Air Quality Management Plan

Visy Pulp & Paper Tumut Mill

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1.0 Introduction

1.1 Background

Visy Pulp and Paper Tumut (VPP) is a fully integrated unbleached Kraft Pulp and Paper Mill, located approximately 8 km West of Tumut and 7 km east of Adelong in the South West Slopes region of New South Wales. Development Approval for the project was obtained on 29 November 1998 pursuant to the provisions of the *Environmental Planning and Assessment Act* 1979. This consent, subject to over 105 individual conditions, was issued for existing operations with capacity of up to 300,000 tonnes per year (tpy) and increase of up to 450,000 tpy for the future mill expansion.

In May 2006, Visy wrote to the Minister for Planning seeking a further increase to the future Mill expansion of up to 700,000 tpy. As this increase was substantially greater than the 450,000 tpy that was originally approved, Visy was required to prepare an Environmental Assessment for the proposed expansion.

The Visy Tumut Expansion Environmental Assessment for the 700,000 tpy was prepared and submitted to the Minister for Planning in February 2007 and approval was granted by the Minister in May 2007 pursuant to the provisions of Section 75J of the *Environmental Planning and Assessment Act* 1979. This approval was granted subject to Concept and Project Approval Conditions issued in Schedule 2 of the approval dated 1 May 2007. Visy sought further modification to this approval in June 2007 (ref. Mod 2007) that considered Project Component Phasing Changes to Emission sources as described below in Table 1.0. The Project Component Phasing was approved under the Modification to the Instrument of Approval (06_0159 Mod 1) in August 2007.

An Air Quality Management Plan (AQMP) for Stage 1 of operations was prepared in accordance with Development Consent Condition (Condition no. 27), in consultation with the then NSW Department of Urban Affairs and Planning and Environmental Protection Authority. Under the current Project Consent Approvals (Condition no. 5.4), Visy are required to prepare an updated AQMP to cover specific items related to the expansion in consultation with the NSW Environmental Protection Authority (NSW EPA) and for the approval of Minister for Planning. This updated AQMP has been prepared in accordance with these Project Approval Conditions and specifically covers the Project Component Phasing under 1a. Subsequent phases will be covered under future updates to this AQMP.

The site's Environment Protection Licence (Licence number 10232) was amended during a licence review in June 2013. The AQMP has been updated to reflect the licence changes.

In design of the new plant and equipment, Visy have incorporated operational experiences from Stage 1 and the latest market technology for the control and monitoring of emissions to atmosphere.

Table 1.0 Project Component Phasing

Phase	Stack No.	Emission Sources
1a	Stack 1	Ex. Recovery Boiler A
		Ex. Power Boiler
		Ex. Lime Kiln A
		New Lime Kiln B
	Stack 2	New Recovery Boiler B
1b	Stack 1	Ex. Recovery Boiler A
		Ex. Power Boiler
		Ex. Lime Kiln A
		New Lime Kiln B
	Stack 2	New Recovery Boiler B
		New Natural Gas Boiler
2	Stack 1	Ex. Recovery Boiler A
		Ex. Power Boiler
		Ex. Lime Kiln A
		New Lime Kiln B
	Stack 2	New Recovery Boiler B
		New Multi Fuel Boiler
	Stack 3	New Gas Turbine

1.2 Overview of Air Quality Assessments

During the assessment for the Environmental Impact Study for the initial development, a detailed air quality assessment was undertaken for a range of pollutants discharging to the atmosphere. The assessment using air dispersion modelling assessed predicted ground level concentrations against guideline levels and had included a health risk assessment for trace metals. Based on these assessments, the NSW Environment Protection Authority (EPA) defined Licence conditions that specified concentration limits and monitoring procedures for air emissions for Stage 1 Operations.

In May 2004, further air dispersion modelling was conducted as part of the Non Standard Fuels assessment process. The air dispersion model was developed in consultation with the DECC, utilising advanced air dispersion modelling software (Calpuff) that considers topographical features within the site's surrounds and 12 months of representative meteorological data gathered from Visy's meteorological stations. The modelling was used in the assessment of potential impacts associated with emissions from using Non Standard Fuels in the Power Boiler. The outcome of this assessment demonstrated that the potential ground level concentrations at sensitive receptors were below the NSW EPA guideline levels.

During the EA (2006) an assessment of the potential impact on air quality as a result of the expanded mil was undertaken. This included:

- A review of compliance of air emissions with standards of concentration stated in the *Protection of Environment Operations Act* (Clean Air Regulation 2005);
- Air dispersion modelling, including knowledge obtained from the model undertaken in 2004 as detailed above;
- An assessment of compliance with ground level concentrations;
- Comparison of estimated emissions to atmosphere with Best Available Technology limits reported;
- An odour assessment, identifying key odour sources for Stage 1 and Stage 2, and the use of monitoring results to develop emission estimates for the expansion during normal operations and during start up/shut down situations;
- A Life Cycle Analysis and assessment of Greenhouse gas production for Stage 1 and 2 and a review of the impact of the use of fossil fuel energy sources and the benefits of onsite power generation using non fossil fuel energy sources within the paper production process; and
- Human health risk assessment of air emissions on surrounding area.

1.3 Environmental Management System

The AQMP is a component of the site's Environmental Management System (EMS), certified to ISO 14,001:2015. The Environmental Management System consisting of the Operational Environmental Management Plans, operational and environment procedures, and detailed monitoring and auditing program aims to maintain compliance with Environmental regulations and achieve best-practice standards through a system of continual improvement, as represented below in Figure 1.0.

The EMS is integrated with the site's Safety and Quality management systems which are both certified to the relevant standards (i.e. ISO 9,001:2015, AS/ZS 45001:2018).

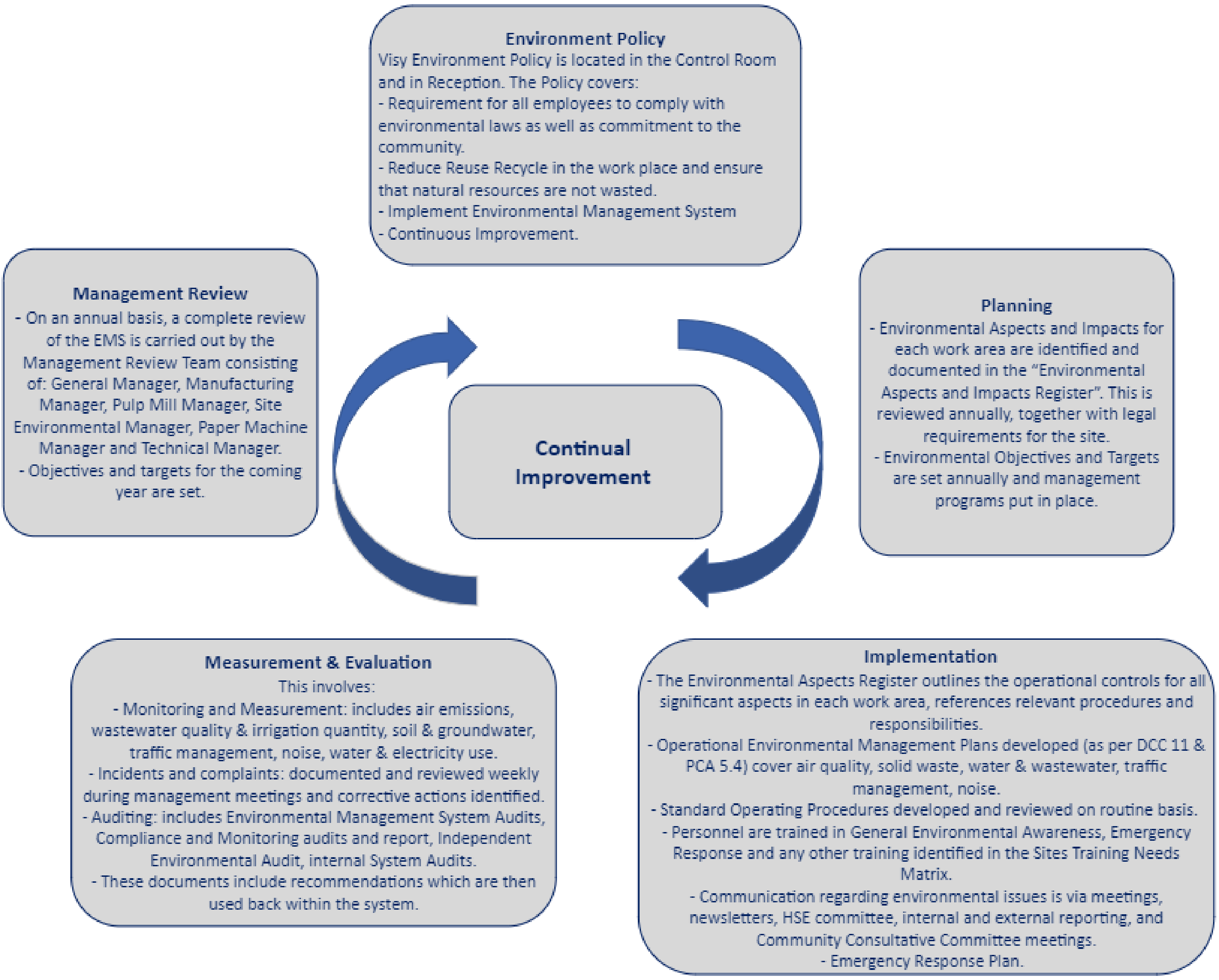

Figure 1.0 Overview of site Environmental Management System (EMS)

2.0 Legal Requirements

The NSW legislation for granting of development approval for the Visy Mill Development is the *Environment Planning and Assessment Act* 1979. Approval of the initial Development (Stage 1) was granted under section 91AB (2) of the Act. Approval was granted subject to meeting the Development Consent Conditions under approval S96/00598. The subsequent Visy Tumut Mill Expansion Development was granted under Part 3A. This approval was granted subject to meeting the Concept and Project Approval Conditions under approval 06_0159.

The *Protection of the Environment Operations Act* 1997, is the key piece of environmental protection legislation administered by the EPA to authorise the carrying out of scheduled activities at Visy Tumut. Under this legislation Visy are issued with a Licence (Licence No. 10232) to operate subject to satisfying the various conditions of this Licence that includes air and water emission limits, waste receival and disposal and requirements for monitoring and reporting.

The statutory requirements for air quality which apply to the Tumut site are:

- Documents as listed under Condition 1 of Development Consent Conditions for the initial development (S96/00598 DCC);
- Additional documents as listed under Condition 2 of Development Consent Conditions for the modified development (S96/00598 DCC_MOD-45-5-2003-1);
- Environmental Protection Licence (Licence No. 10232);
- Documents as listed under Condition 1.1 of Project Approval Conditions for the Expansion (06_0159 PA);
- Documents as listed under Condition 1.1 Concept Approval Conditions for the Expansion (06_0159CA);
- Statement of Commitment Stage 2 (April 2007);
- Documents as listed under Condition 1.1 Modification Approval for the Expansion (06_0159 Mod 1).

Regulations concerning emissions to air relevant to this site are contained within the following legislation and standards:

- *Environmental Planning and Assessment Amendment Act* 2012;
- *Protection of the Environment Operations (Clean Air) Regulation* 2010;
- *Protection of the Environment Operations (General) Regulation* 2009;
- Technical Framework: Assessment and management of odour from stationary sources in NSW (DEC 2006);
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (Jan 2017);
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC 2007).

3.0 Objectives and Performance Outcomes

The objectives and performance outcomes for the Operational Air Quality Management Plan are described, Table 2.0 below.

Table 2.0 Objectives and Performance Outcomes

Objectives	Performance Outcomes
• To comply with all statutory requirements. • To minimise air quality impacts on surrounding environment. • To maintain reasonable levels of amenity for surrounding residents. • To keep the local community informed and regulators informed and to respond quickly and effectively to issues. • To ensure that the results of air quality monitoring comply with EP Licence and applicable air quality criteria. • To ensure air quality monitoring is undertaken in accordance with requirements of the EP Licence and Consent Conditions. • To reduce air quality impacts on local community during periods of Start-up and shutdown and process upsets.	• Continuous Emissions Monitoring System is operated and maintained with greater than 95% uptime. • Appropriate actions are undertaken to quickly and effectively respond to exceedance events. • Plant and equipment that discharges to air are to be operated and maintained in accordance with the Operational and Maintenance procedures. • Periodic emission testing is undertaken in accordance with the specified monitoring frequency. • The results and analysis of all air emissions monitoring is periodically reviewed and compared to that predicted and included in the Annual Environmental Compliance Report and Annual Return. • All complaints are recorded and appropriate actions taken to quickly and effectively respond to the complainant. • All odour checks are undertaken and appropriate actions immediately undertaken to address any issues. • Measures are in place to minimise air emissions and odour impacts during shutdown/start-up activities. • Notify the local community and other relevant stakeholders of start-up/shutdown or malfunctions that may result in air emission impacts.

4.0 Air Quality Issues

The main air quality issues are air emissions both from point and diffuse sources, odour and ambient air quality. These are discussed in separate sections below.

4.1 Air Emissions

4.1.1 Point Source Emissions

The main air emissions discharge points for Phase 1a of the Visy Tumut Expansion (2007) are at the exits from Stack 1 and Stack 2. These points are defined as Point 1 and Point 22 respectively in the Site's Environment Protection Licence (EPL) and are the licensed discharge point to atmosphere. Although the Power Boiler does not discharge directly to atmosphere, it too is considered as a licensed discharge point (Point 3) for specific pollutants in the EPL.

The stacks heights of 85 meters high, were assessed through air dispersion modelling undertaken during the EA(2007) and the Mod(2007) and based on compliance with the impact assessment criteria as defined by EPA in approved *Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Jan 2017). This document has now been revised (Jan 2017).The predicted emissions and impact assessment criteria is further discussed in Section 3 – Emissions inventory and Section 2- Methodology overview respectively.

The emissions discharged from the stacks are generated from five combustion units, each individually ducted to their respective stacks. These sources and the relevant discharge point are summarized in Table 3.0, and diagrammatically presented in Figure 8.0.

Table 3.0 Summary of sources of emissions to atmosphere (Phase 1a)

Discharge Point	EP Licence Point	Combustion Unit
Stack 1	Point 1,	Recovery Boiler A
	Point 3 (Power Boiler Duct)	Power Boiler
		Lime Kiln A
		Lime Kiln B
Stack 2	Point 22	Recovery Boiler B

The emissions from combustion units Recovery boiler A, Power Boiler, Lime Kiln A and Lime Kiln B are individually ducted to Stack 1. Internal mixing vanes inside Stack 1 ensure proper mixing of the emission sources prior to the discharge point. The Recovery Boiler B is the only emission source to Main stack 2. The outlets after each Electrostatic precipitator on Recovery Boiler B are individually ducted to Main stack 2.

All five combustion units have been designed with modern emissions control technologies. Each combustion unit further utilises Electrostatic Precipitators for the efficient removal of particulates from the flue gases prior to discharging into the stacks. This allows the mill to achieve very low emission levels to allow it to comply with very stringent emission standards.

The major components of the air emissions from each of the combustion units including the typical emission levels are summarised below in Table 4.0.

Table 4.0 Summary of Major Pollutants for each Combustion unit

Combustion Unit	Major Pollutants	Average Levels (mg/Nm^3)
Recovery Boiler A and B	Sulfur Dioxide (SO_2) Total Solid Particles (TSP) Total Reduced Sulphides (TRS) Oxides of Nitrogen (NOx) Carbon Monoxide (CO)	3.3 – 40.1 22.0 – 26.3 0.4 – 2.0 96.2 – 128.0 7.3 - 47.3
Power Boiler	Total Solid Particles (TSP) Oxides of Nitrogen (NOx) Carbon Monoxide (CO) Hydrogen Chloride (HCl)	5.0 – 14.8 179.7 – 194.1 28.2 – 37.9 23.3 – 24.5
Lime Kiln A and B	Sulfur Dioxide (SO_2)* Total Solid Particles (TSP) Total Reduced Sulphides (TRS)* Oxides of Nitrogen (NOx) Carbon Monoxide (CO)	34.0 14.8 – 72.5 3.6 163.0 – 318.2 451.2 – 654.2

* Based on Andritz emissions data for Lime Kiln B

The typical emission levels listed in Table 4.0 have been mainly based on historical emissions data from existing combustion units. Emission data shown with an asterix are based on guaranteed emission levels from the equipment supplier Andritz.

4.1.2 Point Source Emissions

Diffuse emissions can occur from various sources around the site. As these are mainly area source emissions, they can be highly variable, and more difficult to accurately measure compared to point source emissions. The typical diffuse emission sources and their descriptions are provided in Table 5.0 below.

Table 5.0 Summary of Diffuse Source Emissions

Diffuse Source	Major Diffuse Components	Description
Woodyard	Dust	Wind-blown wood dust from chip and fuel piles and during chip/boiler fuel unloading
	Vapour	Chip and Wood Piles-Vapour condensation mainly visible on cold mornings
	Carbon Monoxide & Oxides of Nitrogen, Total Solid Particles	Exhaust fumes from Mobile Plant and Log trucks
Paper Machine	Water Vapour, Volatile Organic Compounds, Total Reduced Sulphides	Vapour condensation from Vacuum pump outlets, Hood Exhaust outlet, Building Ventilation Fans, Steam Relief Valves, Storage Tanks

	Carbon Monoxide & Oxides of Nitrogen, Total Solids Particles	Exhaust Fumes from Mobile Plant and Paper Trucks
Cooling Towers	Water Vapour, Volatile organic compounds and Total Solid Particles	Vapour and water droplet emissions from Cooling Tower Fan stack
Cooling Ponds	Water vapour, certain Volatile organic compounds (VOC)	Vapour emissions from pond surface during evaporative cooling of wastewater
Wet Surface Air Condenser	Water vapour	Vapour and water droplet emissions from fan stack
Boiler	Water vapour	Vapour emissions from Steam venting

Most of the above diffuse sources are considered to have a low environmental consequence, unlikely to cause environmental harm. However some of these sources do have potential for off-site odour impacts and are described in more detail in the following section.

4.2 Odour Emissions

Odour control is a significant component of the Kraft Pulp and Paper making process. The principal cause of odour is Sulphur, a key element in the Kraft Sulphate Pulping chemistry. In gaseous form, it is typically present as a reduced sulphide compound with a very low odour threshold. Managing sulphide emissions from the process is fundamental in managing odour impacts from site.

4.2.1 Odour from Non Condensable Gases

The principal emissions of malodorous gases (i.e. Hydrogen Sulphide, Methyl Mercaptan, Dimeythyl Disulphide and Di Methyl Sulphide) are more commonly known as Total Reduced Sulphides (TRS).

These components of TRS have all very low odour thresholds making it detectable to the human nose at very low concentrations. Typical odour thresholds and descriptions are listed in Table 6.0.

Table 6.0 TRS Compounds - Odour Thresholds

TRS Compound	Odour Threshold	Description
Hydrogen Sulphide (H_2S)	5 ppb	Rotten egg, sulphurous
Methyl Mercaptan CH_3SH	2 ppb	gassy, sulphurous
Dimethyl Sulphide $(CH_3)_2S$	1 ppb	cabbage, cooked vegetables, sharp, sickly
Dimethyl Disulphide $(CH_3)_2S_2$	6 ppb	cooked cabbage, intensively onion, sickly, sulphurous

These malodorous gases are generally divided into strong or concentrated and weak or diluted gases. The stronger gases known as Concentrated Non Condensable Gases (CNCG) are generated in the Turpentine

Tank, Evaporation plant after the condenser, Turpentine Condenser, Foul Condensate Tank, Methanol Plant, Vapour Compression Evaporator and the Foul Condensate Stripper. The dilute gases known as Dilute Non Condensable Gases (DNCG) are generated in areas such as chip pre-steaming, screening, pulp washing, smelt dissolver and various storage tanks in the Pulp Mill. The typical concentration of sulphur in these gases is provided in Table 7.0. The TRS compounds make up to 10% by volume of the CNCG making it extremely odorous whereas it only makes up to 0.1% of gases in the DNCG.

