Mt Piper Power Station Extension

ENVIRONMENTAL ASSESSMENT

CHAPTER 12 – HAZARDS AND RISK IMPACTS

- September 2009

Contents

12. Hazards and Risk Impacts

The Director-General's requirements:

The Environmental Assessment must include a screening of potential hazards on site to determine the potential for off-site impacts and any requirement for a Preliminary Hazard Analysis (PHA). The Environmental Assessment must also include a preliminary screening of potential risks to aviation safety associated with exhaust plumes from the operation of the project with consideration to the Commonwealth Civil Aviation Safety Authority's Advisory Circular Guidelines for Conducting Plume Rise Assessments (June 2004).

12.1 Methodology for Hazard Analysis

The methodology used for the study is that published in *Hazardous Industry Planning Advisory Paper (HIPAP) No.6 - Guidelines for Hazard Analysis* (Department of Planning, 1992). A summary of the study approach is presented below:

- Hazard Identification – assessment of the hazards associated with the storage and handling of dangerous goods at the site;
- Consequence Analysis – analysis of the consequence severity and impact at adjacent land uses;
- Frequency Analysis – analysis of the frequency of incidents that have the potential to impact offsite;
- Risk Analysis – combination of the consequence and likelihood to determine the risk;
- Comparison with Risk Criteria – comparison of the assessed risks with those published by the regulatory authorities;
- Risk Reduction and Review – application of risk reduction solutions and review of the risks to ensure risks are below criteria.

The Preliminary Hazard Analysis is provided in **Appendix G**.

The Mt Piper Power Station is located in land zoned Rural General (1a). This land zoning does not prohibit the development of hazardous and offensive industries. Hence, the *State Environmental Planning Policy 33 - Hazardous and Offensive Development* (SEPP 33) would not directly apply to this zoning. In addition, the assessment of the proposed extension under Part 3A of the EP&A Act means that SEPP 33 does not generally apply, but provides an adequate means of hazard assessment. SEPP 33 guidelines were used to assess the facility for hazardous impacts to people and the environment surrounding the site.

The NSW Department of Planning publishes a SEPP 33 application guideline document *Applying SEPP 33: Hazardous and Offensive Development Guidelines* (Applying SEPP 33 guidelines) (DUAP, 1994), which lists threshold levels that must be exceeded before SEPP 33 applies. A full list of the existing storage quantities of Dangerous Goods at the site and those that would be required for the proposed extension is shown in **Appendix G**.

The dangerous goods currently stored at the Mt Piper Power Station and those that would be required for the proposed extension that exceed the threshold quantities listed in *Applying SEPP 33 – Hazardous and Offensive Development Application Guidelines* are presented in **Table 12-1.** The flammable gases and liquids are all stored at sufficient distances from the site boundaries to result in SEPP33 not being applicable for these materials.

- **Table 12-1 Dangerous goods stored and handled at Mt Piper Power Station exceeding the SEPP33 threshold levels**

Name	Class	Packaging Group	Total Quantity Stored	SEPP33 Threshold
Existing Storage Facilities				
Corrosive Substances (acid/alkali)	8	II	256 m^3	25m^3
Corrosive Substances (acid/alkali)	8	III	73m^3	50m^3
Anhydrous Ammonia	2.3	-	30 tonnes	5 tonnes
Chlorine	2.3	-	10 tonnes	5 tonnes
Proposed Storage Facilities				
Corrosive Substances (acid/alkali)	8	II	36.4 m^3	25m^3

The proposed extension project would require the storage of dangerous goods in excess of the threshold quantities in the Applying SEPP 33 guidelines. A preliminary hazard analysis (PHA) for the proposed extension has been prepared and, as the existing power station has not been subjected to a PHA study as it was constructed prior to the introduction of SEPP33, the storage within the existing site has also been included in the assessment.

Existing and proposed dangerous goods stored at the Mt. Piper Power Station are mainly corrosive liquids used for water treatment. The number of flammable liquids is relatively low and the much of the flammable liquid (petroleum) is stored in an underground tank. However, there are two toxic gases stored in relatively high quantities (ammonia – 30 tonnes and chlorine 10 tonnes).

