Midal Cables International Pty Ltd

Report on Tomago Cable Plant

Preliminary Hazard Analysis

August 2011

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- *Preliminary design information including equipment, layout and intended plant capacity*
- *Preliminary list of dangerous goods intended to be used on site*
- *Preliminary site information*

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1. Introduction

Midal proposes to construct an aluminium rod and conductor manufacturing facility on a 2.8 ha parcel of land adjacent to the Tomago Aluminium Smelter at Tomago in Port Stephens, which is subsequently referred to as 'the project' for the purposes of this Environmental Assessment. This project will process molten aluminium purchased and transported from the Tomago Aluminium Smelter, effectively value adding to the smelter's existing output. It will produce products not previously manufactured in Australia thus reducing imports into Australia of aluminium conductors for electricity transmission purposes and provide an export opportunity for aluminium rod.

Midal has entered into a long term supply contract with Tomago to supply molten metal to the project.

The project will process 50,000 tonnes of aluminium per year. This aluminium will be cast into rods with half the production being exported and half being further processed into aluminium conductors.

The project includes;

- Construction of an approximately 150m long dedicated haul road from the Tomago Aluminium Smelter to the project.
- Two large buildings to accommodate the rod and conductor manufacturing processes and storage of finished products.
- Several smaller buildings providing workshop facilities and storage.
- Provisions for car parking.
- Provisions for efficient drainage, water reuse and sewage treatment.

GHD has been engaged to prepare a Preliminary Hazard Analysis (PHA) as part of the preparation of an Environmental Assessment (EA) for the project.

This report was prepared with background information, terms of reference and assumptions supplied and agreed with the customer. The report is not intended for use by any other individual or organisation and as such, GHD cannot accept liability for use of the information contained in this report, except for the purpose for which it was intended at the time of writing.

1.1 Objectives

The PHA objectives are:

- To demonstrate the risks identified during and after the proposed development are acceptable in relation to the surrounding land use;
- That any residual risk will be appropriately managed; and
- To advise risk reduction strategies where unacceptable risks are identified.

1.2 Scope

This PHA includes a description of the proposed development, SEPP 33 screening of dangerous goods, a qualitative assessment and where required subsequent quantitative risk assessment that reviews:

- Input/output materials storage, processing and handling;
- Primary items of the process; and
- Natural disasters, bushfires and flooding if relevant.

2. Statutory Requirements

The current structure for project assessment is established by the Environmental Planning and Assessment Act 1979 (EP&A Act 1979). This project was declared a major development under the NSW State Environment Planning Policy (Major Development) 2005 and accordingly is to be assessed under Part 3a of the Environmental Planning and Assessment Act 1979.

The Director-General’s Requirements for the EA requires a PHA as per State Environmental Planning Policy No.33 – Hazardous and Offensive Development (SEPP 33) [1]. A PHA broadly examines the likely potential hazards that may occur as a result of a hazardous or offensive development.

SEPP 33 requires developments that are potentially hazardous to undertake a PHA to determine the risk to people, property and the environment at the proposed location and in the presence of controls. Should such risk exceed the criteria of acceptability, the development is classified as ‘hazardous industry’ and may not be permissible within most industrial zones in NSW.

For developments identified as potentially offensive the minimum criteria for such developments is meeting the requirements for licensing by the Environment Protection Authority (EPA). If a development cannot obtain the necessary pollution control licenses, then it may be classified as ‘offensive industry’, and may not be permissible within most industrial zones in NSW.

This PHA was prepared applying SEPP 33, and generally in accordance with the Department of Planning (DoP) (formerly Department of Urban Affairs and Planning) publications Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis (2011) (HIPAP 6) [2] and Multi-Level Risk Assessment (2011)[3]. An assessment of the proposed development with respect to the recommended fatality, injury and irritation risk criteria presented in the publication Hazardous Industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Safety Planning (2011) (HIPAP 4)[4] has been undertaken.