Table 7.0 Typical Sulphur content of Non Condensable Gases

Type	Sulphur Content	Flow
CNCG	1 – 2 kg S/ADt*	25 Nm^3/ADt
DNCG	0.05 – 0.1 kg S/ADt*	400 Nm^3/ADt

* Kilograms of Sulphur per Air Dried Tonnes of Pulp

Due to the highly odorous characteristics, the CNCG's are collected from each of the various sources and piped across to the Recovery Boiler where they are burnt as part of the Mill's odour control system. On occasions, upsets in the system can result in a release of NCG directly to atmosphere. Due to the concentration of TRS in the gas, even the smallest gas release to atmosphere can result in off-site odour impacts. The DNCG's are collected separately, scrubbed and combined with the combustion air system to be burnt in the Recovery Boiler.

4.2.2 Odour from Non Condensable Gases

Other main sources of odour include emissions from Cooling Towers, Paper Machine Building Ventilation, Vacuum Pump Outlets, and Cooling Ponds.

Odour generated from these areas generally result from elevated levels of TRS compounds dissolved in clean condensate, used in these areas in place of fresh water. Other potential odour sources can result from high H_2S emissions from either of the Main Stacks. High H_2S emissions can result from poor combustion conditions in either of the Recovery Boilers or poor lime mud washing in the Lime Kilns.

5.0 Criteria and Guidelines

The air standard goals and performance criteria which apply to Visy Tumut in accordance with the consent conditions and Environment Protection Licence (EPL) conditions are detailed below in Tables 8.0 to 10.0.

Table 8.0 Stack 1 - Emission Limits (Point 1)

Parameter	Units	Frequency	Averaging period	Concentration Limit
Chlorine	mg/m^3	Annual	na	100
Flow	Nm^3/sec	Continuous	1 hour	100
Hydrogen chloride	mg/m^3	Continuous	1 hour	50
Nitrogen Oxides	mg/m^3	Continuous	1 hour	400
Opacity	%	Continuous	6 minutes	20
Sulphuric acid mist and sulphur trioxide (SO_3)	mg/m^3	Annual	na	20
Sulphur dioxide	mg/m^3	Continuous	1 hour	250
TCDD (eq)	ng/m^3	Annual	na	0.1
Total Reduced Sulphides (TRS)as (H_2S)	mg/m^3	Continuous	1 hour	3.6
Total Solid Particulates	mg/m^3	Quarterly	na	50
Type 1 and Type 2 substances in aggregate	mg/m^3	Annual	na	1

Table 9.0 Stack 2 - Emission Limits (Point 22)

Parameter	Units	Frequency	Averaging period	Concentration Limit
Chlorine	mg/m^3	Annual	na	100
Hydrogen chloride	mg/m^3	Continuous	1 hour	50
Nitrogen Oxides	mg/m^3	Continuous	1 hour	400
Opacity	%	Continuous	6 minutes	20
Sulphuric acid mist and sulphur trioxide (SO_3)	mg/m^3	Annual	na	20
Sulphur dioxide	mg/m^3	Continuous	1 hour	250
TCDD (eq)	ng/m^3	Annual	na	0.1
Total Reduced Sulphides (TRS)as (H_2S)	mg/m^3	Continuous	1 hour	3.6
Total Solid Particulates	mg/m^3	Quarterly	na	50
Type 1 and Type 2 substances in aggregate	mg/m^3	Annual	na	1

Table 10.0 Power Boiler Duct Emission Limits (Point 3)

Parameter	Units	Frequency	Averaging period	Concentration Limit
Cadmium	mg/m^3	Quarterly(1)	na	0.06
Carbon monoxide	mg/m^3	Continuous	1 hour	140
Dioxins and Furans as TCDD (eq)	ng/m^3	Quarterly(1)	na	0.1
Hazardous substances[2]	mg/m^3	Quarterly(1)	na	0.6
Mercury	mg/m^3	Quarterly(1)	na	0.06
Total Solid Particulates	mg/m^3	Annual	na	30

(1) Special frequency condition.
(2) Type 1 and Type 2 substances in aggregate.

The EPL also specifies Reporting Levels at each of the combustion point sources. These reporting levels are detailed in Tables 11.0 to 13.0 below. Although these are not concentration limits, exceedances of these Reporting Levels are not considered breaches of Licence but are nonetheless reported to the NSW Environment Protection Authority in the Annual Return.

Other air standard goals relevant to the management of air quality and reported maximum ground level concentrations are detailed below in Table 11.0.

Table 11.0 Air Quality Standards

Pollutant	Standard/Goal	Averaging Period	Agency
PM_{10}	< 30 ug/m^3	Annual	NSW EPA
NO_2	<246 ug/m^3 <62 ug/m^3	One hour maximum Annual	NSW EPA
H_2S	4.83 ug/m^3 (1) 1.38 ug/m^3 (2)	99^{th} %ile data, (1 second averaged data)	NSW EPA
VOC	No applicable Australian standards		
Dust	4g/m^2/month	Month	NSW EPA
SO_2	<570 ug/m^3	One hour max	NSW EPA
	<60 ug/m^3	Annual	NSW EPA
TSP (as PM_{10})	<50	24 hour	NSW EPA
	<30	Annual	NSW EPA

(1) For urban population (~2000 people or more)
(2) For single residence (~2 people or less)
(3) PM10, NO2, HF, SO2, TSP from: Approved methods for the modelling and assessment of air pollutants in NSW (Jan 2017), Table 7.1.
(4) H2S Hydrogen sulphide from: Approved methods for the modelling and assessment of air pollutants in NSW (Jan 2017) Table 7.4b.

6.0 Management Safeguards and Controls

6.1 Air Emissions

6.1.1 Recovery Boiler

The Recovery Boiler is a major source of atmospheric emissions in a Kraft Pulp Mill. The main sources of emissions are Sulphur Dioxide (SO_2), Particulates (Na_2SO_4), Oxides of Nitrogen (NOx), Hydrochloric acid (HCl) and Hydrogen Sulphide (H_2S). The primary fuel source used in the Recovery Boiler is black liquor which is approximately 33% inorganic chemicals and 65% organic substances from wood. The Black Liquor is fired at approximately 75% solids to achieve lower emissions and high energy efficiency.

The Recovery Boiler is also used for the incineration of CNCG and DNCG. Liquid methanol containing some of the TRS compounds derived from the Stripper Gases and red oil are also currently burnt in Recovery Boiler A. Due to the design of the Recovery Boiler the sulphur in the NCG's and Methanol are predominantly absorbed in the smelt, reducing emissions of SO_2 and TRS, fundamental to emissions and odour control. Control measures for the Recovery Boiler emissions are detailed in Appendix A.

The key design parameters of the Recovery Boiler that ensures efficient combustion and control of emissions are:

- High solids content of black liquor to maintain high furnace temperatures and combustion efficiency;
- High furnace temperatures above 1000 deg C for efficient combustion and control of emissions;
- Three stages of combustion air to maintain ideal char bed formation and for control of emissions;
- Complete combustion of odorous Non Condensable Gases in a reducing environment;
- High level of automation control using online real-time continuous process monitoring;
- Auxiliary fuel system to maintain bed temperatures during black liquor flow disturbances;
- Continuous emissions monitoring system;
- Two single chamber three field electrostatic precipitators for removal of fine particulates from flue gas emissions.

The typical emissions from a Recovery Boiler and their control are described below:

Sulphur Dioxide (SO_2): The SO_2 creation and subsequent emission from the furnace depends on two major components, the dry solids concentration of the liquor being fired (indirectly), and the sulphidity (sulphur content) of the black liquor. Lack of char bed temperature control is a contributing factor.

The sulphidity expresses the amount of sulphur in the black liquor. When the sulphidity increases, the release of sulphur compounds in the lower furnace will also increase. The best way to decrease the sulphur emissions is to increase the dry solids concentration of the black liquor. This will increase the lower furnace temperature especially when it is coupled with supplying the correct amount of air at different levels and spraying the black liquor evenly. A higher furnace temperature will result in more evaporation of sodium compounds that will, in the middle of the furnace, react with SO_2 and bind it in the form of Na_2SO_4.

The boiler load will also have an impact on the SO_2 emissions. When the load is below 85% the SO_2 emissions will increase. At low loads, the furnace is less stable so the variations in the SO_2 and HCL emissions will increase significantly. Maintaining the Recovery Boiler at high loads reduces the SO_2 and HCL emissions.

Total Reduced Sulphur (TRS): The TRS is released due to the conditions in the lower furnace. The creation of TRS is increased by a cold char bed or upset operation (which creates cold pockets in the char bed that are strongly reducing). Almost all of the generated TRS is burned into SO_2 in the secondary and tertiary air regions of the furnace. The TRS combustion is enhanced by higher temperatures and better mixing.

The concentration of TRS in the flue gases expressed at 8% O_2 can usually be kept below 5ppm. Even long periods of operation at less than 2ppm level are quite possible with steady, high boiler load operating conditions.

The TRS generated in the furnace consists mainly of H_2S (95%) with small amounts of methyl-disulphide, di-methyl-disulphide and methyl-mercaptan. High firing rates with low excess air and minimum unburned carbon equal low TRS emissions.

The TRS concentration in the flue gases correlates very well with CO content, so that low CO concentrations equal low TRS concentrations.

Nitrogen Oxides (NOx): The Nitrogen oxides emissions consist of more than 95% NO with the balance being NO2. Nitrogen oxides are generated by two different mechanisms: oxidation of fuel Nitrogen, and oxidation of combustion air Nitrogen.

The oxidation of fuel nitrogen seems to be the dominant reaction in Recovery Boilers. Since Nitrogen levels in black liquor are low (approx. 0.1%) we can expect relatively low emissions, compared to Power Boilers.

The oxidation of combustion air nitrogen is a function of the combustion temperature and the availability of oxygen. The recovery furnace temperatures are comparatively low, due to the high water and inorganic content in the fuel. Staged combustion is used (primary, secondary and tertiary air) to maintain the reducing reaction. This staging of the air supply also helps in achieving low NOx creation. The oxygen levels are kept very low in the high temperature areas, resulting in low overall NOx emissions. In general, the level of NOx in the flue gas increases with increased temperatures and decreases with reduced temperatures.

Carbon Monoxide (CO): The CO emissions from a boiler are a function of the completeness of combustion and directly related to the amount of excess combustion air used. This relationship can vary, depending on the mixing of air with combustible gases. A good mixing will permit using lower excess air amounts while still maintaining low carbon monoxide levels. Increased CO can also be seen as a pre-warning for increasing TRS emissions.

Total Solid Particles (TSP): TSP in the Recovery Boiler flue gases consist of Na_2SO_4, Na_2CO_3 and minor portions of other inorganic impurities.

The generation of particulates is a function of the furnace temperature, the liquor spraying pattern and combustion air distribution. The removal of particulates occurs through passing the flue gases through two Electrostatic Precipitators located after the boiler bank.

The precipitators in combination are designed for 140% of the Recovery Boiler capacity to ensure that the minimum Manufacturers certified rating of 70% can be maintained by the Recovery Boiler while one of the Electrostatic Precipitator is off-line. The flue gases on entering the precipitators pass through an arrangement of emitting and collecting electrodes, this is shown diagrammatically below, Figure 2.0.

The emitting electrode is fed with current (at a very high voltage) that will discharge onto the gas dust particles as they pass through the field between the electrodes. The dust particles absorb the negative charge and then immediately attract to the collecting electrode plates. A coating (i.e. dust layer) is formed on the collector plates. The resultant dust coating is removed from the electrode systems with the assistance of an emitting rapper system and collector rapper system.

To achieve a high degree of precipitator efficiency, as many electrons as possible must cling to the dust particles. Consequently the voltage is at such a level that sparks between the discharge electrode and the collecting electrode will occur.

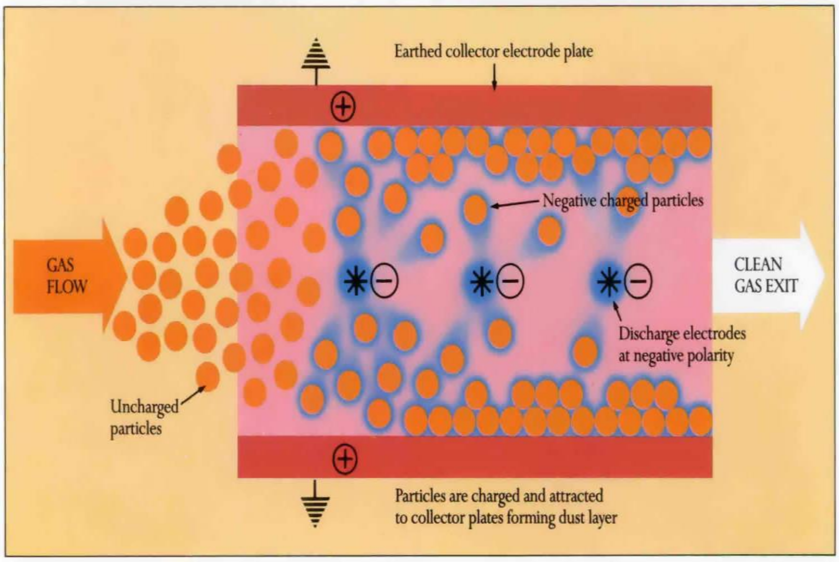

Figure 2.0 Electrostatic Precipitator Electrode

The precipitator operation is monitored from the main control room. A display of each unit's precipitator current and voltage aids in diagnosing problems. Opacity monitors are located in the outlet duct on each precipitator to monitor the relative dust load of each precipitator and for indication of any drop in performance. Sampling ports on the inlet and outlet ducts of each precipitator allow routine testing of dust concentrations through isokinetic sampling to assess the precipitator efficiencies.

6.1.2 Power Boiler

The Power Boiler is a bubbling fluidised boiler designed for burning of solid fuels such as wood waste, paper machine rejects and sludges. The Power Boiler is also fired with Natural Gas mainly for start-up and as an auxiliary fuel. The Power Boiler is also used as the secondary back-up system for NCG firing in the event the Recovery Boiler is not available. Control measures for the Power Boiler emissions are detailed in Appendix B.

The Power Boiler uses a modern fluidised combustions system comprised of following features that maintains the combustion efficiency while minimising emissions:

- Fluidising sand layer is maintained in suspension by fluidising primary air;
- Pressure indication used to control fluidised bed depth within defined parameters;
- Lower furnace walls are protected with refractory to promote an elevated combustion zone to efficiently burn high moisture content fuels;

- Bed temperature maintained between 750^{0}C to 950^{0}C above the volatilization temperature of wood;
- Bed temperature is measured at six locations to ensure better control of combustion and optimising fuel efficiency;
- Temperature is primarily controlled by varying the fluidising air flow. Natural gas auxiliary burners can also be used to increase temperature or recirculating flue gases to reduce temperatures;
- High turbulence within fluidised bed zone continuously scrapes of ash from the outside of the fuel exposing more un-burnt surface to oxygen for complete combustion of fuel;
- Staged combustion (i.e. addition of secondary air above the bed) ensures complete combustion of solid fuel to minimise hydrocarbon, oxides of Nitrogen and TRS emissions;
- High residence time in the furnace ensuring complete dioxin destruction;
- Regular removal and screening of sand to remove coarse particles and fine ash to maintain optimum bed fluidity;
- Continuous online Oxygen and CO monitoring for process control;
- Duel solid fuel feed system each designed to 70% of the maximum feed rate to maximise uptime and minimise furnace temperature variations;
- Two field single chamber Electrostatic Precipitator for particulate removal;
- Continuous emissions monitoring system.

Typical emissions from a Power Boiler and their control are described below.

Nitrogen Oxides: Nitrogen Oxides are formed during combustion process. The basic mechanisms for formation are thermal and fuel bound nitrogen conversion. Thermal NOx is strongly temperature dependant, generated at furnace temperatures above 1204^{0}C. As the temperature of the bed is controlled well below this, thermal NOx formation is minimal.

Fuel bound NOx is dependent on Nitrogen content of the fuel along with oxygen availability (or limiting). The nitrogen content of biomass fuels is relatively low at 0.3%.

Nitrogen Oxide emissions can be further minimised by maintaining optimum bed temperatures and good control of combustion conditions.

Carbon Monoxide: Carbon monoxide is formed when some of the carbon from the fluidised bed is released to form carbon monoxide. The amount is largely dependent on the amount of fuel in the bed and the amount of primary air. Carbon Monoxide is further converted to Carbon Dioxide by the secondary air. Ensuring the regular removal of the bottom ash and providing sufficient excess air at secondary air levels reduces emissions of CO.

Sulphur Dioxide: Sulphur dioxide emission from the Power Boiler during normal operations is typically low due to low Sulphur content of wood and bark. High Sulphur dioxide emissions do occur when non condensable gases are burnt in the Power Boiler due to the high sulphur content of these fuels. This occurs infrequently for relatively short periods of time, when the Recovery Boiler is not available for burning of NCG's.

Hydrogen Chloride: As the chloride content of wood and bark is quite low, the hydrogen chloride emission from the Power Boiler is for the majority of time undetectable. Spikes in HCl can occur from time to time mainly due to poor quality fuel loads and low combustion temperatures.

Total Solid Particles: The Power Boiler is provided with a single chamber, two field electrostatic precipitator. As the flue gases pass between plate and electrode in each field, the dust is attracted to the electrode plate from where it is removed. Key parameters indicating the performance of the electrostatic precipitator is monitored continuously by operators from the Main Control Room. Audible and visual alarms are used to alert operators when these values go outside the acceptable range. An Opacity monitor located in the Power Boiler flue gas exhaust duct prior to the stack provides a direct measurement of dust load.

6.1.3 Lime Kiln

The Lime Kiln is a horizontal cylindrical brick lined steel drum 2.6m in diameter and 50 metres in length, Figure 3.0. The Lime Kiln's primary purpose is to calcine lime mud that consists primarily of oxidising carbonate into quicklime which is calcium oxide for reuse in the causticising process. The Lime is conveyed from the feed end to the firing end as the kiln rotates. A gas burner, located at the discharge end of the kiln provides the heat energy for calcining. Calcining occurs between 850 -1100^{0}C.

The primary fuel used in the Lime Kiln's is Natural Gas. The Lime mud which contains residual amounts of sodium sulphate and sodium sulphide is the primary source for emissions of lime dust, TRS, CO_2 and SO_2. Other emissions consisting of Nitrogen Oxides and Carbon Monoxide, more specifically result from the combustion of Natural Gas inside the kiln. Control measures for the Lime kiln emissions are detailed in Appendix C.

The exit flue gas from the Lime Kiln A and Lime Kiln B are ducted to Stack 1 where they combine with flue gases from Recovery Boiler A and the Power Boiler. Both Lime Kilns contribute approximately 20% of the total flow exiting the main stack. Continuous emissions monitoring is undertaken on the flue gas duct after each Lime Kiln prior to the stack.