Based on the nature of the stored materials (i.e. corrosives, flammable gases/liquids and toxic gases) and that the adjacent land uses do not contain a sensitive population, a Level 2 assessment was selected for the PHA. The Level 2 analysis permits a qualitative assessment of the corrosive materials to be conducted along with a detailed consequence analysis for the flammable gases/liquids and toxic gases, to determine the impact at the closest sensitive receptor.

12.2 Hazard Analysis

A review of the dangerous goods currently stored and handled at the site, and proposed under each extension option was undertaken to identify the hazards. **Table 5-19** lists the classes of dangerous goods, their uses and the hazards associated with each dangerous good.

- **Table 12-2 Class, nature and hazards of the dangerous goods stored at Mt Piper Power Station**

Class and nature of dangerous good	Material and storage type	Hazard
Class 2.1 Flammable Gas	Liquefied Petroleum Gas (LPG) stored in a horizontal tank Hydrogen/acetylene/LPG stored in cylinders Natural Gas transfer pipelines	Gas Release and Ignition Jet Fire / Flash fire Gas cloud Explosion Boiling Liquid Expanding Vapour Explosion (BLEVE)
Class 2.2 Non-Toxic/Non-Flammable Gas	Liquefied Refrigerated Carbon Dioxide stored in vertical tanks	Gas Release Asphyxiating Gas Cloud
Class 2.3 Toxic Gas	Anhydrous Ammonia stored in a horizontal tank and Liquid chlorine stored in drums	Gas Release Toxic Gas Cloud
Class 3 Flammable Liquid	Gasoline stored in an underground tank and kerosene/turpentine stored in drums and bottles	Liquid Release and Ignition Pool Fire
Class 8 Corrosive Substances	Sulphuric acid stored in tanks and batteries, sodium hydroxide stored in tanks, ammonia solution stored in drums and hypochlorite solution stored in drums	Liquid Release Corrosion burns to people contacting the corrosives Environmental Damage
Class C1 Combustible Liquid	Diesel fuel stored in above ground and underground tanks	Liquid Release and Ignition Pool Fire
Class C2 Combustible Liquid	Transformer oil stored in transformers; and Lube Oil stored adjacent to CCGT units	Liquid Release and Ignition Pool Fire

The dangerous goods listed do not present a hazard unless released from the containment systems (e.g. tanks, pipework, etc.). A review of the storage facilities and their capacity to contain releases was conducted, along with a qualitative assessment of the impact potential for hazardous incidents to offsite areas (i.e. heat radiation, discharge of drains, explosion overpressure, toxic gas concentration, etc.). Based on the existing and proposed storages of dangerous goods, the following hazardous incidents had the potential to impact offsite:

- Transformer fire;
- Gasoline fuel spill during transfer to underground tanks and fire;
- Diesel fuel spill and bund fire;
- LPG tank BLEVE;
- Ammonia releases;
- Chlorine releases;
- Natural gas pipeline failure and jet fire; and
- Gas turbine enclosure leak and explosion.

12.3 Consequence Analysis

The consequence analysis identified the following potential releases from existing and proposed operations for both the coal fired and CCGT extension options:

- Transformer fire – the transformer fire would be contained in the bunded area surrounding the transformer unit. The heat radiation impact from the fire reaches 4.7kW/m^2 at a distance of 29.4m (Note: the maximum permissible level of heat radiation impact at the site boundary is 4.7kW/m^2 –Ref.18). The distance from the transformers to the site boundary is 600m. Hence, there is no potential for impact offsite;
- Gasoline fuel spill during transfer to underground tanks and fire – the gasoline fuel spill would be contained within the transfer area. The heat radiation impact from the fire reaches 4.7kW/m^2 at a distance of 15.5m. The distance from the gasoline transfer point to the site boundary is 350m. Hence, there is no potential for impact offsite;
- Diesel fuel spill and bund fire - the heat radiation impact from the fire reaches 4.7kW/m^2 at a distance of 35.4m. The distance from the diesel fuel tanks to the site boundary is 40m. Hence, there is no potential for impact offsite;
- LPG tank BLEVE – the BLEVE impact (fireball) was estimated to occur with a diameter of 147m (radius - 73.5m). The distance to the site boundary from the LPG storage is over 600m. Hence, there is no potential for impact offsite;
- Ammonia releases – the impact to people from ammonia (i.e. fatality/injury) was identified to occur at a concentration of 1000 parts per million (ppm) for exposures of 1 hour. A gas dispersion analysis was performed for postulated ammonia releases at the ammonia tank. It was identified that the ammonia concentration at 1000 ppm reached 320m, in the worst case and did not extend to the boundary. For the same release scenario and under worst case conditions concentrations computed at the boundary were 460 ppm. It was concluded most individuals will not develop or experience irreversible or serious health effects. Daytime

