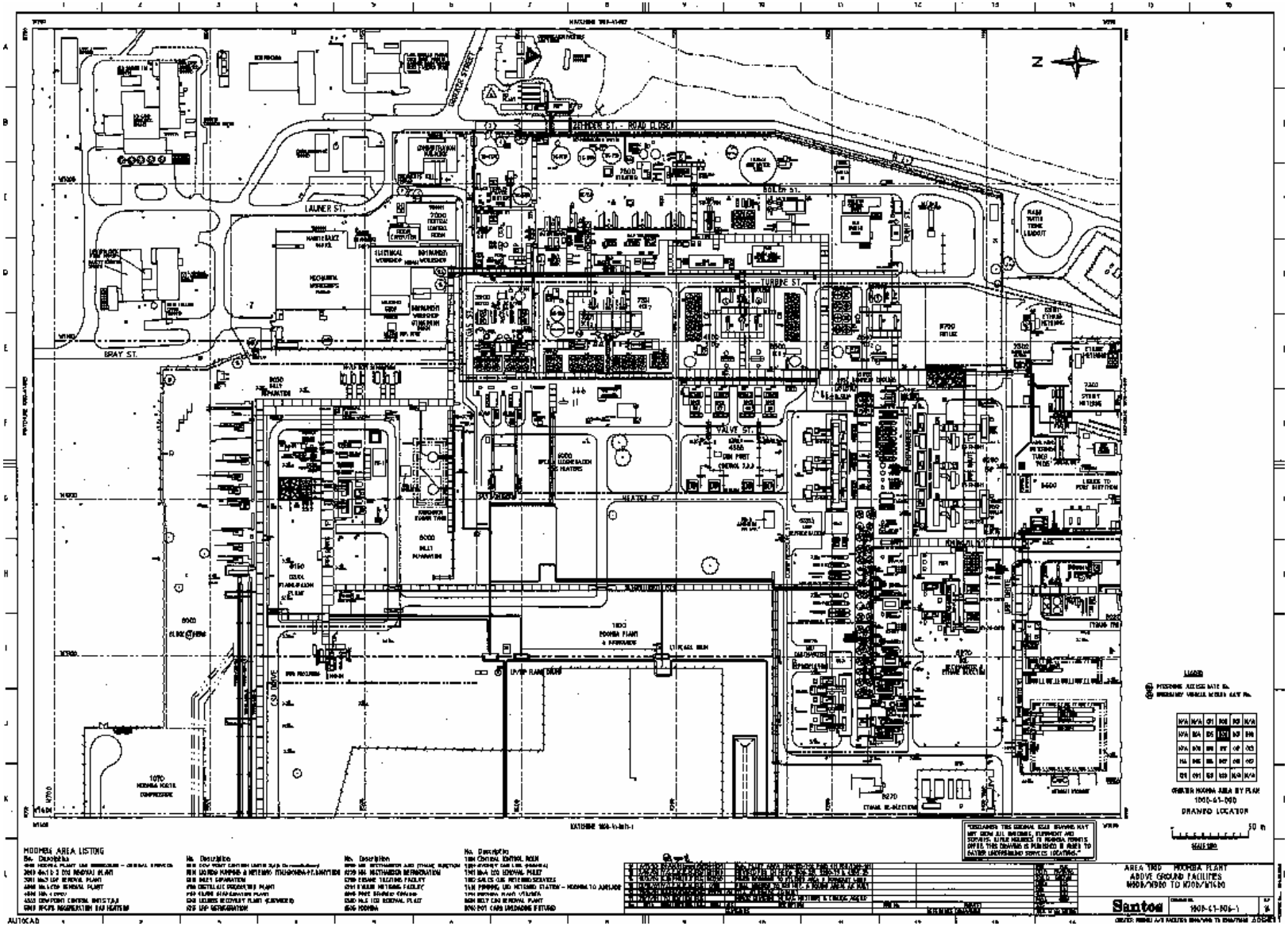
Legend

Level 1 Risk
Level 2 Risk
Level 3 Risk
Level 4 Risk
Level 5 Risk

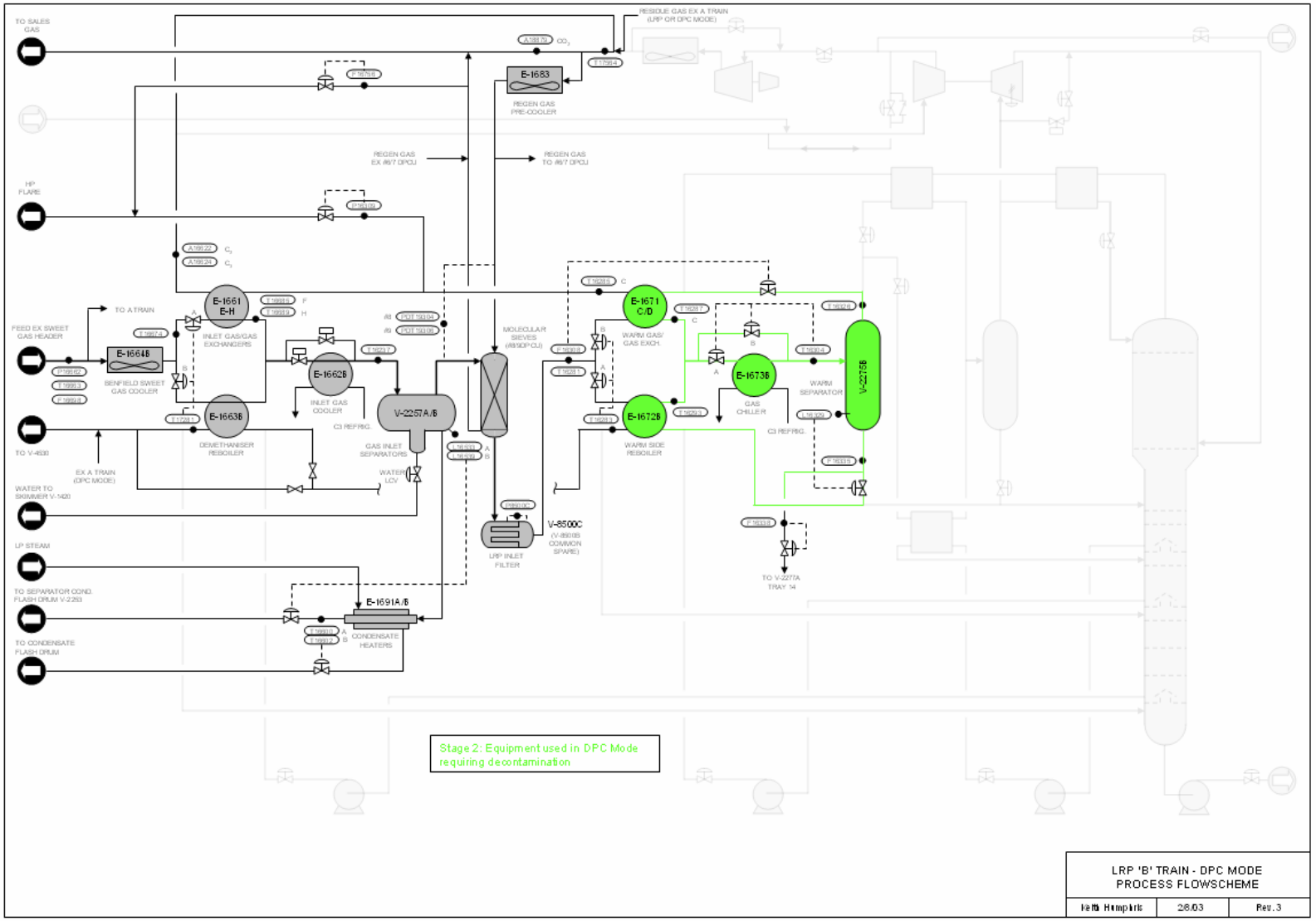
Attachment 4 Plot Plan – Greater Moomba Area



Attachment 5 Plot Plan – Moomba Processing Plant



Attachment 6 Simplified Flow Diagram – DPC Mode of Operation



Attachment 7 Simplified Process Flow Diagram – Crude Stabilisation Liquid Recovery