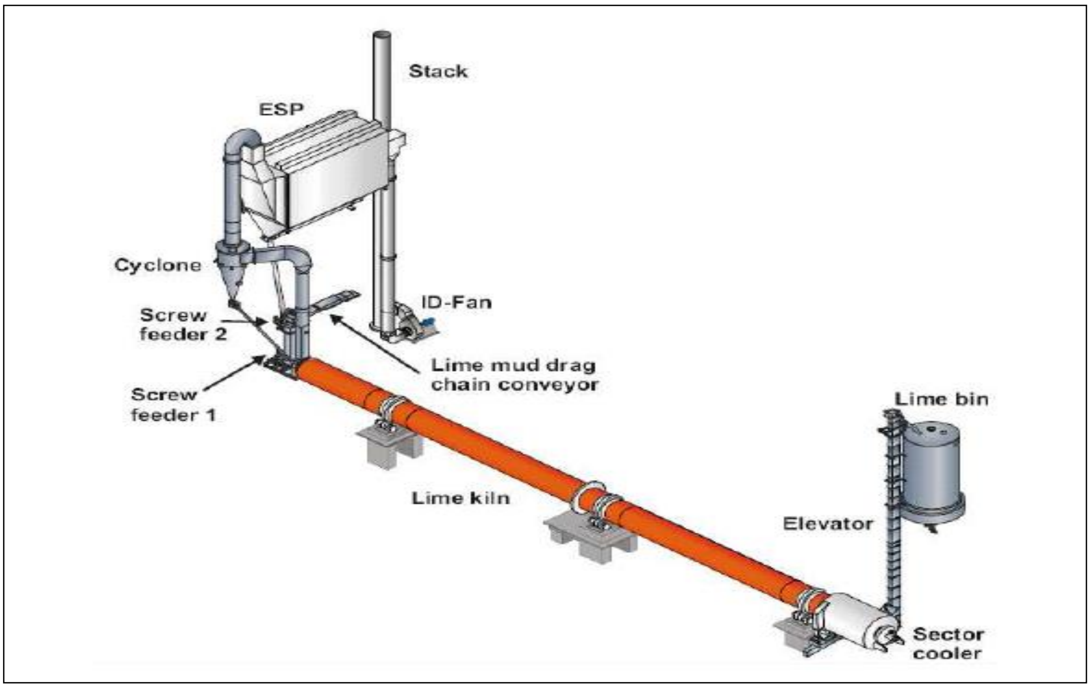

Figure 3.0 Typical Lime Kiln

The key design parameters of the Lime Kiln to minimise emissions are as follows:

- Natural gas used as primary fuel;
- Lime mud washing to remove alkali;
- Monitoring of residual alkali levels in lime mud;
- Purging of lime mud to reduce alkali levels;
- Maintain high lime mud solids content for improved energy efficiency and lower emissions;
- O_2 measurement for combustion control;
- Electrostatic precipitator to remove lime dust from flue gases;
- Return of lime dust back to the process.

Typical emissions from a Lime Kiln and their control are described below.

Nitrogen Oxides: Nitrogen Oxides emissions from the Kiln results from burning Natural Gas and the high temperatures in the kiln. NOx emissions can be controlled by adjusting flame shape, air distribution and excess oxygen. Flame shape and symmetry are important to minimise localised hot spots. Continuous monitoring of NOx emissions in the flue gases allows fine tuning of lime kiln parameters to minimise emissions.

Carbon Monoxide: Carbon monoxide is formed through incomplete combustion due to poor fuel/air ratio. Emissions can be minimised through adjustments to excess air provided at by secondary airflow via the ID fan. Continuous monitoring of O_2 at the feed end and CO in the flue exhaust gases allows fine tuning of lime kiln parameters to minimise emissions.

Sulphur Dioxide: Sulphur Dioxide emissions result from residual sodium sulphate and sulphide compounds in the Lime mud feed. Poor lime mud washing results in higher residual levels and hence higher SO_2 emissions. Poor lime mud washing also causes formation of rings and balls inside the kiln due to higher sodium concentration in the lime mud. High lime mud washing efficiency results in lower SO_2 emissions and higher productivity through the kiln.

Total Reduced Sulphide: The Total Reduced Sulphide emissions from the Lime Kiln is dependent on the residual amount of sodium sulphide left in the Lime Mud after lime mud washing and the amount of excess oxygen. The sodium sulphide in the lime mud in the presence of CO and water react to form H_2S and bi-sodium carbonate. Good Lime Mud washing and sufficient excess oxygen minimises TRS emissions. Control of emissions is maintained through continuous monitoring of CO and Oxygen levels and routine measuring of free alkali concentration in the Lime Mud.

Total Solid Particles: The flue gases from the Lime Kiln are passed through a single chamber 3 field electrostatic precipitator (ESP) prior to discharging into the Main Stack. In the ESP, the dust which is mainly $CaCO_3$ is removed, passed through a cyclone and returned back to the Lime Kiln. Key parameters indicating the performance of the electrostatic precipitators is monitored continuously from the Main Control Room. Audible and visual alarms are used to alert operators when values are outside of the acceptable range. An opacity monitor located on the outlet duct of the electrostatic precipitator provides a direct indication of dust load in the flue gases prior to entering the Main Stack.

6.2 Odour Sources

The Management of odour emissions at the Visy mill in Tumut is a key aspect of the mill's environmental performance. The release of odorous emissions is mainly in the form of TRS compounds at levels unlikely to cause adverse health effects but still able to be unpleasant or a nuisance within the mill boundaries or to the surrounding community.

The main odour sources from the mill are well known and identified. Odour control technologies and operational procedures have been integrated into the operation of plant and equipment.

The main odour source is from emissions Non Condensable Gases (NCG) which are predominantly concentrated TRS gases. These gases are generated from various locations in the process. Due to their highly odorous characteristics, these gases are collected within a closed system to prevent their release to atmosphere. The NCG can be further characterised into the following different streams:

- Concentrated Non Condensable Gases (Strongly odorous)
- Dilute Non Condensable Gases (Weakly odorous)

Control of these sources of odour has been specifically incorporated into the design of the mill's Non Condensable Gas System.

Other major odour emission sources as listed below, are not as odorous as NCG, but have nevertheless resulted in unpleasant odours within the surrounding community.

- Cooling Towers
- Paper Machines
- Cooling Ponds

The management and control of odour from these sources are further discussed in detail in the followings sections.

6.2.1 Concentrated Non-Condensable Gases (CNCG)

The most odorous gases (high odour concentration) have relatively low air flow rates and are known as Concentrated Non Condensable Gases (CNCG) or High Concentration Low Volume (HCLV) Gases. These gases are formed in various areas of the process (VCE, Evaporators, Stripper column and Methanol column) where they collected and are transferred via the NCG system to the Recovery Boiler. The advantage of burning these gases in the Recovery Boiler is the sulphur is recovered as it is absorbed back into the smelt, minimising SO_2 and TRS emissions. The process areas where these gases are formed are shown below in Figure 4.0. The CNCG's can be further separated into two main streams, CNCG from the multi effect evaporators and foul condensate tank and the Stripper Gases (SOG) from the Stripper column, Methanol column and VCE.

The CNCG's and SOG are collected and treated in a closed system to maintain the gas concentration above the Upper Explosive Limit by preventing air from getting into the system and to avoid any unnecessary leaks to atmosphere. All CNCG gases are led to collection tanks. In the collection tank gas pipes are led under the water surface, which prevents gases from flowing back to the collection points.

All CNCG lines are equipped with:

- Droplet separator to take out water droplets from the gas;
- Flame arrester to stop the possible flashback from the burner;
- Rupture disk to protect the system in case of explosion; and
- Pressure control with low pressure steam (up to 4.5 Bar).

The CNCG pipes going to the Recovery Boiler A are equipped with shut-off valves to prevent the gases from entering the Recovery Boiler building in case of an evacuation. To prevent water from entering the Recovery Boiler/s furnace, condensate is collected from several points in the NCG piping. The NCG lines are also equipped with level switches in order to stop the possible water flow to the boiler. This condensate is led to pumping tanks and pumped further to the foul condensate tank.

From the collection tanks, the CNCG's are extracted as a single gas flow by means of a steam ejector. Vacuum in the collection piping is maintained with pressure control. From the ejector, gases are led to one of two NCG burners located at the secondary air level of Recovery Boiler A which acts as the primary burner. The burners are equipped with a continuous gas-electric type igniter and flame scanner. The secondary air of Recovery Boiler A is used as combustion air for the burners.

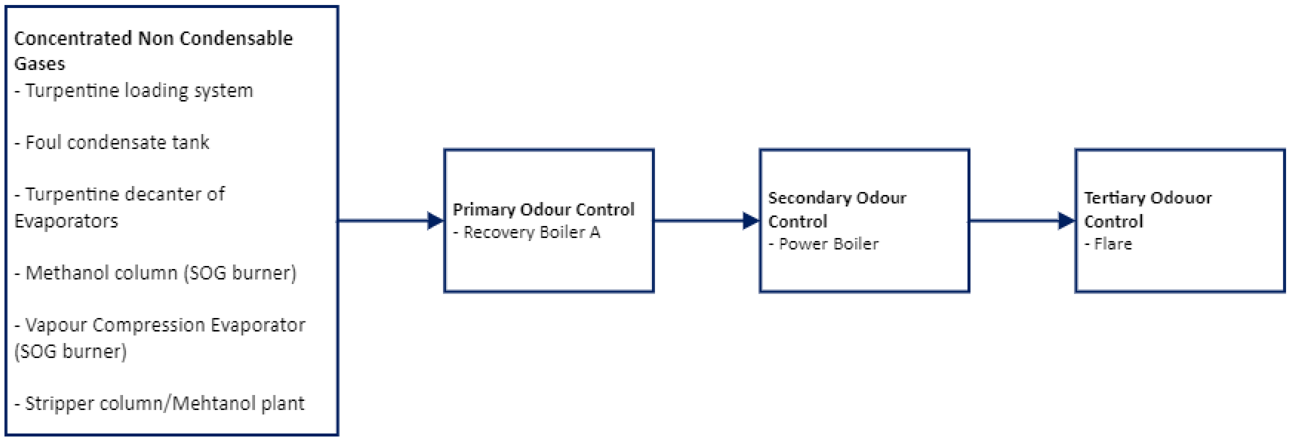

Figure 4.0 Concentrated Non-Condensable Gases

At an operating temperature of 900^{O}C and a retention time of 2 seconds the TRS removal efficiency in the Recovery Boiler is over 99.95%. The SO_2 emissions are also very effectively controlled due to an excess of vaporised Sodium in the Recovery Boiler flue gases. Due to better emissions control the CNCG are burnt in the Recovery Boiler over 99% of the time. When the CNCG cannot be burnt in Recovery Boiler A, the gases are diverted to the Power Boiler, which is the secondary burner. Due to high temperatures, excess oxygen and high retention time; the Power Boiler is as efficient in controlling TRS emissions from the CNCG's. However the SO_2 emissions cannot be controlled as effectively. When the CNCG cannot be burnt in either the Recovery Boiler A or Power Boiler, they are diverted to the flare burner (Torch). The flare burner (Torch) is located on the roof of the Recovery Boiler A building and is used as reserve burner in the event that the Recovery Boiler and Power Boiler are not operating. Natural gas is the auxiliary fuel and the torch is equipped with a gas-electric type igniter, a flame scanner and a combustion air fan. The combustion air for the flare is taken from the atmosphere. The flare has a minimum of 95% efficiency in burning the CNCG's. Control measures for CNCG's and Stripper gases are detailed in Appendix D.

The SOG which account for over 60% of the total CNCG gas, is collected from the Stripper Column and transferred across to the Liquid Methanol Plant using steam ejectors as illustrated below in Figure 5.0. The SOG and steam are combined in the methanol column. Vapour from the top of the column containing methanol is extracted and directed to the partial condenser. Vapours from the column are condensed and condensate produced is returned back to the column to build up concentration. The vapour from the partial condenser is directed to the methanol condenser where it is condensed to form a liquid Methanol. Liquid methanol is drained from the condenser into the Methanol Storage Tank via the level tank. The liquid methanol fuel is then pumped across to the methanol burners in either Recovery Boiler A which is the primary burner or Recovery Boiler B which is the secondary burner. If either of the Recovery Boilers is not available, the methanol can remain in the storage tank. The tank provides a buffer of up to 18 hours after which point, the Stripper Column will be shut down.

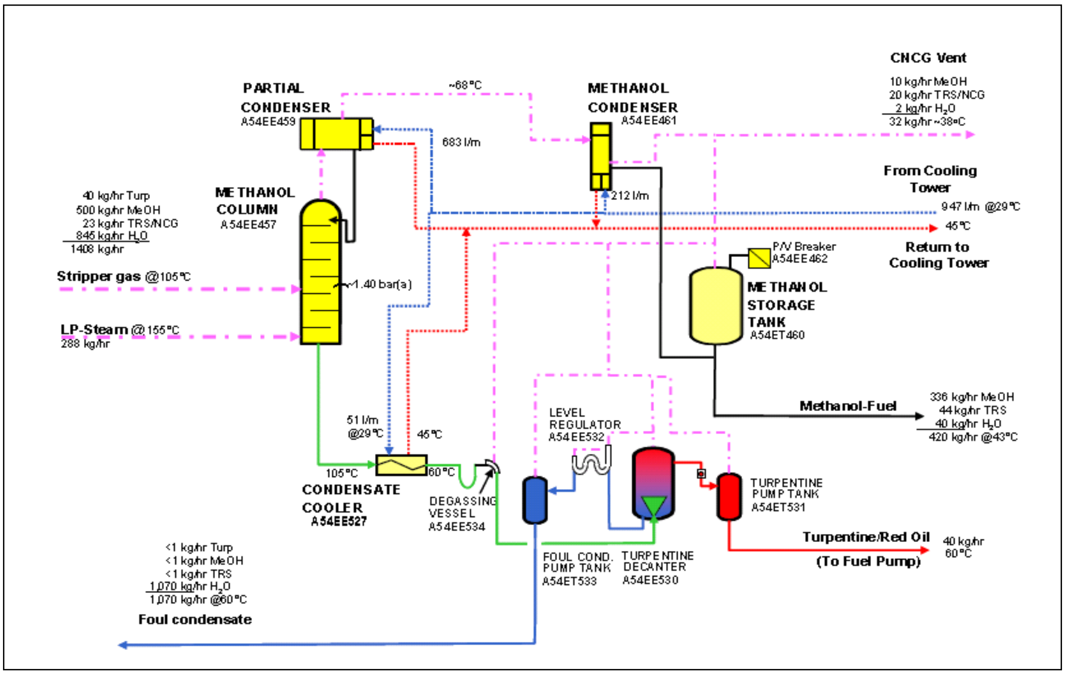

Figure 5.0 Liquid Methanol Plant

6.2.2 Dilute Non-Condensable Gases (DNCG)

Less odorous gases are known as Dilute Non Condensable Gases or High Volume Low Concentration (HVLC) gases). These gases have TRS concentrations below the lower explosion limit and are formed in tanks and washers where liquor comes into contact with air. The sources for these gases are shown in Figure 6.0. The DNCG include the vent gases from the Dissolving and Mixing Tanks in each of the Recovery Boilers. Although these gases are treated separately, the systems are analogous.

The Dilute Non Condensable Gases (DNCG) are collected and treated in an open system in order to keep the concentrations below the lower explosion limit under all conditions. All tanks and equipment connected to the DNCG system are equipped with a vent pipe to the atmosphere.

These vent pipes have two functions:

- A large amount of dilution air is taken to the system from these vents to keep the gas below the lower explosion limit.

- In case of shutdown of the dilute NCG system the gases can exit the tanks from these vents.

Every connection pipe in the dilute NCG system is equipped with a manual valve and an adequate vacuum in each connection points set with these valves. The dilute NCG gas duct going to Recovery Boiler A is equipped with a shut-off valve to prevent the gas from entering the Recovery Boiler building in case of evacuation. In case of Recovery Boiler A being unavailable, dilute NCG will be diverted to Recovery Boiler B.

The DNCG are scrubbed and also burnt in the NCG burner in the Recovery Boiler, entering with the secondary air. Under certain conditions, for example very low boiler load or complete shutdown of Recovery Boiler A, gases will be diverted to Recovery Boiler B and if this is not operating they will be vented to atmosphere through the scrubber.

The Vent Gases from the Recovery Boiler Dissolving Tank and Mixing Tank are collected, directed through the Vent Gas Scrubber to remove TRS compounds and combined with fresh air in the tertiary air port of the Recovery Boiler. If under certain firing conditions in the Recovery Boiler, these gases cannot be burned, they are vented to atmosphere through the scrubber. The pH control of the water circulation on the vent gas scrubber ensures optimum conditions for TRS removal. Control measures for DNCG's are detailed in Appendix E.

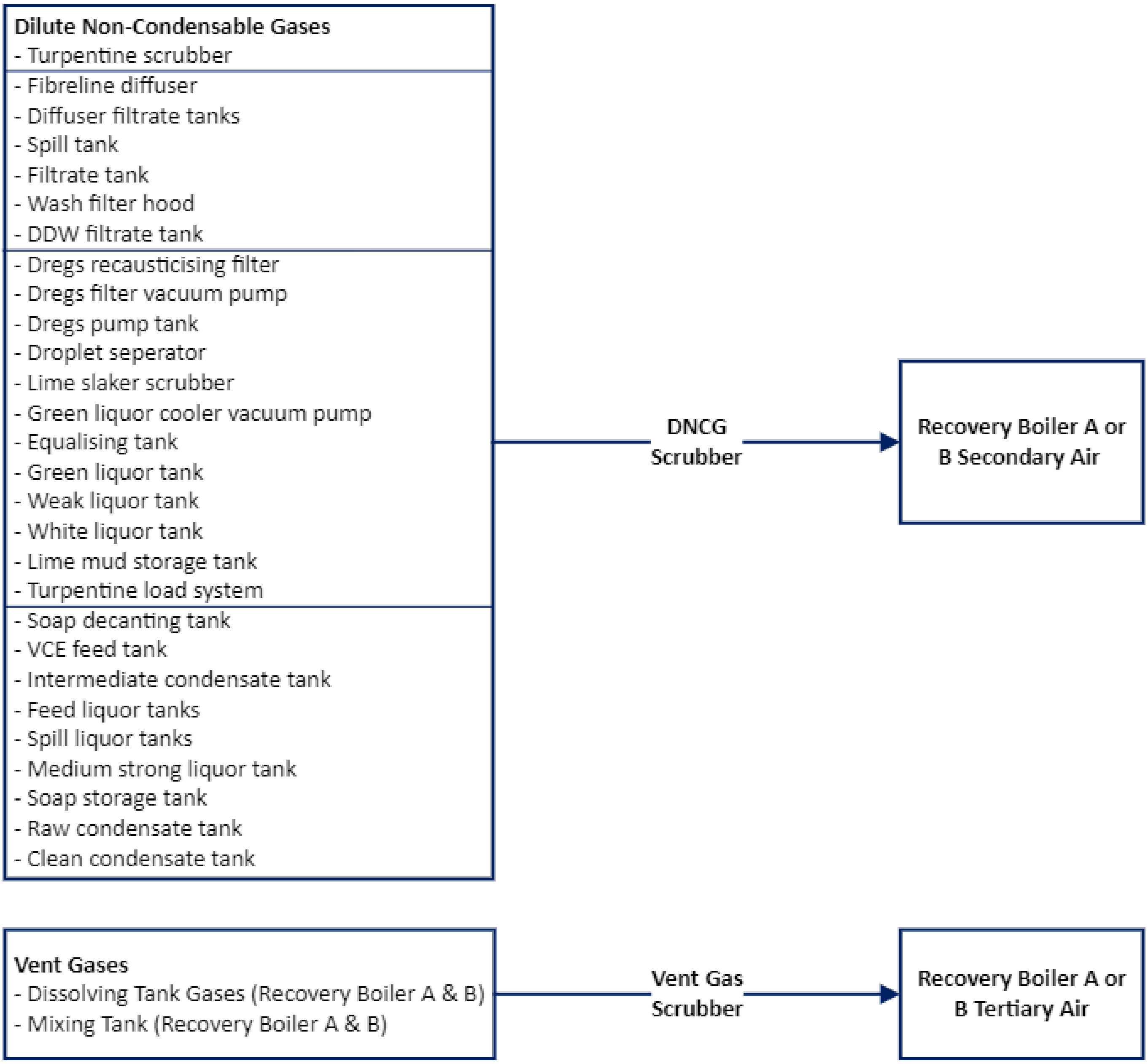

Figure 6.0 Dilute Non-Condensable Gases

6.2.3 Other Sources

The major diffuse sources of odour at the mill during steady state operations are from the following processes:

- Cooling Towers
- Vacuum Pump Outlets
- Paper Machine Building Ventilation
- WWTP Cooling Ponds

The main cause of odour from these areas is from the secondary condensates (ie. clean condensate). These condensates originate from process vapours during evaporation of black liquor. It primarily contains methanol, terpenes, ketones, phenolic acids along with TRS compounds. Clean condensate which has the lowest concentrations of these compounds is used in open areas of the plant, such as those listed above to reduce consumption of fresh water. The quality of clean condensate can be affected by process upsets, resulting in higher concentrations of TRS compounds. These compounds vaporize in these open processes, causing them to be emitted to atmosphere. Due to the low odour thresholds of the TRS compounds even at very low concentrations combined with adverse meteorological conditions, can result in off-site odour impacts.