levels are considerably lower, around140 ppm, and hence there is no fatality potential (fatality risk) for offsite impact from the postulated ammonia releases at the station.

- Chlorine releases - the impact to people from chlorine (i.e. fatality/injury) was identified to occur at a concentration of 20ppm (fatal) & 5ppm (injury). A gas dispersion analysis was performed for postulated chlorine releases at the chlorine storage area (drum storage). It was identified that the worst case chlorine concentrations for 20ppm (ERPG-3) and 3-5ppm (ERPG-2) occurred at 558m and 1558m respectively under F1 stability/wind conditions. The closest site boundary (Boulder Road) to the chlorine storage is 900m. Hence, there is no potential for fatal offsite impact from the postulated chlorine releases at the station; however, there is a possibility for injury impact at the site boundary from the postulated releases.
- Natural Gas Pipeline release and jet fire – resultant heat flux levels of 4.7kW/m2 will extend beyond the easement boundary (inside the site), but may have an impact to offsite areas located around 105m distant. Hence, the impact to offsite facilities from a jet fire at the pipeline gantry/ metering station was carried forward for detailed analysis; and
- Gas Turbine Enclosure Explosion Risk - At the boundary close to Boulder Road (500m away), the explosion overpressure is lower than 4 kpa (at 14kPa the risk of fatality to a person in the open is 0.01). Hence the effect is not significant. For the purpose of computation the risk of fatality will be taken as 0.01. Hence, this incident has been carried forward for further analysis (injury potential).

12.4 Frequency Analysis

As described above, those incidents carried forward for frequency analysis are:

- Gas fitting line incident leading to gas leak as a result of external interference;
- Gas leak into the gas turbine enclosure, ignition and explosion/jet fire; and
- Chlorine release from a pigtail failure in the chlorine storage area.

12.4.1 Natural Gas Pipeline Failure

The pipeline failure frequency has been assessed using two data sources, including CCPS (CCPS 1989) and University of Sydney (Tweeddale, H.M. 1993). There was some commonality in the failure rate in the two data sets, and to ensure a conservative assessment, a value of $1x10^{-4}$ has been selected as the pipeline rupture failure rate.

12.4.2 Gas Turbine Explosion

The gas fitting lines inside the gas turbine enclosures deliver fuel to the combustion chambers. The pipework would be fully welded, with the exception of sections where valves are installed. At these locations flanges are used to fit the valve into the pipe. Whilst there is negligible likelihood of failure of the pipe (i.e. hole) due to the dry gas, it was identified in the consequence analysis that leaks from flanges and valves could result in build up of gas in the turbine enclosure. However, for this incident to occur, this would require failure of the gas detection and isolation system and failure of the ventilation fans in the enclosure. In addition, ignition of the gas would also be required.

For the estimation of valve and the flange leaks, as the detailed design of the gas turbine installation is not yet complete, the number of valves and flanges has been assumed to be 10 valves and 20 flanges, based on similar facilities. The total (valve and flange) leak frequency in the enclosure has been calculated to be 0.136 per annum (p.a.).

The failure frequency for a fan is given as 2.2x10-3 p.a. (NPRD, 1995). Assuming the fan is tested every six months (i.e. electrical test, inspection and planned maintenance), the failure probability during operation is estimated using fractional dead time (FDT) theory and is calculated to be 5.5×10^{-4}.