The primary mechanism for odour generation from using clean condensates in the above processes is described as follows:

Cooling Towers: Cooling water is piped around to heat exchangers located through-out the mill to reduce the build-up of heat. As the cooling water system is a closed system, the hot cooling water is returned to the Cooling Towers for cooling. The Cooling Towers consist of 5 cells which are a mechanical induced draft counter flow system. The fans located at the top of the cooling tower cells, draw ambient air from the bottom of the Cooling Tower up through the fill media counter current to the flow of cooling water. As the air passes through the cooling water, heat is removed and the saturated warm air is discharged to atmosphere through the Cooling Tower Stack. The much cooler cooling water is collected in the cold water basin at the bottom of the Cooling Tower, for re-distribution through the cooling water circuit. Clean condensate and recycled water from the Wastewater Treatment Plant are introduced as make-up for water losses through evaporation.

Odours from the Cooling Towers can result when clean condensate contains higher than normal levels of TRS compounds. The TRS compounds in the cooling water are transferred from the fluid into the saturated exhaust air stream. Due to the large volume of exhaust air from the Cooling Towers, the resulting odour although not high in strength, can be a significant contributor to background odour levels.

This mainly occurs through-out autumn and winter during low dispersion conditions. Good control of clean condensate quality in the evaporation process is the primary means of odour control. The practice of replacing clean condensate with treated waste water as make-up to the Cooling Water System is also beneficial in reducing odour. This is due to treated waste water having lower COD and TRS concentrations after having undergone further treatment and aeration in the biological reactor.

Paper Machine Vacuum Pumps: Large quantities of water are used on the Paper Machine primarily for dilution, shower systems and cleaning. To reduce fresh water consumption, all of the water is recovered as white water (i.e. process water containing fibres) and re-used back in the process. As white water is also used in the Fibreline, losses in the system are made up with fresh water and clean condensate.

At the wet end of the paper machine, low consistency pulp is sprayed from the head box onto the wire to form a mat. As the wire passes over vacuum boxes, water is drawn out of the wire under vacuum and directed through a water separator to separate water from the discharge air. While the water is recovered for re-use back in the process, the moist air is discharged via the vacuum pumps and vented to atmosphere. As with the Cooling Towers, odours can be generated when TRS compounds from the clean condensate are transferred from liquid to exhaust air exiting the vacuum system. The odour intensity is quite low, but due to the volume of air discharged, and under low dispersion conditions, it can be a contributor to the background odour levels. Controlling of clean condensate quality is the primary means of odour control.

Paper Machine Building Ventilation: The primary function of the Paper Machine Building ventilation is to draw warm dry air from outside of the building to replace the moist air over the wet end of the paper machine. Extraction fans located in the roof directly above the wet end, remove the moist air from inside the building and discharge this air directly to atmosphere. As with the Paper Machine Vacuum pumps, odours can be generated when TRS compounds are carried with the moist laden air through the extraction fans and vented. Controlling of clean condensate quality is the primary means of odour control.

WWTP Cooling Ponds: The primary function of the cooling ponds is to cool the raw effluent received from various areas of the process prior to biological treatment in the Sequencing Batch Reactor (SBR). Excess Clean condensate makes up over 55% of the total influent. As the clean condensate cools, dissolved TRS gases in the condensate evaporate from the surface of the Cooling Ponds. Depending on the concentrations of TRS in the Condensate, this can result in low level odours from the Cooing Ponds. Minimising the TRS concentrations in the clean condensate is the primary means of odour control. A floating aerator can also be used to minimise odour by aerating the surface of the Cooling Pond to oxidise any TRS gases present.

Clean Condensate Quality: The control of condensate quality is achieved through separating out the volatile odorous compounds from the condensate through evaporation. This results in the concentration of the volatile compounds into a relatively smaller stream of foul condensate, allowing the bulk of the condensate to contain much lower concentrations. This works on the basis that the volatile compounds have different boiling points, all of which are lower than water (except DMDS). The foul condensate is then treated through the steam Stripper where the volatile components are flashed off producing the Stripper Off Gas (SOG). To further enhance the removal of the higher boiling point components from the 'clean' condensates, for example dimethyl disulfide, two air strippers are used as a final polishing stage to further reduce the risk of releasing odour-causing compounds to the atmosphere.

To estimate the total effectiveness of separation of the volatile components, the measure of Chemical Oxygen Demand (COD) is used, which is based on the proportion of methanol (CH_3OH or MeOH) in the condensate. The typical composition of COD in condensate is given below in Table 12.0.

Table 12.0 Typical Composition of COD in Condensate

Component	Concentration	Proportion of COD
COD	10 – 20 kg/Adt	
Methanol	5 – 10 kg/Adt	50%
TRS	1 – 2 kg/Adt	10%
Turpentine	1 – 2 kg/Adt	10%

Methanol which is also quite volatile is produced in the pulping process in larger quantities than the organic sulphur compounds, as detailed above in Table 12.0. It is likewise separated in the evaporation process by selective condensation. Although Methanol removal on its own will not reduce odour, as it is over 1000 times less odorous than the other compounds, it is used as the COD benchmark because only one other compound (di-methyl disulfide) has a higher boiling point.

Thus to demonstrate the relative quantity of odour causing compounds in the condensate streams, the distribution of methanol in the Evaporation Process is illustrated in Figure 7.0. As can be seen, over 69% of the total methanol coming in with the feed liquor is removed as Foul Condensate from the VCE and a further 7% is removed as foul condensate from the MEE.

These flows are combined for further treatment in the Steam Stripper where over 95% of the methanol (and TRS compounds) is removed from the condensate. The resultant 'stripped' condensate is combined with MEE secondary condensate and a small proportion of Intermediate condensate to undergo final polishing in the Air Stripper System. The resultant MeOH load in the clean condensate is 11% of that in the original weak Liquor. This equates to an equivalent COD concentration of 266.5 ppm which is a reduction of over 50% from previous COD concentrations in the Clean Condensate.

Based on correlation of odour monitoring data with COD concentrations, and air dispersion modeling, the design COD concentration in the clean condensate is expected to maintain odour concentrations at off-site receptors below the DECC Odour Assessment Criteria.

The key measures to manage the COD concentrations in the condensates within the target range and thus minimising odour emissions areas are as described in Appendix F.

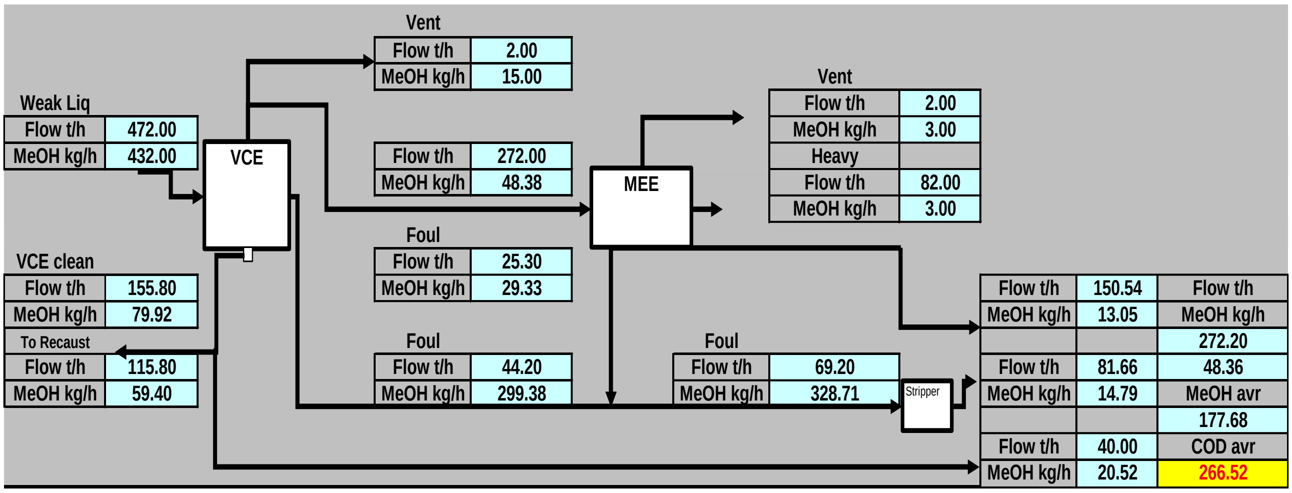

Figure 7.0 Stage 2 COD distribution based on COD concentration in the feed liquor as at Stage 1

6.3 Start-Up and Shutdown of Process Plant

The previous section discussed the management and control safeguards for air and odour emissions during steady state conditions. At various periods during the year the mill undertakes partial or total plant shutdowns in order to undertake routine maintenance activities. During start-up/and shutdown of main process plants, the effectiveness of some of these control devices is reduced leading to some emissions in excess of the standard. Under the NSW *Protection of Environment Operations (Clean Air) Regulation* 2010 (Clause 56) start-up and shutdown events are exempt from compliance with the prescribed standards of concentration. However, Visy are still subject to the requirements of section 128(2) POEO Act in regards to the prevention and minimisation of air pollution and seek to minimise their emissions to air under these circumstances as far as practicable.

Planning for shutdowns also take into consideration meteorological conditions where practicable. Major Shutdowns are typically undertaken to avoid the temperature inversions conditions that typically occur during winter months. Larger vessels or tanks especially those associated with the concentrated NCG system are flushed with clean condensate and steam if possible prior to opening, and the timing of opening is scheduled for late morning early afternoon when dispersion levels are optimal.

When odour is created in any start-up phase, the answer to achieving "no odour" is not immediate shut down but working through that period to optimum performance. It is for this reason that clear and informative communication with the local community is an important part of Visy's Environmental Communication Procedure (VP9-10-10.4-OP-001).

The following section outlines typical events that take place during partial and annual mill shutdowns which can result in potential odour or other air emissions impacts. Control measures for annual and partial shutdowns are provided in detail in Appendix G and H.

6.3.1 Routine Partial Shutdowns

Routine partial shutdowns are undertaken primarily to replace felts and wires on the paper machines every 8 - 10 weeks. The duration of these shutdowns normally last between 12 to 18 hours. To maintain material balances within the mill other process areas are also shutdown, providing opportunity to undertake routine inspections, maintenance and cleaning activities. During these partial shutdowns, at least one Recovery Boiler and the Power Boiler may remain in operation at reduced capacity, to maintain some of the odour control system.

The activities that may result in odorous or other air emissions and the control measures in place to minimise their impacts are described in Appendix G.

6.3.2 Annual Shutdowns

On an annual basis, the entire mill is shut for planned maintenance activities. Major maintenance activities are undertaken in all areas of the mill including cleaning and inspection of major vessels and boilers. These activities also incorporate scheduled preventative maintenance on the odour and emissions control and monitoring systems. This type of shut normally extends over 10 to 12 days. Elevated odour or air emissions are more likely to occur in the first few days of the shutdown as the process cools or at the end of a shut when starting up the process.

The typical start-up duration for the Recovery Boiler from a cold bed is 18 hours. This is the length of time required to re-form the char bed to achieve target reduction levels in the furnace. Once these conditions are maintained, odour and air emissions will return to steady state levels. The typical activities including control measures are outlined in Appendix H.

6.4 Malfunction and Process Upsets

Malfunctions and process upsets occur infrequently but have the potential to cause elevated odour and air emissions. The identification of potential process upsets, has been undertaken through a comprehensive hazard identification and risk assessment that encompasses all design including facilities, hardware systems, equipment, products, tooling, materials, maintenance, energy controls, layout and configuration. The control measures identified through this process have due consideration for the safety of personnel and plant along with any potential impacts on the local environment. These control measures have either been incorporated into the hardware design, the process control logic of the mill's automation system or included in standard operational procedures. Certain scenarios even with control measures in place still have a high potential to result in elevated odour or air emissions. These scenarios along with their control/contingency measures are outlined in Appendix I.

6.5 Contingency Measures

Contingency measures are integrated into the control measures for each of the Malfunction and Process Upset Scenarios outlined in Appendix I. Where upset conditions result in a discharge of strong CNCG or SOG to atmosphere, the process and operational controls ensure that the duration and intensity is minimised by automatically shutting down the specific source of CNCG.

When upsets in the process have the potential to result in a moderate to severe odour impact or air emission, where practicable the local community considered to be directly impacted are to be notified immediately as part of Visy's Environmental Communication Procedure (VP9-10-10.4-OP-001). In accordance with this procedure and as required by the EP Licence and Project Consent Conditions, the NSW EPA and NSW DPE are also to be notified of the event as soon as practicable.

Emergency and troubleshooting procedures which are provided for each of the process areas are to be implemented to control odour and air emissions and to return the process back into steady state operations as quickly and as efficiently as possible.

6.6 Energy Efficiency Measures

The mill generates on average 44% of its own electricity by utilising renewable fuel such as bark, wood residues, paper machine residues and black liquor in its boilers. The balance of power used for the mill is sourced from available electricity from the grid. Natural gas is used as the primary fuel in the Lime Kilns and as auxiliary fuel in the Power Boiler and Recovery Boilers. In addition to utilising steam produced from the boilers for power generation, this steam is the main energy source used in the various areas of the process. Specific energy efficiency measures have been incorporated into the mill process design and operational procedures, and are detailed in Appendix J.

Carbon dioxide from the consumption of electrical energy derived from the combustion of fossil fuels is the main greenhouse gas generated on site. Natural Gas which emits less carbon dioxide than other fossil fuels is used directly in the process. The use of black liquor, wood residues and the fibre component of the paper machine residues as boiler fuel delivers a net greenhouse gas benefit.

Plantations from where the wood, which is the primary raw material used at the mill is sourced, are also counted as carbon sinks, providing a significant carbon offset for emissions of fossil fuels. Recycling of paper generates a greenhouse benefit by avoiding methane generation from the alternative landfill decomposition of the paper fibre. Through maximising the usage of renewable energy and implementing control measures for energy efficiency, greenhouse gas emissions from the site can be minimised.

6.7 Training and Responsibilities

A competency based training system for the operation of plant and equipment has been well established for existing operations. This program will be extended to cover new plant and equipment as they come on line.

Training will cover the basic operations and include the roles and responsibilities in achieving conformance with the AQMP, Visy Environment Policy and Environmental Management System.

In order to ensure compliance with the AQMP and relevant regulatory requirements, it requires each person within the organisation to be aware of their responsibilities in regards to the Management Plan. The key to roles and responsibilities of the relevant personnel are as follows:

General Manager:

- Ensure provisions are made to provide adequate resources and training.

Pulp Mill and Paper Machine Managers:

- Ensure Operational Personnel are trained in their responsibilities for implementing the AQMP;
- Management and implementation of AQMP.

Area Managers:

- Support Senior Area Managers in ensuring Operational Personnel are trained in their responsibilities for implementing the AQMP;
- Support to Senior Area Managers in the management and implementation of the AQMP;
- Liaison with Shift Supervisors in operation of the plant and equipment in accordance with the AQMP;
- Investigation of environmental incidents and complaints.

Shift Supervisors:

- The operation of plant and equipment in accordance with Standard Operating Procedures and the EP Licence, and in order to meet the concentration limits specified in the Licence;
- Monitoring air emissions trends through the CEMS to ensure they are in compliance with EP Licence conditions and report exceptions.

Reliability Engineers:

- Scheduling and carrying out routine maintenance of emissions control and monitoring systems;
- Maintaining maintenance and calibration records.

HSE Manager:

- Acting as interface between Community, government authorities and mill Operational Management;
- Preparation and submission of reports as required by the AQMP;
- Update and review of AQMP;
- Co-ordination of external/internal audits on the implementation of the AQMP;
- Scheduling and co-ordination of air quality monitoring and assessment program as per the AQMP;
- Follow-up and close-out of environmental complaints and incidents.

7.0 Monitoring

The comprehensive air quality monitoring program consists of:

- Continuous emissions monitoring system;
- Periodic stack testing;
- Continuous meteorological monitoring;
- Periodic odour sampling and assessment;
- Air quality performance testing for Phase 1a and 2;
- Odour quality performance testing for Phase 1a and 2.

All monitoring is undertaken in accordance with the Sites Environment Protection Licence, and Project Consent Conditions and the *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (DEC 2005).

7.1 Continuous Emissions Monitoring System

Continuous emissions monitoring is undertaken at the following locations and as illustrated in Figure 8.0.

- Monitoring platform at Reduced Level (RL) 436m Australian Height Datum (AHD) on Stack 1;
- Monitoring platform at RL 397.5m on Stack 2;
- Combined outlet ducts on Recovery Boiler A (upstream of Stack 1);
- Outlet ducts on Recovery Boiler B (upstream of Stack 2);
- Outlet duct of Lime Kiln A (Upstream of Stack 1);
- Outlet duct of Lime Kiln B (Upstream of Stack 1);
- Outlet duct of Power Boiler (Upstream of Stack 1).

7.1.1 Equipment and Parameters

The CEM system comprises of air sampling probes, gas analysers and data acquisition system. The data acquisition system logs and records data at one minute averages and is designed to interface with the Mill's central Data Control System (DCS), in the Main Control Room. The CEM data is stored electronically on the Mill's Network server which is backed up routinely. The various instruments for analysing each of specific pollutants and relevant test methods are listed in Tables K1 to K7 located in Appendix K and described in more detail in Table 13.0 below.

The sampling points of the above equipment have been located where possible, to minimise upstream and downstream disturbances in accordance with TM-1 (Methods of Sampling and Analysis of Air Pollutants in NSW).

7.1.2 Data Acquisition and Retrieval System

The data acquisition and retrieval system is illustrated in Figure 9.0. The CEMS components of the system comprises of the following main systems.

- Analyser Control for Windows for Networks *(ACWN PROTEA)* – consisting of a dedicated CEMS PC/Server running Procal analyser control software. Data from each of the field devices/analysers is transmitted to the ACWN that provides control and display functions for diagnostics and reporting.

The raw data transmitted from each of the emissions monitoring equipment located on Stack 1, Recovery Boiler A, Power Boiler and Lime Kiln A and Lime Kiln B is used by the ACWIN to automatically calculate the normalised values to the standard conditions as specified under the EPL. These normalised values are instantaneously transmitted and displayed on operating screens in the Control Room for process control and so that operators can be immediately alerted of any exceedences or other issues that may arise. The data containing both raw and normalised values is backed up onto the main network server each day and normalised data stored on the Process Data Control System (DCS).

- *Envidas Data Acquistion System (EDAS)* - operates similar to the Procal system, whereby it collects data from the field devices, and provides control and display requirements. The system comprises of a central PC with Envidas Data Control software. The raw data from each of the emissions monitoring equipment on Stack 2 and Recovery Boiler B is transmitted to the Envidas PC located adjacent to Stack 2. This data containing both raw and normalised values is backed up onto the Network Server each day and normalised data stored on the Process Data Control System (DCS).

Various programs and data extraction tools have also been developed internally to assist with data analysis and reporting. This includes exception reports for exceedances that occur during each 12 hour shift, as well as weekly and monthly reports used for data validation and auditing. This process is detailed under internal auditing in Section 9.2.

7.2 Continuous Emission Monitoring Availability

In accordance with the Approved Methods for the Sampling and Analysis of Air Pollutants in NSW, the minimum data capture for opacity monitoring should be 95%, and for all other CEM systems, 90%. This allows a reasonable period of monitor downtime in the following situations:

- Monitor breakdown;
- Scheduled monitor maintenance;
- Daily zero and span checks;
- Performance specification testing.

This excludes data capture during general Maintenance Shutdown periods.

7.3 Periodic Stack Testing

Periodic stack testing is undertaken in accordance with the site's EPL, Development and Project Consent Conditions. The testing parameters, frequency of testing and test methods are as listed in Tables K1 to K7 in Appendix K. Testing is typically carried out during the reporting period in accordance with the monitoring schedule VP9-10-10.5-OP-001-A01 prepared at the beginning of the reporting period. The sampling is undertaken by specialist stack testing company and analysis of samples undertaken by appropriately NATA registered laboratories. The locations of sampling planes and number of sampling ports meet requirements of AS4323. Testing is carried out during normal steady state conditions to ensure emissions are representative of 'normal' operations.

Results of monitoring which can typically take between 4 to 6 weeks are communicated to the Pulp Mill Operations Manager. Should results indicate exceedances in concentrations, an Environmental Incident report is entered into the Visy reporting system and investigation is undertaken by the Operations Manager into the likely cause. All monitoring results are summarised and reported to the EPA and DPE in annual reports.

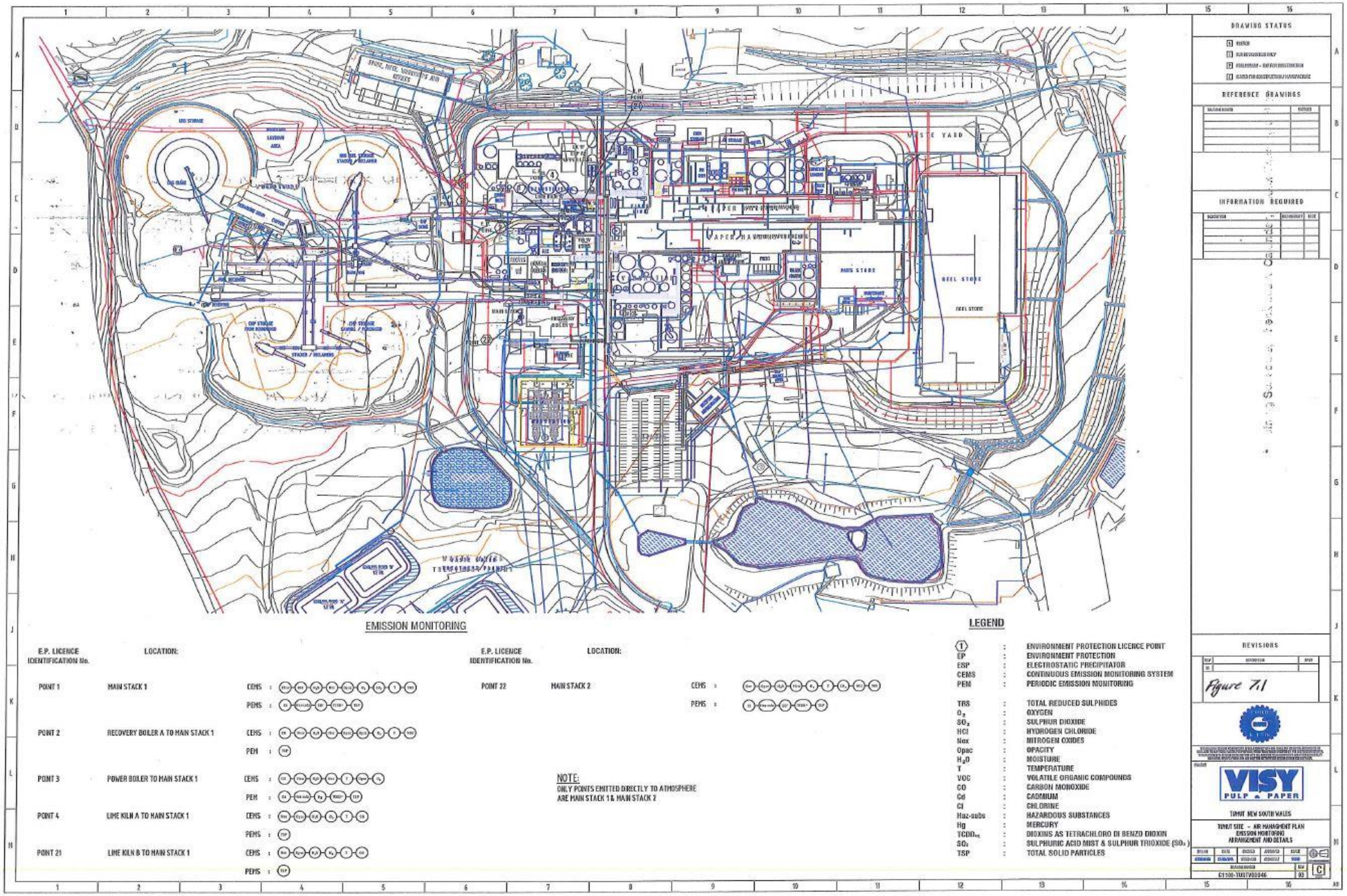

Figure 8.0 Air Monitoring Locations

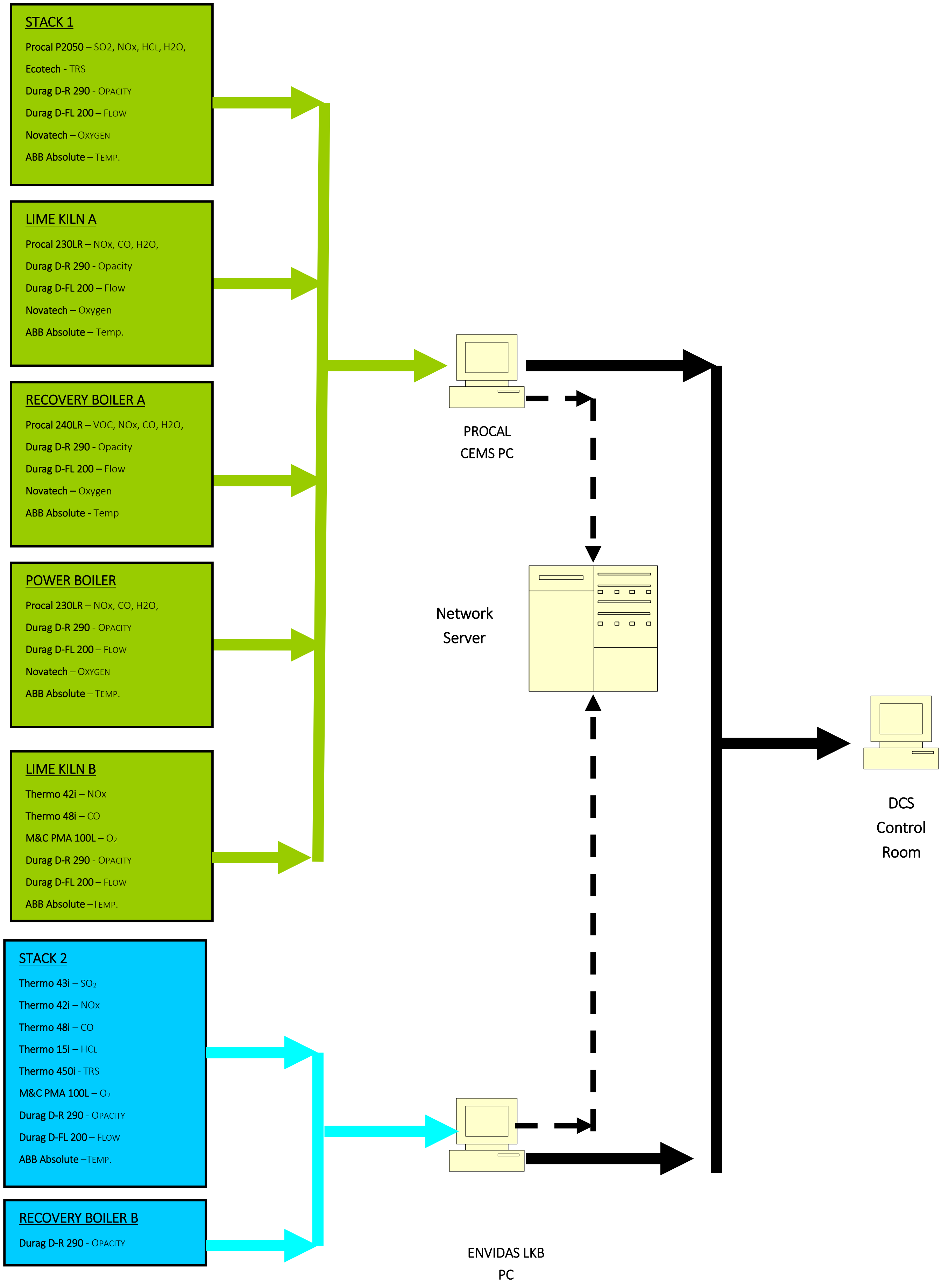

Figure 9.0 Continuous Emissions Monitoring Data Acquisition System

Table 13.0 Continuous Emissions Monitoring - Equipment

Equipment	Description	Features
Procal P2000	Insitu multi-gas analyser located in Stack 1, to monitor SO_2, NOx, HCl, and H_2O.	An in-situ sample cell that allows an unmodified representative gas sample to be obtained from the flue gas stream. Sintered stainless steel filter panels allowing permeation of stack gas while preventing ingress of dust or particulates. Auto or manual zero calibration checks through the use of clean and dry instrument air. Dual wavelength infra-red analyser where pulses of two wavelengths per gas at specified wavelengths are sent through the sample cell of the Optical Head Unit mounted on the stack or duct. The pulse is partially absorbed by the gaseous components to be measured whilst the reference pulse is relatively unaffected. A total of 8 wavelengths are available and in some circumstances reference wavelengths are shared. This allows up to six gas phase concentrations to be monitored simultaneously.
Procal P2000	Insitu multi-gas analyser located in Recovery Boiler A to monitor NOx, CO, VOC and H_2O.	Same as above.
Procal P2000	Insitu multi-gas analyser located in Power Boiler and Lime Kiln A to monitor NOx, CO, and H_2O.	Same as above.
Ecotech ML 9850B	Extractive system located in Stack 1 to monitor TRS. This system draws a sample from the stack and dilutes it to reduce the dew point of the gas.	Dilution probe and controller to provide a reliable diluted gas sample at a known dilution ratio to the analyser. Inline regenerative SO_2 scrubber to remove SO_2 from diluted dry gas sample. TRS converter operated at 800 – 900 deg C to reduce TRS components in gas sample to SO_2 at 98% efficiency. ML 9850B SO_2 analyser operating on UV fluorescent spectroscopy method. The analyser is based on principal that fluorescent radiation is produced by SO_2 molecules when excited by UV radiation between 200 and 240nm, the subsequent fluorescent emission is a linear process that is proportional to the SO_2 concentration.

Thermo 43iHL	Extractive system located in Stack 2 to monitor SO_2. This system draws a sample from the stack through the Perma Pure sample conditioning unit to remove moisture and diluted prior to analysis.	Perma Pure sample conditioning unit utilising nafion drying technology to effectively remove the moisture from the undiluted gas sample stream. UV pulsed fluorescence analyser operates on similar principal to the ML 9850B, with the addition of the pulsed fluorescent technology providing an increased optical intensity resulting in greater UV energy throughput and lower detectable SO_2 concentration.
Thermo 42i	Extractive system located in Stack 2 and Lime Kiln 2 to monitor NO_x. This system draws a sample from the stack/duct through the Perma Pure sample conditioning unit to remove moisture and diluted prior to analysis.	Perma Pure sample conditioning unit as described above. Chemiluminescence technology with single Chamber, single photomultiplier tube design that cycles between NO and NOx mode.
Thermo 48i	Extractive system located in Stack 2 and Lime Kiln 2 to monitor CO. This system draws a sample from the stack/duct through the Perma Pure sample conditioning unit to remove moisture prior to analysis.	Perma Pure sample conditioning unit as described above. Utilises undiluted gas sample for analysis. Gas filter correlation technology based on principle that carbon monoxide absorbs infrared radiation at wavelength of 4.6 microns. The infrared absorption is a non linear measurement technique thus the instrument electronics transforms the basic analyser signal into a linear output.
Thermo 15i	Extractive system located in Stack 2 to measure HCl. This system draws a sample from the stack through the Perma Pure sample conditioning unit to remove moisture prior to analysis.	Perma Pure sample conditioning unit as described above. Utilises undiluted gas sample for analysis. Gas filter correlation technology based on the principle that Hydrogen Chloride absorbs infrared radiation at a wavelength of 3.4 microns. The infrared absorption is a non linear measurement technique thus the instrument electronics transforms the basic analyser signal into a linear output.
Thermo 450i	Extractive system located in Stack 2 to measure TRS. This system draws a sample from the stack through the Perma Pure sample conditioning unit to remove moisture and diluted prior to analysis.	Perma Pure sample conditioning unit as described above. Diluted gas sample (100:1) utilising mass flow controller. SO_2 regenerative scrubber to remove all SO_2 from sample gas. High temperature converter to convert all TRS to SO_2. UV pulsed fluorescence analyser for SO_2 measurement operating on similar principal to the 43iHL.

Novatech Oxygen Analyser	Located in Stack 2 and Lime KIln 2 to measure Oxygen for normalising pollutant measurement.	Insitu oxygen analysis using Zirconia sensor with integral heater. Porous electrodes are placed on two sides of a zirconia ceramic element. When one side is exposed to air and the opposite side to exhaust gas, a voltage is generated in response to the difference in O2 concentration.
Durag D-R 290 Opacity Monitor	Located in Stack 1, Stack 2, Recovery Boiler A (2 off), Recovery Boiler B (2 off), Power Boiler, Lime Kiln A and Lime Kiln B.	Insitu device to measure directly into flue gas path. Operates on the autocollimation principle whereby the light crosses the measurement path twice and the system measures the light attenuation from dust in the stack. Performs check cycle of zero value to compensate for window dirtying. Heated plane to prevent condensation and deposits on the optics. Auto and manual calibration capabilities.
Durag D-FL 200 Velocity/Flow Monitor	Located in Stack 1, Stack 2, Recovery Boiler A, Recovery Boiler B, Power Boiler, Lime Kiln A and Lime Kiln B.	In situ measuring method. Operates on ultrasonic measurement where ultra sound impulses are sent to and from two ultrasonic transducers located across the stack at an angle of about 45 degrees from the perpendicular. The velocity is calculated by the difference in transit time for the sinusoidal wave through the gas medium (i.e. the acoustic propagation delay). Suitable for use wet and high particulate flue gas streams making it extremely reliable. Purge air system to prevent accumulation of excessive dirt and protect the system from the heat of the flue gases.
MAC Mod 155 Moisture Measurement	Located in Stack 2, and Lime Kiln B to measure moisture for normalising.	In situ measuring method. Operates on the use of high temperature capacitive sensor that responds to water vapour pressure in the presence of other gases. 10 micron stainless steel sintered filter element to protect against particulates in the gas stream. Built in equipment to allow automatic two point calibration check.

7.4 Ambient Air Quality Monitoring

The ambient air quality and meteorological monitoring (AAQM) locations, parameters and test methods are listed in tables K8 and K9 in Appendix K. Monitoring is undertaken at these locations for the following meteorological parameters in accordance with the EP Licence:

- Wind direction;
- Wind speed;
- Solar radiation;
- Ambient temperatures;
- Rainfall;
- Barometric pressure; and
- Relative Humidity.

The siting of the ambient stations was initially established in consultation with the EPA approximately 1 kilometre east of the mill site (Point 8) and at Pleasant View (Point 6) approximately 2 kilometres North West of the mill site as a requirement of the DCC and EPL prior to commencement of Stage 1. The relocation of the ambient air quality station from Point 8 to 'Havilah', North West of the mill site (Point 5&7) was undertaken in September 2001 after the commencement of operations at the request of the EPA. Meteorological monitoring at Point 8 along with PM_{10} Monitoring has been maintained at this location.

An additional monitoring station although not required under the EPL was located in Tumut to establish the intensity of potential odour impacts from the Visy Mill on the Tumut township. The locations of these AAQM stations are detailed in Figure 10.0.

An EP Licence Review was carried out in 2013 and as a result the requirement for ambient air quality monitoring was removed from the licence and some of the monitoring points are now redundant. Only meteorological monitoring is required at (Point 7) on top of the Recovery Boiler B building and (Point 8) South east of the mill. The main equipment used for AAQM is as described in Table 14.0 below.

The AAQM stations are equipped with data acquisition system to continuously log and store data from the various sensors. Modems, connected to the data-loggers allow transfer of data from the logger to a central AAQM computer running Airodis Software at the mill. The Airodis software allows data analysis and reporting from the two stations. The data collected is primarily used for correlation of community complaints.

7.5 Periodic Odour Monitoring

Periodic odour monitoring undertaken at the mill incorporates:

- Qualitative odour survey carried out by operational personnel of all potential odour sources as a part of the leak detection and repair (LDAR) program;
- Daily sampling and analysis of clean condensate;
- Annual odour sampling and analysis using odour olfactometry and sample speciation using a gas chromatograph;
- Annual LDAR carried out by external Stack Testing consultants;
- TRS monitoring in Stack 1 and Stack 2.

7.5.1 Odour Survey

An odour checklist has been compiled by Visy's operational personnel of all potential fugitive odour/volatile organic compounds sources in the mill. These include any potential accessible leakage points from flanges, vents or water droplet separators on the non-condensable gas systems. Operational personnel on a routine basis or after receiving odour complaints from the community, undertake an odour survey using a combination of handheld TRS monitor and olfactometry methods. As issues are identified, work orders are raised and prioritised, to ensure issues are rectified systematically.

7.5.2 Sampling and Analysis of Condensate Quality

Sampling and analysis of condensates qualities is undertaken on a daily basis to assess for potential issues in the Evaporation plant that can result in high COD concentrations in clean condensate. Issues that can occur such as black liquor carry-over into the condensates due to a leak in the tubes cannot always be immediately detected but can result in an increased condensate COD and conductivity. Any substantial deterioration in condensate quality will trigger an investigation by the Pulp Mill Operations Manager into the possible causes and proposed corrective actions.

7.5.3 Odour Sampling, Analysis and LDAR Sampling

On an annual basis Visy commission external specialist consultants to undertake an odour sampling program in accordance with Australian Standard AS4323.3 and chemical speciation analysis of samples. The odour sampling program focuses on the main odour emission sources from the process, Figure 11.0. Duplicate odour samples are taken at each of these locations to determine the odour concentration in Odour Units (OU) and the concentrations of TRS and VOC. The odour sampling results are compared to previous results and correlated with operating conditions at the time of sampling. The results provide an indication of the major sources of odour, any changes to odour levels from these sources and potential impacts at local sensitive receptors.

A Leak Detection and Repair programme (LDAR) is also carried out on an annual basis by the same consultants in conjunction with the odour sampling. The programme is carried out in accordance with USEPA Method 21 and USEPA *LDAR Best Practices Guide*. The programme focuses on the entire foul gas system and foul condensate collection systems using an inventory of potential component sources of odourous gaseous/light liquid leakage. A preliminary report is prepared for Visy indicating status of the plant. If leaks are identified Visy carry out repairs and arrange retesting, before a final report is submitted.