The failure frequency for a gas detector is given as 0.0125 p.a. and the failure frequency for an isolation valve to close on demand (i.e. the emergency shut down or ESD valve outside the enclosure) is given as 0.075 p.a. (OREDA 2003). Assuming that these are tested every six months, the failure on demand is estimated using FDT theory and is calculated as 3.125×10^{-3} for the gas detector and 1.8×10^{-2} for the ESD valve.

The ignition frequency in an enclosed space is given as 0.3 for large releases in excess of 50kg of gas (Cox, A.W. Lees, GF.P. & Ang, M.L. 1991). The explosion frequency is estimated using a fault tree analysis. The results of the analysis indicates the explosion frequency (per one CCGT turbine) to be 1.58×10^{-6} p.a. For two OCGT turbines the frequency is 3.16×10^{-6} p.a. These values have been carried forward for risk analysis.

12.4.3 Chlorine Release

The postulated release occurs as a result of a pigtail failure in the line between the drum and the manifold. In the event of a chlorine release, the chlorine room is fitted with a gas detector system which activates a chlorine shut down system (chlorguard) attached to the chlorine drum valve.

A fault tree analysis was conducted for the incident. The results of this analysis estimated the chlorine release frequency to be 1x10-5 per annum (p.a.). The chlorine release frequency has been carried forward for risk analysis.

12.5 Risk Analysis

All three incidents from the frequency analysis were carried forward for risk analysis.

12.5.1 Natural Gas Pipeline Failure

A pipeline failure (rupture), and ignition, would result in the jet flame being directed parallel to the pipeline, with heat radiated from the flame towards the areas adjacent to the piperack. The heat radiation impact at the boundary for the site is estimated at 0.7 kW/m^2 and is considered insignificant is risk terms. The probability a jet fire is dependent on the ignition probability and the failure of the isolation valve to activate.

The failure probability of a shut down valve to close on demand was calculated to be 3.75×10^{-8} per year.

12.5.2 Gas Turbine Enclosure Explosion

A review of the distance from the turbines to the fenced site boundaries indicates that, as a result of the postulated explosion in the turbine enclosure, explosion overpressure at the fence line surrounding the site exceeds 100kPa. However, the power station site boundaries extend well beyond the fenced area and a buffer zone has been established around these sites such that no industrial, residential or commercial developments can be established within a specific distance of the power station site. The analysis conducted in the study identified that in the event of an explosion, there would be insufficient overpressure at the buffer zone boundary to cause fatalities. However, the analysis indicated that there would be sufficient pressure to cause injuries.

The fatality risk for the turbine enclosure explosion was calculated to be 0.158 pmpy. *Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 - Risk Criteria for Land Use Safety Planning* (DIPNR 1997) indicates that the accepted injury risk at residential areas is 1 pmpy (taken as the nearest boundary of the site), hence, the criteria is not exceeded in this case.

12.5.3 Chlorine Release

The consequence analysis indicated that injury was the maximum consequence severity that could occur at the site boundary from postulated releases at the chlorine storage. The frequency of chlorine release was estimated to be 7.3×10^{-6} p.a. Hence, the risk of injury as a result of the postulated chlorine release is 7.3×10^{-6} p.a. or 7 chances in a million per year.

12.5.4 Overall Risk Evaluation

The events that may have an impact at the site boundary comprise:

- Gas fitting line incident leading to gas leak as a result of external interference;
- Gas leak into the gas turbine enclosure, ignition and explosion/jet fire; and
- Chlorine release from a pigtail failure in the chlorine storage area.

The risk levels expected at the boundary of the site are around 0.336 pmpy. These risk levels are considered acceptable under the NSW Department of Planning guidelines. Notwithstanding the low risk levels estimated form this assessment, and to ensure the risks are maintained in the 'as low as reasonably possible' (ALARP) range, the following measures in **Section 12.7** are recommended.