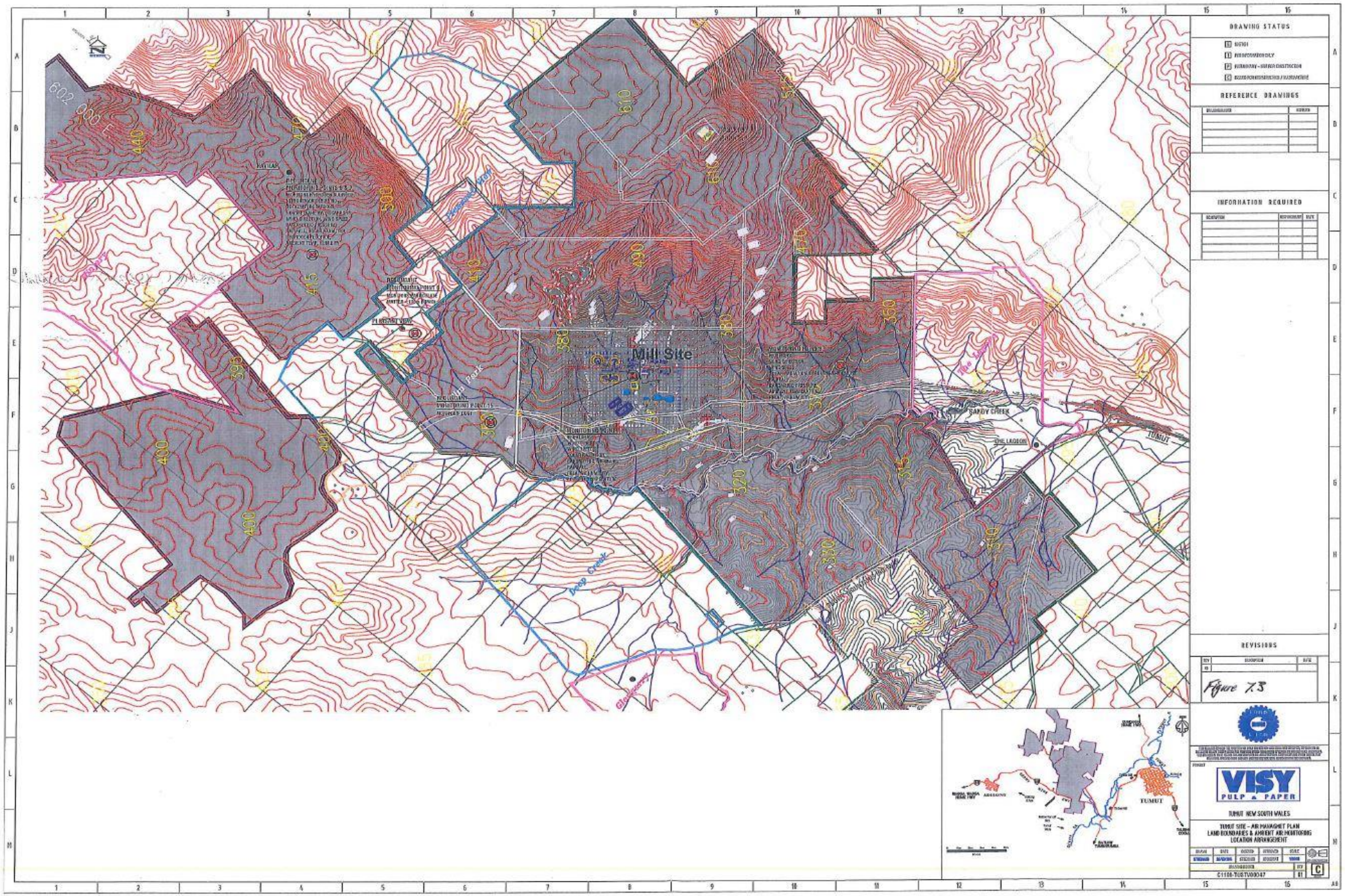

Figure 10.0 Location of Ambient Air Monitoring Stations

Table 14.0 Ambient Air Quality Monitoring Stations - Main Equipment

Equipment	Description	Features
Meteorological Equipment	Located at Point 7 to monitor meteorological parameters.	Weather Maestro made by Environdata. Monitoring stations will measure wind speed and direction, solar radiation, ambient temperatures, rainfall barometric pressure and relative humidity.
Meteorological Equipment	Located at Point 8 to monitor meteorological parameters.	Weather Maestro made by Environdata. Monitoring stations will measure wind speed and direction, solar radiation, ambient temperatures, rainfall barometric pressure and relative humidity.

The data provides Senior Operational personnel important feedback on the effectiveness of odour mitigation strategies.

Results of odour sampling will also be incorporated into Section 7.6 Odour Performance Testing for Phase 1a.

7.5.4 TRS Monitoring

TRS in each stack is continuously monitored and displayed on the DCS Operating stations in the Main Control Room. The TRS limit of 3.6 mg/Nm^3 (i.e. the EPL concentration limit at point 1 and 22) has been determined from air quality assessment undertaken in the EA(2007) and MOD(2007) to ensure that ground level concentrations at the most effected residential locations is below the NSW EPA guideline levels of 1.38 ug/m^3 for urban population (i.e. 2000 residents) and 4.38 ug/m^3 for single resident. Alarm levels have been programmed into the DCS at 80% of Licence limit to alert operators of high TRS levels. This will trigger immediate investigation into the possible causes and proposed corrective actions.

7.6 Air Quality Performance Testing for Phase 1a

Project Approval condition 3.2 requires that air quality performance testing is to be undertaken to confirm the air emission performance of the project within 90 days of commencement of Phase 1a operations or as may be agreed by the Director General, and during a period which the expanded mill is operating under design load and normal operating conditions. The performance testing shall be in accordance with PCA condition 3.2 for Phase 1a and shall include but not necessarily limited to the following:

- Point source emission sampling and analysis subject to the requirements listed under condition PA condition 3.1 and Tables K2, K4 and K7;
- Comprehensive air quality assessment using emissions data collected above and in accordance with the methods outlined in *Approved Methods and Guidance for the Modeling and Assessment of Air Pollutants in NSW* (EPA, 2017);

- Comparison of the results of the air quality impact assessment above, and the predicted air quality impacts detailed in PA condition 1.1;
- Details of any entries in the Complaints Register (PA condition 4.3 of this approval) relating to air quality impacts.

A report providing the results of the program shall be submitted to the Director-General and DECC within 28 days of completion of the performance testing. The Air Quality and Odour Performance Verification Report was submitted on 5 December 2012.

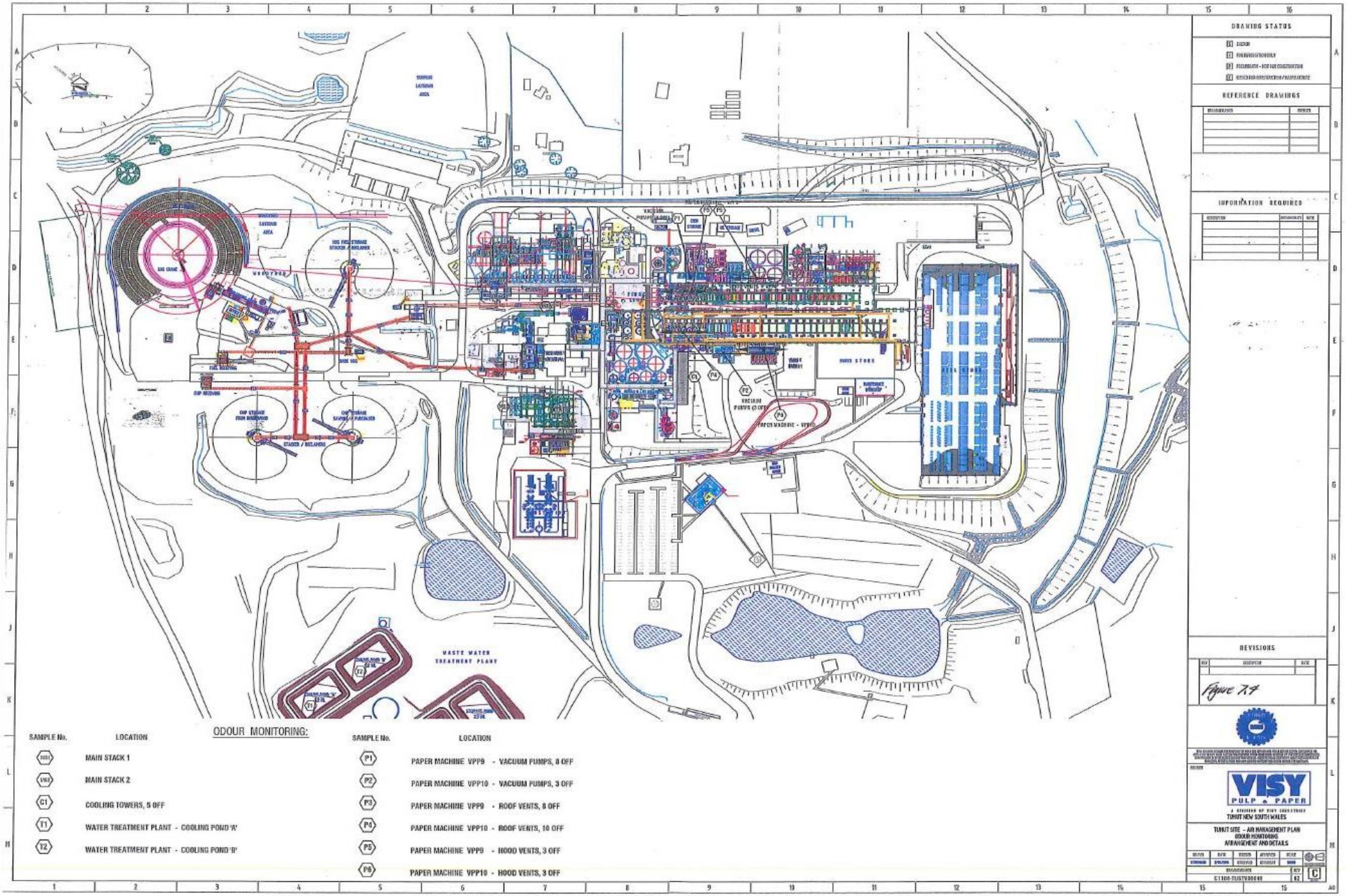

Figure 11.0 Odour Monitoring Locations

PCA condition 3.3 requires that in the event that the program undertaken to satisfy PA condition 3.2 of the approval indicates that the operation of the project, under design loads and normal operating conditions, will lead to:

- Greater point source emissions or ground-level concentrations of air pollutants than predicted in the documents listed under PA condition 1.1; or
- Greater point source emissions or ground-level concentrations of air pollutants than the impact assessment criteria detailed in *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (DECC, 2005);

Then details shall be provided of remedial measures to be implemented to reduce point source emissions or ground-level concentrations of air pollutants to no greater than that predicted in the documents listed under PA condition 1.1 of this approval and to meet the impact assessment criteria detailed in *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DECC, 2005).* Details of the remedial measures and a timetable for implementation shall be submitted to the Director-General for approval within such period as the Director-General may require, and be accompanied by evidence that the DECC is satisfied that the remedial measures are acceptable.

7.7 Odour Performance Testing for Phase 1a

Project Approval condition 3.4 requires that within 90 days of the commencement of Phase 1a of Mill Expansion, and every year thereafter, or as may be agreed by the Director-General, Visy shall commission an independent, qualified person or team to undertake odour performance monitoring. The independent person or team shall be approved by the Director-General prior to the commencement of monitoring. The monitoring program shall occur during a period in which the project is operating under design loads and normal operating conditions. The program shall include, but not necessarily be limited to:

- Point and area source emission sampling and analysis subject to the requirements listed under PA condition 3.1;
- A comprehensive odour assessment, using actual air emission data collected under a). The assessment shall be undertaken strictly in accordance with the methods outlined in *Approved Methods and Guidance for the Modeling and Assessment of Air Pollutants in New South Wales (Jan, 2017)* and *Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW* (DEC, 2006);
- A comparison of the results of the odour impact assessment required under b) above, with the predicted odour impacts detailed in the documents listed under condition 1.1 of this approval and previous odour performance assessments undertaken to satisfy this condition;
- A comparison of the results of the odour assessment required under b) above, and the impact assessment criteria detailed in *Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW* (DECC, 2006) and *Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW* (EPA, 2006); and
- Details of any entries in the Complaints Register (condition 4. of this approval) relating to odour impacts.

A report providing the results of the program shall be submitted to the Director-General and DECC within 28 days of completion of the testing required under a). The Air Quality and Odour Performance Verification Report was submitted on 5 December 2012.

PA condition 3.5 requires that In the event that the program undertaken to satisfy condition 3.4 of the approval indicates that the operation of the project, under design loads and normal operating conditions, will lead to greater odour impacts than that predicted in the documentation listed under PA condition 1.1 of this approval, then Visy shall provide details of remedial measures to be implemented to reduce odour impacts to levels required by that condition. Details of the remedial measures and a timetable for implementation shall be submitted to the Director-General for approval within such period as the Director-General may require, and be accompanied by evidence that the DECC is satisfied that the remedial measures are acceptable.

8.0 Reporting and Review

8.1 Legal Reporting Requirements

8.1.1 Complaint and Incident Reports

The Shift Supervisor or HSE Manager is informed immediately of any incidents to ensure that appropriate and immediate actions are undertaken to mitigate the issue.

All Incidents are ranked from 1 to 5 in accordance with Visy Incident Classification (refer Table 1.0 in Section 4.0 of Environmental Incident Reporting HowTo (HOWTO-VPP-TUM-HSE-041) and reported to relevant personnel and agencies in accordance with Visy Reporting Requirements (refer to section 5.0 of Environmental Incident Reporting HowTo (HOWTO-VPP-TUM-HSE-041) and with DCC15, Concept Approval 6.1 and EP licence clause R2.).

In accordance with the Visy Environmental Reporting Procedure, all incidents are reported in Noggin; Visy's electronic reporting database system that automatically notifies relevant personnel and senior management and used for incident review and tracking results of investigations and corrective actions.

8.1.2 Annual Return

An Annual Return in the approved format in accordance with Condition R1 Annual Return Documents in the EP Licence 10232 must be completed and supplied to the NSW EPA. The Annual Return comprises of monitoring and complaints summary along with all non-compliances that have occurred through-out the reporting period.

This Annual Return must include a Statement of Compliance signed by a delegated authority and submitted to the NSW EPA by registered post within 60 days of the end of the Reporting Period.

8.1.3 Annual Environmental Compliance and Monitoring Report

An Environmental Compliance and Monitoring report to satisfy Condition 12 of the Development Consent Conditions (Oct 1998) and Condition 6.3 of the Concept Approval Conditions (May 2007) must be submitted to the NSW Department of Planning, Industry and Environment (NSW DPIE). This report is to provide a summary of all environmental monitoring, the Environmental Complaints register for the preceding 12 months period and an annual review of operational environment management plans, the conditions of consent and other licenses and approvals relating to the operation of the plant as well as comparisons with the EIS (1996) and EA (2007) predictions.

This report is submitted annually to the Department of Planning and Environment and copies provided to the EPA in accordance with Condition R1.10 of the EPL, Snowy Valleys Council, Visy Community Consultative Committee (VCCC) and Office of Water.

8.1.4 National Pollution Inventory

Visy Tumut are required under the Protection of the Environment Operations (General) Regulation 2009 to report emissions of National Pollutant Inventory (NPI) substances above the NPI threshold levels to the NSW EPA in accordance with the NPI Guideline and Emissions Estimation Technique Manuals.

The National pollutant inventory covers the reporting period from 1 July to 30 June and is to be submitted to the NSW EPA by 30 September each year.

8.1.5 Odour Mitigation Measures Report for Start-Up, Shutdown and Malfunctions

An Odour Mitigation Measures Report as per Condition PAC 2.6, on all feasible and reasonable mitigation measures to reduce adverse odour impacts arising from start-up and shutdown activities, is to be prepared in consultation with the EPA. This report is to be submitted to NSW DPIE prior to the commencement of operations.

8.1.6 Revised Health Impact Assessment

A Health Risk Assessment was undertaken during the EA (2007) using predicted air emissions data for each phase of the project. A revised Health Risk Assessment as required by Project Approval condition 3.6 is to be undertaken within 12 months of the commencement of operation of each phase of the project, using Air Quality Performance Testing data referred to in Section 7.5 of this report.

The revised Human Health Impact Assessment shall be submitted to the Director-General and NSW Health within three months of emission data collection. The revised Health Risk Assessment was submitted to the Department of Planning and Infrastructure on 5 December 2012.

8.1 Legal Reporting Requirements

8.2.1 Monthly Environmental Accounts

Monthly environmental accounts are reported to Visy Corporate in accordance with procedure 205.0. The monthly environmental accounts include key performance indicators for the raw materials, water and energy consumption as listed in the Appendix of procedure 205.0. This data is collected, verified and reviewed by the Visy Environmental representative prior to submission.

9.0 Auditing

9.1 Legal Requirements and External Audits

9.1.1 Annual Audit

An Independent Environmental Audit is to be undertaken in accordance with Condition 71 of DCC (1998) and Condition 3.16 of PAC (2007). This audit covers all aspects of monitoring and environmental performance and compliance with DCC (1998), PAC (2007) and predictions in the EIS (1998) and the EA (2007).

The audit report is submitted to the Department of Planning and Environment, Snowy Valleys Council, and Visy Community Consultative Committee. In addition a copy is supplied to the NSW EPA in accordance with Condition R1.10 of the EPL No. 10232.

9.1.2 Odour

Within 12 months of the commencement and operation of the first phase of the project, Visy is required to undertake an odour audit of the plant in accordance with Condition 61b of DCC(1998), 3.15 of PCA(2007 and Condition O5.1 of the EPL).

The requirements include a leak detection and repair (LDAR) program (as outlined in the MACT Rules) for all fugitive odour/volatile organic compounds sources that are collected and ducted to each of the boilers, and the entire foul gas and foul condensate collection systems.

The Odour Audit Report shall be submitted to the satisfaction of the EPA no later than one month after the completion of the Audit. Further Odour Audits shall include the existing plant and shall be undertaken annually, or as otherwise agreed or required by the Director-General.

9.2 Internal Auditing

Internal audits are routinely undertaken in accordance with the sites Environmental Management System and as documented below.

9.2.1 Continuous Emissions Monitoring System

As described in Section 7.1 a number of electronic data extraction tools have been developed by site electronic engineers for data tracking and to allow for analysis of the data. This includes a system for automatic notification to control room operators and supervisors when an exceedance of licence concentration limit or reporting level has occurred, as well the production of a twice daily electronic report. Operators are able to view the exceedance and provide any information as to why the exceedance occurred, including instrument calibration and start-up – shut down. This information is then collated and checked on a weekly and monthly basis and used in the production of a monthly audit report on the Continuous emissions monitoring system. The monthly report is provided to the Pulp Mill Manager and General Manager for sign off before it is uploaded for publishing on the Visy website by the HSE Manager or Environmental Officer.

9.2.2 Internal Environmental Management System and Compliance Audit

An internal EMS and Compliance Audit of the site is undertaken in accordance with Visy Corporate Procedure 1102 and HSE Standard 11. The Visy Group Manager Safety and Environment co-ordinates and implements the audit program and which is conducted in accordance with Corporate EMS Audit Protocol.

9.2.3 Leak Detection and Repair – Odour

Periodic audits of all known potential odour emitting sources that includes the CNCG, DNCG and Foul Condensate systems are undertaken by Pulp Mill Operational Personnel. These odour sources are monitored periodically and upon receiving odour complaints from the community. Any issues identified during the audit are further investigated and reported in accordance with the Environmental Incident Reporting HowTo (HOWTO-VPP-TUM-HSE-041).

9.3 Environmental Management System Audit

Triennial Re-certification and annual Surveillance audits of Visy Pulp & Paper (Tumut) Integrated Management System, which incorporates the quality, environment and safety management systems, are undertaken in accordance with requirements of international standards relating to audit practice such as ISO 19011 by a certified Auditing Organisation. The purpose of the audit is to assess the sites compliance to the principles of the Management System Standards (i.e. ISO 14001, ISO 45001, ISO 9001).

References

AS/NZS ISO 14,004:2004 Environmental management systems-General guidelines on principles, systems and support techniques.

JAN 2017. Approved Methods for the Modelling and Assessment of Air Pollutants in NSW. Sydney NSW.

DEC, 2006. Technical Framework: Assessment and management of odour from stationary sources in NSW. Sydney NSW.

DEC 2007, Approved Methods for the Sampling and Analysis of Air Pollutants in NSW. Sydney NSW.

NSW Government, 2010. *Protection of Environment Operations Act* (Clean Air) Regulation 2010. Government Printer, Sydney.

NSW Government 2009. Protection of the Environment Operations (General) Regulation 2009. Government Printer, Sydney.

Appendix A – Control Measures for Recovery Boiler Emissions

Objective	Control Measures	
Control SO_2, TRS Emissions	Monitor Process Conditions	• Monitor SO_2, TRS levels in Main Stack • Monitor O_2 and CO levels • Monitor furnace and flue gas temperatures
	Process control optimisation	• Process automation and control • Routine maintenance and calibration of Instrumentation for online monitoring and process control
	Maintain furnace Temperatures	• Operate Recovery Boiler at high loads • Optimise combustion air ratios • Routine inspections of black liquor burner system • Use of gas auxiliary burners during black liquor disturbances
	Maintain high dry solids of heavy Black Liquor	• Optimise operation of Evaporation Plant • Routine Monitoring of black liquor solids
	Char bed temperature control	• Visual inspection on in-bed cameras to ensure proper char bed formation
	Maintain Sulphidity of Heavy Black Liquor within specification	• Monitor sulphidity of liquor • Increase salt cake or Caustic make-up to control sulphidity • Increase black liquor solids
	Staged combustion (primary, secondary and tertiary air)	• Optimise combustion air ratios • Maintain high turbulence for good mixing
	Training and awareness	• Training on Operation and Maintenance manuals • Training on Standard Operating Procedures • Training on Environmental Aspects of the process • Operator Competency Assessments
	Complaints Handling	• Correlation of complaints to process conditions • Investigation and reporting of issues

Control NOx Emissions	Monitoring Process Conditions	• Monitor NOx levels in Recovery Boiler Duct 1 and Main Stack • Monitor O_2 • Monitor furnace and flue gas temperatures
	Process control optimisation	• Process automation and control • Routine maintenance and calibration of Instrumentation for online monitoring and process control
	Maintain Furnace Temperatures	• Optimise combustion air ratios • Check black liquor solids content • Routine inspections of black liquor burner system • Use of gas auxiliary burners during black liquor disturbances
	Maintain high dry solids of heavy Black Liquor	• Optimise operation of Evaporation Plant • Monitor black liquor solids
	Staged combustion (primary, secondary and tertiary air)	• Optimise combustion air ratios • Maintain high reduction efficiencies • Maintain high turbulence for good mixing
Control CO Emissions	Monitoring Process Conditions	• Monitor CO, O2 levels in furnace • Monitor furnace Temperatures
	Process control optimisation	• Process automation and control • Routine maintenance and calibration of Instrumentation for online monitoring and process control
	Maintain Furnace Temperatures	• Optimise combustion air ratios • Check black liquor solids content • Routine inspections of black liquor burner system • Use of gas auxiliary burners during black liquor disturbances
	Maintain high dry solids of heavy Black Liquor	• Optimise operation of Evaporation Plant • Monitor black liquor solids

	Staged combustion (primary, secondary and tertiary air)	• Optimise combustion air ratios • Maintain high turbulence for good mixing
Control TSP Emissions	Monitoring Process Conditions	• Monitor Opacity • Monitor furnace and flue gas Temperatures • Monitor pressures/temperatures through economiser and boiler banks
	Process control optimisation	• Process automation and control • Routine maintenance and calibration of Instrumentation for online monitoring and process control
	Maintain Furnace Temperatures	• Optimise combustion air ratios • Check black liquor solids content • Routine inspections of black liquor burner system • Use of gas auxiliary burners during black liquor disturbances
	Maintain high dry solids of heavy Black Liquor	• Optimise operation of Evaporation Plant • Monitor black liquor solids
	Staged combustion (primary, secondary and tertiary air)	• Optimise combustion air ratios • Maintain high turbulence for good mixing
	Soot-blower operation	• Optimise soot blowing sequence • Monitor blowing pressure • Routine inspection
	Electrostatic Precipitator Operation	• Maintain uniform flue gas distribution • Monitor precipitator current and voltage in each field • Optimise and maintain rapping system • Routine inspections and cleaning during scheduled plant shutdowns

Appendix B – Control Measures for Power Boiler Emissions

Objective	Control Measures	
Control SO_2, TRS Emissions	Monitor Process Conditions	• Monitor SO_2 levels in Main Stack • Monitor O_2 and CO levels • Monitor furnace and flue gas temperatures
	CNCG System	• Monitor temperatures and pressures in CNCG System • Routine inspection and maintenance of NCG burners system
	Staged combustion (primary, secondary air)	• Optimise combustion air ratios • Maintain high turbulence for good mixing
	Training and awareness	• Training on Operation and Maintenance manuals • Training on Standard Operating Procedures • Training on Environmental Aspects of the process • Operator Competency Assessments
	Complaints Handling	• Correlation of complaints to process conditions • Investigation and reporting of issues
Control NOx , CO, HCl Emissions	Monitoring Process Conditions	• Monitor NOx levels in Power Boiler Duct 1 and Main Stack • Monitor O_2 • Monitor furnace and flue gas temperatures
	Process control optimisation	• Process automation and control • Routine maintenance and calibration of Instrumentation for online monitoring and process control
	Optimise combustion control	• Optimise combustion air ratios (ensure sufficient excess air at secondary air level) • Flue gas recirculation to reduce furnace temperatures • Routine inspection of solid fuel quality and feed system • Utilise gas auxiliary burners during low bed temperatures

	Optimise combustion control	• Optimise combustion air ratios (ensure sufficient excess air at secondary air level) • Flue gas recirculation to reduce furnace temperatures • Routine inspection of solid fuel quality and feed system • Utilise gas auxiliary burners during low bed temperatures
	Maintain high turbulence in furnace	• Monitor fluidised bed pressures • Removal and screening of fluidising sand to remove coarse fragments • Fluidised bed sand make-up
	Complaints Handling	• Correlation of complaints to process conditions • Investigation and reporting of issues.
Control TSP Emissions	Monitoring Process Conditions	• Monitor Opacity • Monitor furnace and flue gas Temperatures • Monitor pressures/temperatures through economiser and boiler banks
	Process control optimisation	• Process automation and control • Routine maintenance and calibration of Instrumentation for online monitoring and process control
	Soot-blower operation	• Optimise soot blowing sequence • Monitor blowing pressure • Routine inspection
	Electrostatic Precipitator Operation	• Maintain uniform flue gas distribution • Monitor precipitator current and voltage in each field • Optimise and maintain rapping system • Routine inspections and cleaning during scheduled plant shutdowns
		• Routine inspections of ash removal/handling system
	Complaints Handling	• Correlation of complaints to process conditions • Investigation and reporting of issues

Appendix C – Control Measures for Lime Kiln Emissions

Objective	Control Measures	
Control SO_2, TRS Emissions	Monitor Process Conditions	• Monitor SO_2 levels in Main Stack • Monitor O_2 and CO levels • Monitor kiln and flue gas temperatures
	Lime mud washing	• Maintain optimum lime mud washing • Monitor alkalinity of Lime Mud • Minimise formation of rings and balls inside of kiln
	Optimise combustion control	• Optimize combustion air ratios • Maintain sufficient excess oxygen and low CO • Maintain high Lime Mud Solids
	Training and awareness	• Training on Operation and Maintenance manuals • Training on Standard Operating Procedures • Training on Environmental Aspects of the process • Operator Competency Assessments
	Complaints Handling	• Correlation of complaints to process conditions • Investigation and reporting of issues
Control NOx , CO Emissions	Monitoring Process Conditions	• Monitor NOx, CO levels in Lime Kiln Duct • Monitor O_2 and CO levels • Monitor kiln and flue gas temperatures
	Process control optimisation	• Process automation and control • Routine maintenance and calibration of Instrumentation for online monitoring and process control
	Optimise combustion control	• Optimise combustion air ratios (ensure sufficient excess air) • Maintain good flame shape to minimise hot spots • Inspect and maintain refractory lining

Control TSP Emissions	Monitoring Process Conditions	• Monitor Opacity • Monitor kiln and flue gas Temperatures
	Process control optimisation	• Process automation and control • Routine maintenance and calibration of Instrumentation for online monitoring and process control
	Electrostatic Precipitator Operation	• Maintain uniform flue gas distribution • Monitor precipitator current and voltage in each field • Optimise and maintain rapping system • Routine inspections and cleaning during scheduled plant shutdowns
		• Routine inspections of cyclone and screw feeder systems
	Complaints Handling	• Correlation of complaints to process conditions • Investigation and reporting of issues

Appendix D – Control Measures for CNCG and SOG

Objective	Control Measures	
Prevent CNCG emissions to atmosphere	Monitor Process Conditions	• Monitor CNCG and Steam pressures • Monitor CNCG gas Temperatures • Monitor droplet separators
	Maintaining CNCG concentration outside of explosion range	• Minimising flanged joints • Monitoring flanged joints and valves for leakage • Small continuous water flow to maintain seal on water droplet separators • Steam ejectors • All steam lines and CNCG lines after the ejector to be insulated to prevent condensation • Pressure/vacuum breakers
	Prevention of excessive pressures	• Water droplet separators • Pressure control • Safety valves
	Explosion prevention	• Flame arrestor • Collection tanks • Rupture discs • Using steam ejectors to minimise ignition source • Velocity of gas greater than flame propagation velocity • Isolation valves
	Condensate collection	• Water droplet separator to remove condensation or water droplets • Condensate pump tank to collect condensate and re-direct to Foul Condensate Tank
	Incineration	• Recovery Boiler Furnace • Divert to Power boiler as the primary back-up • Divert to flare as the secondary back-up system

Prevent CNCG emissions to atmosphere (cont.)	Training and awareness	• Training on Operation and Maintenance manuals • Training on Standard Operating Procedures • Training on Environmental Aspects of the process • Operator Competency Assessments
	Complaints Handling	• Correlation of complaints to process conditions • Investigation and reporting of issues
Prevent SOG emissions to atmosphere	Monitor Process Conditions	• Monitor SOG and Steam pressures • Monitor SOG gas Temperatures • Monitor droplet separators
	Maintaining SOG concentration outside of explosion range	• Minimising flanged joints • Monitoring flanged joints and valves for leakage • Small continuous water flow to maintain seal on water droplet separators • Steam ejectors • All steam lines and SOG lines after the ejector are insulated to prevent condensation • Pressure/vacuum breakers
	Prevention of excessive pressures	• Water droplet separators • Pressure control • Safety valves
	Explosion prevention	• Flame arrestor • Rupture discs • Using steam ejectors to minimise ignition source • Velocity of gas greater than flame propagation velocity • Isolation valves
	Methanol Condenser System	• Buffer storage of Liquid methanol • Hazardous Zoning of plant and equipment

Prevent SOG emissions to atmosphere (cont.)	Incineration	• Recovery Boiler B • Divert to Recovery Boiler A as the secondary back-up system • Automation of Methanol Burner control logic
	Shut-down of Stripping Column	• Automatic closure of Isolation valve on SOG gases • Shut-down of Stripping Column
	Training and awareness	• Training on Operation and Maintenance manuals • Training on Standard Operating Procedures • Training on Environmental Aspects of the process • Operator Competency Assessments
	Complaints Handling	• Correlation of complaints to process conditions • Investigation and reporting of issues

Appendix E – Control Measures for Dilute Non Condensable Gases (DCNCG)

Objective	Control Measures	
Prevent odorous DNCG emissions to atmosphere	Monitor Process Conditions	• Monitor DNCG gas pressure • Monitor DNCG gas Temperatures • Monitor DNCG fan • Monitor pressure differential across Scrubber Filter
	Maintaining DNCG concentration below explosion range	• Vents installed on all tanks to ensure sufficient dilution • Isolation valves on all tank vents and variable speed drive on fan to allow gas flow control • Isolation valve on system
	Two stage Cooling scrubber	• First stage removal of fibre and dry solids • Second stage to cool gas for removal of turpentine and water • Collection of condensate and transfer to Foul Condensate System • Scrubbing of gas with high alkali washing liquid to remove TRS compounds • pH control of washing liquid • Routine filter washing to minimise blockages
	Incineration	• Recovery Boiler Furnace • Divert to Power boiler as the primary back-up • Divert to flare as the secondary back-up system
	Venting	• Maintain high scrubbing efficiency • pH control of washing liquid

Appendix F – Control Measures for Clean Condensate Quality

Objective	Control Measures	
Maintain COD levels on Clean Condensate	Process control optimisation	Installation of instrumentation for online monitoring and process control Functional descriptions supplied by equipment supplier programmed into the DCS
	Routine monitoring of COD concentrations of various condensate sources	Checked against design balance of plant Diagnosing fouling of evaporative surfaces Diagnosing black liquor carry-over
	Correlation of odour monitoring with process conditions	Compare odour intensity from main odour sources with COD levels in clean condensate Check against initial assumptions in EA
	Maintain evaporation efficiencies	Monitor temperatures, pressures for any drop off in heat transfer rates Monitor weak, medium and heavy black liquor solids Routine washing of evaporators to remove build-up on evaporative surfaces Undertake visual inspections and high pressure washing during plant shutdowns
	Training and awareness	Training on Operation and Maintenance manuals Standard Operating Procedures Training on Environmental Aspects of the process
	Complaints Handling and Investigation	Correlation of odour complaints to COD levels and meteorological conditions Undertake inspections of process areas Complete odour checklist and report any issues

Appendix G – Partial Shutdown Control Measures

Scenario	Potential Emission	Control Measures
Reduced Black Liquor Firing in Recovery Boiler	Cold bed resulting in high SO_2 and TRS emissions.	• Maintain gas burners in furnace
Black Liquor firing in Recovery Boiler A reduced to below 50% MCR	CNCG gases diverted from Recovery Boiler resulting in odour emissions.	• CNCG diverted to Power Boiler as primary back-up • CNCG diverted to flare as secondary back-up
	Methanol diverted from Recovery Boiler A resulting in odour emissions.	• Methanol diverted to Recovery Boiler B • Methanol maintained in storage vessel
Black Liquor firing in Recovery Boiler B reduced to below 50% MCR	Methanol diverted from Recovery Boiler B resulting in odour emissions.	• Methanol diverted to Recovery Boiler B • Methanol maintained in storage vessel
Evaporator shutdown	As Evaporators cool down, less CNCG gases are generated reducing the gas pressures which can result in gases being diverted from Recovery Boiler.	• CNCG diverted to Power Boiler as primary back-up • CNCG diverted to flare as secondary back-up, temperature in flare increased to 850^{0}C • If gas pressure less than 0.5kPa, CNCG diverted to vent stack located above Recovery Boiler • Reduced CNCG concentration
Stripper/Methanol column shutdown	During shutting down of steam stripper, condensate and vapour flow to stripper is gradually decreased, reducing the temperature and amount of TRS going to the stripper. This will result in lower stripper gas generation and hence pressure.	• Stripper Column is washed with clean condensate and water over 24 hour period. Water and condensate along with gases/vapour are diverted across to methanol column and used for simultaneous washing of methanol column. The condensate is pumped across to trim condenser and then foul condensate tank. This is continued until all condensate and methanol residue is removed from both stripper and methanol column • If stripper gases cannot be directed to Methanol plant, they can be diverted to the Flare, temperature in flare is increased to 850^{0}C

		• NCG ejector
Methanol plant shutdown	During shutting down of methanol plant, stripper gases can no longer be diverted to Methanol Column, resulting in possible emissions of SOG.	• Stripper column must be shutdown prior to shutdown of Methanol Plant • Automatic closure of Isolation valve on stripper column to contain SOG
Opening up of Evaporator or Methanol Vessel	If any evaporator or methanol vessel is required to be opened up for inspection or carry out maintenance work, potential short term odour can result while purging of residue foul condensate, TRS gases or methanol from the system.	• Prior to purging with air, pipes and vessels are initially flushed with condensate and then water to remove as much of the residue as possible
Start-up of Lime Kiln	Air purge of electrostatic precipitator while electrical fields are turned off to displace any potentially explosive gases. This can result in excessive lime dust emissions from the main stack.	• Extended continuous rapping and discharge of excess lime dust from ESP during shutting down of Lime Kiln
Evaporator start-up	Purging air through evaporators during start-up causes pressure swings in CNCG system resulting in NCNG being diverted to flare and on occasions to the vent stack.	• While CNCG are burnt in the flare, temperature of flare is maintained at maximum of 850 ^{O}C • During start-up as a result of low temperatures, TRS concentration of CNCG is low • Operators manually divert CNCG over to Power Boiler or Recovery Boiler as soon as process conditions allow
Steam stripper start-up	During Steam Stripper start-up Methanol Plant is not ready to receive SOG hence SOG can be diverted to flare until Methanol Plant is operating.	• Temperature of flare is increased to 850 ^{O}C to maximise destruction efficiency • If SOG are diverted to atmosphere, Stripper shut-off valve is automatically isolated

		• Manually divert Stripper Gases to Methanol System once ready to receive SOG
VCE start-up	During start-up of VCE,, the CNCG bypass valve is open until the desired VCE density has been reached resulting in potential short-term odours.	• Communication with community of potential for odour • Low temperature and pressure in system while starting up will minimise odour impact • Divert to flare of CNCG burner in boilers as soon as conditions will allow

Appendix H – Annual Shutdown Control Measures

Scenario	Potential Emission	Control
Recovery Boiler A Shutdown and Start-up	Burning out char bed resulting in elevated SO_2 and TRS emissions. During start-up as char bed is being reinstated there is more SO_2 and TRS emissions. The Dilute Non Condensable Vent gases diverted to atmosphere as the smelt bed is cooled off.	• Gradually reduce black liquor firing during shutdown • Use gas burners to raise bed temperatures • Char bed formation • Ensure efficient operation of Vent gas scrubber by utilising high alkaline weak wash
Recovery Boiler B Shutdown and Start-up	Burning out char bed resulting in elevated SO2 and TRS emissions. During start-up as char bed is being reinstated there is more SO2 and TRS emissions.	• Gradually reduce black liquor firing during shutdown • Use gas burners to raise bed temperatures • Char bed formation • Ensure efficient operation of Vent gas scrubber by utilising high alkaline weak wash
	Methanol diverted from Recovery Boiler B resulting in odour emissions.	• Methanol diverted to Recovery Boiler A • Methanol maintained in storage vessel
Opening of Heavy Black Liquor tank	Open heavy black liquor tank to undertake regulatory inspections and cleaning. Residual heavy black liquor can result in odour emissions once opened to atmosphere.	• Vessel is depressurised while connected to DNCG system. After draining of tank, contents flushed with clean condensate to remove heavy black liquor residual
Stripper column shutdown	During shutting down of steam stripper, flow to stripper is gradually decreased, reducing the temperature and amount of TRS going to the stripper. This will result in lower stripper gas generation and hence pressure. Stripper gases diverted to flare and then vent stack, causing potential odour emissions.	• Vapour from 1st effect is replaced with steam • Condensate and steam is reduced gradually • Steam purge is continued for 15 minutes after foul condensate is off • If stripper gases cannot be directed to Methanol plant, they can be diverted to the Flare, temperature in flare is increased to 850^0C