12.6 Risks to Aviation Safety

The existing and proposed stacks at Mt Piper Power Station may pose a hazard to aircraft flying in the vicinity of the exhaust plumes. The risk to an aircraft during low level flight can be managed or reduced if information is available to pilots so that they can avoid the likely area of air disturbance.

Aviation authorities have determined that damage to the frame of an aircraft may occur when the vertical velocity of a wind gust exceeds 4.3 metres per second (m/s). The Civil Aviation Safety Authority (CASA) has subsequently required that plume rise modelling be undertaken to assess the potential hazard to aircraft operations where the vertical velocity of exhaust plumes exceed 4.3 m/s at an aerodrome Obstacle Limitation Surface (OLS), or at 110 metres above ground level anywhere else. Requirements of the plume rise modelling are outlined in CASA's Advisory Circular *Guidelines for Conducting Plume Rise Assessment* (CASA, 2004).

A screening level assessment has been undertaken to quantify the existing and potential aviation hazard. The assessment includes:

- Identification of the nearest airport;
- Plume rise modelling for a one year simulation period; and
- Analysis of model results for the regions of space where plume vertical velocities are predicted to exceed 4.3 m/s.

Bathurst is the nearest airport to Mt Piper, approximately 40km to the west. This large distance was the main factor to suggest that a screening level assessment would be adequate in this instance.

The output from the plume rise modelling for a one year simulation period included information on plume location and movement for every hour and for each stack. The plume rise data included vertical velocity, plume height and plume dimensions from the time of release to the time of final plume height. An analysis of the data was undertaken to determine the maximum, minimum and average heights at which the plume vertical velocity exceeded the critical velocity of 4.3 m/s. Results of this analysis are shown in **Table 12-3**.

- **Table 12-3 Summary of height at which plume vertical velocity falls below 4.3 m/s**

Stack ID	Stack name	Height at which plume vertical velocity falls below 4.3 m/s (m)		
		Minimum	Maximum	Average
1	Existing Mt Piper A stack	265	885	308
2	Proposed Mt Piper B (USC) stack	271	1,076	324
3	One proposed CCGT stack	53	222	73

Over the one year modelling period, the maximum height at which the plume vertical velocity falls below 4.3 m/s for the existing Mt Piper stack is predicted to be 885 m. For the proposed USC plant, the maximum height of the critical vertical velocity is slightly higher at 1,076 metres. For the CCGT plant, the maximum height of the critical vertical velocity is only 222 metres, which is lower than the height of the existing stack.

The maximum height of the plume vertical velocity exceeding 4.3 m/s is located approximately above each stack location. For the USC plant, the potential aviation hazard area changes slightly from the existing hazard area, approximately 400 metres further to the west and approximately 200 metres higher above local ground level. It is likely that CASA has already identified a region of space around Mt Piper Power Station that poses a potential hazard to aircraft. The proposed extension options are unlikely to change the existing restricted area.

12.7 Mitigation Measures

Measures to minimise the potential for hazard and risk incidents arising from the existing Mt Power Piper Station and proposed extension include:

- The gas pipeline easement and the gas pipeline along the piperack would be clearly marked with “High pressure gas pipeline” at regular intervals (20m) to ensure that personnel working in the area (especially on the piperacks) understand that a high pressure gas fitting line is present.
- A safety management system would be developed (in accordance with *Hazardous Industry Planning Advisory Paper (HIPAP) No.9 – Safety Management System Guidelines*) for the site as part of the current proposed development, covering particularly the risk events that may have effects at the boundary, notably:
  - Gas fitting line incident leading to gas leak as a result of external interference;
  - Gas leak into the gas turbine enclosure, ignition and explosion/jet fire; and
  - Chlorine release from a pigtail failure in the chlorine storage area.

  The safety management system would cover:

- Management of process changes (use of hazard and operability (HAZOP) critic methods);
- Accident /incident reporting;
- Safety training requirements;
- Emergency plans (based on risk assessment and *HIPAP No. 1 - Industry Emergency Planning Guidelines*);
- Site security and access; and
- Audit program.

No mitigation measures would be required for aviation safety as such measures would be in place for the existing Mt Piper Power Station.