Opening of Stripper Column	Opening of stripper column for inspection and cleaning. Residual foul condensate/TRS can result in odour emissions.	• Follow controls for stripper column shutdown above to minimise residual gases/vapours • Vent remaining vapours contained in vessel to atmosphere with fan
Opening up of Evaporator or Methanol Vessel	If any evaporator or methanol vessel is required to be opened up for inspection or carry out maintenance work, potential short term odour can result while purging of residue foul condensate, TRS gases or methanol from the system.	• Prior to purging with air, pipes and vessels are initially flushed with condensate and then water to remove as much of the residue as possible
Opening of Foul Condensate tank	When opening of foul condensate tank for inspection and cleaning, residue foul condensate inside tank will result in odour emissions.	• Drain tank of all foul condensate • Flush with clean condensate and purge with steam for 12 hours to remove all residue
Evaporator Start-up	During evaporator start-up, a large amount of air is purged through the evaporators and diverted to the Recovery Boiler or Power boiler. During this period CNCG can divert to the flare due to low and fluctuating NCG line pressures until equilibrium conditions are reached. As Evaporators are starting from cold conditions, low TRS levels in the CNCG can result in low odour emission.	• While CNCG are burnt in the flare, temperature of flare is maintained at maximum of 850 ^{O}C • During start-up as a result of low temperatures, TRS concentration of CNCG is low • Operators manually divert CNCG over to Power Boiler or Recovery Boiler as soon as process conditions allow
Power Boiler Start-up	Replacing sand in bed-filling with new sand after annual shut releases fines material from sand which is evacuated by ID fan to stack prior to start up of Electrostatic Precipitators. Results in high dust emissions from Main stack.	• The fine sand particles emitted from the stack have no ash content as sand bed has been replaced
Recovery Boiler Start-up	During start-up due to low temperatures, cannot operate high tension due to safety interlocks. This results in high dust emissions from stack.	• Gradually increase temperatures in Electrostatic Precipitators by initially burning natural gas in Recovery Boiler prior to burning black liquor

Start-up of Lime Kiln	Air purge of electrostatic precipitator while electrical fields are turned off to displace any potentially explosive gases. This can result in excessive lime dust emissions from the main stack.	• Extended continuous rapping and discharge of excess lime dust from ESP during shutting down of Lime Kiln

Appendix I - Malfunctions

Scenario	Potential Emission	Control/Contingency Measure
Loss of process control system i.e. transmitter failure	Loss of process control system can cause major steam pressure fluctuation causing SOG and CNCG to be diverted to flare and/or vent resulting in potential severe odour emissions.	• Routine inspection and maintenance of all critical instrumentation • Steam stripper and outlet valve automatically shuts down if SOG diverts to vent stack • Evaporation plant is automatically shutdown to minimise emissions when CNCG are diverted to vent stack • Vent Stack outlet valve automatically shuts when CNCG gases are diverted to vent stack to minimise odour release • Alarms alerting operators of SOG/CNCG diversion to Flare and vent stack • Operators manually divert CNCG back to Power or Recovery Boiler as soon as conditions allow
Loss of mill compressed air system resulting in loss of process control	Loss of compressed air can result in SOG and CNCG to be diverted to vent stack resulting in potential severe odour emissions.	• Air Compressor system includes standby air compressor and air receivers. Routine servicing and maintenance carried out. Critical operating parameters are continuously monitored on DCS in Control Room. Alarm set-points are programmed into DCS to alert operators of any potential issues • Steam stripper and outlet valve automatically shuts down if SOG diverts to vent stack • Evaporation plant is automatically shutdown to minimise emissions when CNCG are diverted to vent stack • Control valve on vent stack automatically closes on loss in compressed air

CNCG burner trip in Recovery Boiler due to high pressure or temperature	CNCG burner trip will cause CNCG to be diverted to Power Boiler or Flare resulting in potential low odour emissions.	• CNCG pressure and temperature monitored continuously • Alarm set-points are programmed onto DCS to alert operators of potential issues • CNCG burner is routinely serviced and maintained
Loss of external power from grid	Loss of power from grid can result CNCG and Stripper Gases to be diverted to vent stack resulting in potential severe odour emissions.	• Power distribution automatically diverts to island mode to ensure generated power can maintain critical plant • Steam stripper and outlet valve automatically shuts down if SOG diverts to vent stack • Evaporation plant is automatically shutdown to minimise emissions when CNCG are diverted to vent stack • Control valve on vent stack automatically closes
Poor black liquor combustion conditions due to blockages to combustion air ports or liquors gun and uneven char bed	Can result in high emissions of TRS, SO2 and HCl from stack.	• Continuous monitoring of liquor temperature and pressure, steam flow and O2 levels • In-bed cameras to allow visual display of char bed • Improve black liquor combustion and temperature control • Routine and preventative maintenance on black liquor nozzles and air ports • Manage primary, secondary and tertiary air flows to provide appropriate oxidising/reducing conditions • Rod combustion air ports, increase primary air pressure
Failure of DNCG (HVLC) fan on Recovery Boiler B results in loss of vacuum in the DNCG collection system. For example, drive motor failure, bearing failure.	Due to loss of vacuum in system, sources of DNCG for example storage vessels, will vent to atmosphere resulting in potential low odour emissions.	• Routine and preventative maintenance on HVLC fan • Operators manually divert DNCG to Recovery Boiler A, minimising duration that gases are vented
DNCG Vent gases vented to atmosphere due to low pressure	DNCG vent gases when vented to atmosphere can result in low level odour emissions.	• Periodical cleaning of heat exchanger to prevent fouling • Increase pH of scrubbing liquid to maximise TRS absorption

Failure of one or more fields in one of the Electrostatic Precipitators on the Recovery Boiler	Failure of one or more fields in the ESP will affect the performance and result in high dust emissions from the stack outlet.	• Continuous monitoring of Opacity and ESP voltages and currents • Periodic and preventative maintenance on the ESP system • Firing in Recovery Boiler is reduced to 70% of MCR or until Opacity levels in Stack are below EP Licence Limit
Complete shutdown of both Electrostatic Precipitators on the Recovery Boiler due to ash transfer conveyor failure	Shutdown of both ESP will result in high dust emissions from stack outlet.	• Black liquor firing in Recovery Boiler is stopped, and gas burners put in to maintain furnace temperatures to control other emissions • Periodic and routine maintenance of ash conveyor system
Complete emergency shutdown of Electrostatic Precipitator on Power Boiler or Lime Kiln due to high CO levels or ID fan trip	Shutdown of ESP can result in high dust emissions from stack outlet.	• Periodic and preventative maintenance on the ESP system • Continuous monitoring of CO and O_2 levels in flue gases to provide early warning • Stop solid fuel firing in Power Boiler and lime mud addition in Lime Kiln
Complete emergency shutdown of Recovery Boiler to avoid smelt water reaction (i.e. boiler explosion)	Emergency shutdown of Recovery Boiler can result in elevated odour and air emissions.	• Periodic and preventative maintenance of Recovery Boiler internals • Continuous monitoring of steam pressures and temperatures • Routine monitoring of boiler water and condensate quality • All liquor and auxiliary fuels (i.e. Methanol, CNCG and DNCG) will be diverted from Recovery Boiler reducing fuel load • Continuous air purge to cool down furnace

Appendix J – Energy Efficiency Measures

Energy Efficiency Measures	Control Measure	Benefit
Minimise excess oxygen in combustion zone of Power and Recovery Boilers	Monitor excess oxygen. Implement control strategy to maintain combustion air to fuel ratio.	• Maximises energy efficiencies by reducing amount of heat energy used in heating combustion air
Maintain high evaporation rates in Evaporation area	Routine washes of plate and tube surfaces to remove scale and deposits. Monitor differential pressures, liquor and vapour temperatures. High pressure washing of plates and tubes during routine shutdowns.	• Maximises heat transfer across tube surfaces reducing steam demand to evaporation area
Keeping Hood doors closed on Paper Machine drying section	Keeping hood door closed reduces amount of air required to vent the required amount of moisture from inside the hood.	• 10 -15% energy savings achieved by keeping hood doors closed
Group starts on large motors during start-up	Group starts to avoid power overloads while starting up process after a shutdown.	• Reduces energy consumption through more efficient start-up
Optimise sootblowing in Recovery Boiler	Differential pressure and flue gas temperatures monitored in economiser, super-heater and boiler bank sections of the Recovery Boiler. Soot blowing sequence selected based on adverse changes in differential pressure and flue gas temperatures.	• Reduce excessive steam usage for soot blowing while maintaining target differential pressures in boiler bank and economiser areas of Recovery Boiler
Maximise percentage solids of lime mud feed to the Lime Kilns	Through better control of washing, the lime mud solids content can be maximised.	• Improves energy efficiency by having less water to evaporate and maintain higher temperatures in the lime kiln

Minimise steam and compressed air leaks	Routine maintenance inspections of steam and compressed air system.	• Improve energy efficiency by reducing losses in system due to leaks
Maintain steam traps	Routine maintenance of steam traps.	• Improve energy efficiency by reducing losses in system
Minimise hosing down with fresh water within process areas	Recycled water hose stations located in various process areas (i.e. Paper Machine, Fibre Line, etc).	• Reducing amount of fresh water that will need to be evaporated reduces steam/energy consumption in the evaporation area
Monitoring and reporting of Energy KPI to Senior and Divisional Management	Specific Energy consumption reviewed by senior management at regular intervals.	• Maintains key focus on energy usage
Maintain high availability on steam turbine system	Routine maintenance and servicing of Steam Turbine system to ensure high availability.	• Maximises power generation and utilisation of steam energy and reduces external power demand
Maintain high primary and secondary air temperature in Recovery Boiler	Primary and secondary air heater used to maintain high combustion air temperatures to the Recovery Boiler.	• Improves char bed formation and high efficiencies in Recovery Boiler • Reduced energy consumption to heat combustion air in the furnace
Maintain optimum black liquor spray temperature and droplet size	Black liquor spray temperature, reduction efficiencies and spray patterns are monitored.	• Low black liquor spray temperatures results in more moisture entering bed and lower smelt bed temperature, reducing reduction efficiencies and thus the energy efficiency of the system • Too large a droplet result in too large a char bed reducing reduction efficiencies and thus energy efficiency • Too small a droplet will vapourise before reaching char bed resulting in smaller char bed and reduced energy efficiencies • Too high black liquor spray temperatures increase black liquor carry-over into flue gases, reducing the size and formation of smelt bed thus reducing energy efficiency of system

Maintain optimum feed liquor temperature to VCE	Monitor feed liquor temperature.	• 91% of heat energy if from feed liquor. Low feed liquor temperature will increase steam consumption and hence reduce energy efficiency of system
Run minimum number of cooling tower fans	Run minimum number of cooling tower fans to meet mill cooling requirement.	• Reduced electricity consumption
Run mill on one air compressor	Provide higher efficiency air dryers, monitor usage, reduce system air pressure where possible, repair leaks and maintain system to allow the mill air requirements to be supplied by single compressor.	• Reduced electricity consumption
Provide wet air system	Use wet (un-dried) air for process where possible. Reduces air wastage through unnecessary drying.	• Reduced air and consequent reduced electricity consumption
Maximise percentage solids of Heavy Black liquor fired in recovery boiler	Through optimising evaporator operation maximise solids of heavy black liquor.	• Improves energy efficiency by having less water to evaporate in the recovery boiler • Increases water recovered as condensate • Improves Recovery Boiler operation and emissions controls

Appendix K – Air Quality Monitoring

Table K1 – Stack 1 (EPL Point 1)

Pollutants	Units of Measure	Frequency	Sampling Method	Equipment	Measurement Range
Chlorine	mg/m^3	Yearly	TM-7 & TM-8	Isokinetic sampling	-
Flow	Nm^3/s	Continuous	CEM-6	Durag D-FL 200	
Hydrogen Chloride	mg/m^3	Continuous	Continuous	Procal P2000	0-500ppm
Moisture	%	Continuous	TM-22	Procal P2000	0-50%
Nitrogen Oxides	mg/m^3	Continuous	CEM-2	Procal P2000	0-400ppm
Opacity	%	Continuous	CEM-1	Durag D-R 290	0-100%
Oxygen	%	Continuous	CEM-3	Novatech 1632/1231	0-21%
Sulfuric Acid Mist and Sulfur Trioxide	mg/m^3	Yearly	TM-3	Isokinetic sampling	-
Sulphur Dioxide	mg/m^3	Continuous	CEM-2	Procal P2000	0-350ppm
TCDD Equivalent	ng/m^3	Yearly	TM-18	Isokinetic sampling	-
TRS (as H2S)	mg/m^3	Continuous	CEM-5	Ecotech ML 9850B	0-20 ppm
Temperature	deg C	Continuous	TM-2	ABB Absolute Temperature	0-400deg C
Total Solid Particles	mg/m^3	Quarterly	TM-15	Isokinetic sampling	-
Type 1 and Type 2 substances in aggregate	mg/m^3	Yearly	TM-12, TM-13, & TM-14	Isokinetic sampling	-

Table K2 – Stack 2 (EPL Point 22)

Pollutants	Units of Measure	Frequency	Sampling Method	Equipment	Measurement Range
Chlorine	mg/m^3	Yearly	TM-7 & TM-8	Isokinetic sampling	-
Flow	Nm^3/s	Continuous	CEM-6	Durag D-FL 200	0-100Nm3/s
Hydrogen Chloride	mg/m^3	Continuous	Continuous	Thermo 15i	0-60mg/Nm3
Moisture	%	Continuous	TM-22	MAC instruments Model 155	0-50%
Nitrogen Oxides	mg/m^3	Continuous	CEM-2	Thermo 42i	0-500 mg/Nm3
Opacity	%	Continuous	CEM-1	Durag D-R 290	0-100%
Oxygen	%	Continuous	CEM-3	Novatech 1632/1231	0-21%
Sulfuric Acid Mist and Sulfur Trioxide	mg/m^3	Yearly	TM-3	Isokinetic sampling	-
Sulphur Dioxide	mg/m^3	Continuous	CEM-2	Thermo 43i	0-350mg/Nm3
TCDD Equivalent	ng/m^3	Yearly	TM-18	Isokinetic sampling	-
TRS (as H2S)	mg/m^3	Continuous	CEM-5	Thermo 450i	0-5 mg/Nm3
Temperature	deg C	Continuous	TM-2	ABB Absolute Temperature	0-400deg C
Total Solid Particles	mg/m^3	Quarterly	TM-15	Isokinetic sampling	-
Type 1 and Type 2 substances in aggregate	mg/m^3	Yearly	TM-12, TM-13, & TM-14	Isokinetic sampling	-

Table K3 – Recovery Boiler A – Duct (EPL Point 2)

Pollutants	Units of Measure	Frequency	Sampling Method	Equipment	Measurement Range
Carbon Monoxide	mg/m^3	Continuous	CEM-4	Procal P2000	0-2000ppm
Flow	Nm^3/s	Continuous	CEM-6	Durag D-FL 200	-
Moisture	%	Continuous	TM-22	Procal P2000	0-50%
Nitrogen Oxides	mg/m^3	Continuous	CEM-2	Procal P2000	0-400ppm
Opacity	%	Continuous	CEM-1	Durag D-R 290	0-100%
Oxygen	%	Continuous	CEM-3	Novatech 1632/1231	0-21%
Temperature	deg C	Continuous	TM-2	ABB Absolute Temperature	0-400deg C
Total Solid Particles	mg/m^3	Yearly	TM-15	Isokinetic sampling	-
Volatile organic compounds	mg/m^3	Continuous	CEM-8	Procal P2000	0-350ppm

Table K4 – Power Boiler – Duct (EPL Point 3)

Pollutants	Units of Measure	Frequency	Sampling Method	Equipment	Measurement Range
Cadmium	mg/m^3	Special Freq. 2	TM-12, TM-13, & TM-14	Isokinetic sampling	-
Carbon Monoxide	mg/m^3	Continuous	CEM-4	Procal P2000	0-2000ppm
Flow	Nm^3/s	Continuous	CEM-6	Durag D-FL 200	-
Mercury	mg/m^3	Special Freq. 2	TM-12, TM-13, & TM-14	Isokinetic sampling	-
Moisture	%	Continuous	TM-22	Procal P2000	0-50%
Nitrogen Oxides	mg/m^3	Continuous	CEM-2	Procal P2000	0-400ppm
Opacity	%	Continuous	CEM-1	Durag D-R 290	0-100%
Oxygen	%	Continuous	CEM-3	Novatech 1632/1231	0-21%
TCDD (Equivalent)	ng/m^3	Special Freq. 2	TM-18	IsokInetic sampling	-
Temperature	deg C	Continuous	TM-2	ABB Absolute Temperature	0-400deg C
Total Solid Particles	mg/m^3	Yearly	TM-15	Isokinetic sampling	-
Type 1 and Type 2 substances in aggregate	mg/m^3	Special Freq. 2	TM-12, TM-13, & TM-14	Isokinetic sampling	-

Table K5 – Lime Kiln A – Duct (EPL Point 4)

Pollutants	Units of Measure	Frequency	Sampling Method	Equipment	Measurement Range
Carbon Monoxide	mg/m^3	Continuous	CEM-4	Procal P2000	0-2000ppm
Flow	Nm^3/s	Continuous	CEM-6	Durag D-FL 200	-
Moisture	%	Continuous	TM-22	Procal P2000	0-50%
Nitrogen Oxides	mg/m^3	Continuous	CEM-2	Procal P2000	0-400ppm
Opacity	%	Continuous	CEM-1	Durag D-R 290	0-100%
Oxygen	%	Continuous	CEM-3	Novatech 1632/1231	0-21%
Temperature	deg C	Continuous	TM-2	ABB Absolute Temperature	0-400deg C
Total Solid Particles	mg/m^3	Yearly	TM-15	Isokinetic sampling	-

Table K6 – Lime Kiln B – Duct (EPL Point 21)

Pollutants	Units of Measure	Frequency	Sampling Method	Equipment	Measurement Range
Carbon Monoxide	mg/m3	Continuous	CEM-4	Procal P2000	0 – 3000ppm
Flow	Nm^3/s	Continuous	CEM-6	Durag D-FL 200	-
Moisture	%	Continuous	TM-22	Procal P2000	0-50%
Nitrogen Oxides	mg/m^3	Continuous	CEM-2	Procal P2000	0-500 mg/Nm3
Opacity	%	Continuous	CEM-1	Durag D-R 290	0-100%
Oxygen	%	Continuous	CEM-3	Novatech 1632/1231	0-21%
Temperature	deg C	Continuous	TM-2	ABB Absolute Temperature	0-400deg C
Total Solid Particles	mg/m^3	Yearly	TM-15	Isokinetic sampling	-

Table K7 – Meteorological Monitoring – "Mill Site Recovery Boiler B Building (Elevated)" (EPL Point 7)

Pollutants	Units of Measure	Frequency	Sampling Method	Equipment	Measurement Range
Wind speed @ 10 m	m/sec	Continuous	AM-4	Weather Master 2000 (Environdata)	0-175kph
Wind direction @ 10m	deg	Continuous	AM-4	Weather Master 2000 (Environdata)	0-360deg
Sigma Theta @ 10m	deg	Continuous	AM-4	Weather Master 2000 (Environdata)	5-100deg
Temperature @ 2m	deg C	Continuous	AM-4	Weather Master 2000 (Environdata)	-39-+60 deg C
Temperature @ 10m	deg C	Continuous	AM-4	Weather Master 2000 (Environdata)	-39-+60 deg C
Total Solar Radiation @ 10m	W/m2	Continuous	AM-4	Weather Master 2000 (Environdata)	
Barometric Pressure	mBar	Continuous			
Rainfall	mm	Continuous			

Table K8 – Meteorological Monitoring – “Southeast of Mill Site” (EPL Point 8)

Pollutants	Units of Measure	Frequency	Sampling Method	Equipment	Measurement Range
Wind speed @ 10 m	m/sec	Continuous	AM-4	Weather Master 2000 (Environdata)	0-175kph
Wind direction @ 10m	deg	Continuous	AM-4	Weather Master 2000 (Environdata)	0-360deg
Sigma Theta @ 10m	deg	Continuous	AM-4	Weather Master 2000 (Environdata)	5-100deg
Temperature @ 2m	deg C	Continuous	AM-4	Weather Master 2000 (Environdata)	-39-+60 deg C
Temperature @ 10m	deg C	Continuous	AM-4	Weather Master 2000 (Environdata)	-39-+60 deg C
Total Solar Radiation @ 10m	W/m2	Continuous	AM-4	Weather Master 2000 (Environdata)	
Barometric Pressure	mBar	Continuous			
Rainfall	mm	Continuous			