This PHA considers risks associated with the development in terms of accidental loss scenarios and their potential for hazardous incidents. General handling of waste materials and emissions produced during normal operations are dealt with elsewhere in the EIS.

The primary objectives of a PHA are to:

- Identify potential hazards associated with the proposal;
- Analyse the consequences of significant hazards on people and the environment, and the likelihood or frequency of these hazards occurring;
- Estimate the resultant risk to the surrounding land uses and environment; and
- Analyse the safeguards to ensure they are adequate, and therefore demonstrate that the operation can operate within acceptable risk levels to its surroundings.

3. Methodology

3.1 General

A PHA is to provide sufficient information and assessment of risks to show that a project satisfies the risk management requirements of the proponent company and the relevant public authorities. Within this brief, the main objective of the PHA is to show that the residual risk levels are acceptable in relation to the surrounding land use, and that risk will be appropriately managed. This is done by systematically:

- Identifying intrinsic hazards and abnormal operating conditions that could give rise to hazards;
- Identifying the range of safeguards;
- Assessing the risks by determining the probability (likelihood) and consequence (effects) of hazardous events for people, the surrounding land uses and environment; and
- Identifying approaches to reduce the risks by elimination, minimisation and/or incorporation of additional protective measures.

With proper application, this method should demonstrate that the operation can operate within acceptable risk levels in relation to its surroundings.

The PHA needs to be carefully and clearly documented with the assumptions and uncertainties of final design and operation defined.

3.2 Preliminary Risk Screening

The need for a PHA under SEPP 33 is determined by a preliminary risk screening of the proposed development. The preliminary screening methodology concentrates on the storage of specific dangerous goods classes that have the potential for significant off-site effects. Specifically the assessment involves the identification of classes and quantities of all dangerous goods to be used, stored or produced on site with an indication of storage depot locations. Details of the methodology are described in the DoP's - Applying SEPP 33 – Hazardous and Offensive Development Application Guidelines (2011)[1].

3.3 Risk Classification and Prioritisation

Multi-Level Risk Assessment (2011)[3] suggests the use of preliminary analysis of the risks related to a proposed development, to enable the selection of the most appropriate level of risk analysis in the PHA. The preliminary analysis, detailed in this document (section 6), includes risk classification and prioritisation using a technique adapted from the Manual for Classification of Risk due to Major Accidents in Process and Related Industries (IAEA, 1993)[5].

3.4 Analysis and Assessment Levels

The hazard analysis and quantified risk assessment regime promoted in NSW relies on a systematic and analytical approach to the identification and analysis of hazards and the quantification of off-site risks to assess risk tolerability and land use safety implications. Two key objectives are emphasised in the implementation of this process:

a. The systematic and analytical nature of the assessment process enables the nature of the hazards, risks, leading risk contributors and events to be identified and understood from design, operational and organisational viewpoints.
b. The quantification of off-site risks, where applicable, enables judgments to be made on locational safety implications with regard to people, the biophysical environment and other land uses.

Multi-Level Risk Assessment (2011)[3] prescribes three levels of risk assessment that can be undertaken. The choice of an appropriate technique is based on the results of preliminary screening, risk classification and prioritisation and the potential for significant off-site consequences arising from hazards identified for the proposed development.

Level 1 - This is a qualitative assessment using word descriptions to approximately assess and rank risks. This is used when risk screening, classification and prioritization indicate no major off-site consequences, adequate controls exist, and surrounding land uses are not sensitive to the hazards posed.

Level 2 - A semi-quantitative assessment that utilises the hazards identified in Level 1 and provides a focused quantification of key potential off-site risk contributors to demonstrate that risk criteria will be met.

Level 3 - This involves a full quantitative risk assessment and is undertaken whenever the scale and nature of an activity creates a significant risk of a major accident. A full-scale analysis should also be carried out if partial quantification cannot sufficiently demonstrate that relevant criteria will be met.

The rationale for the multi-level risk assessment approach is that:

- Preliminary analyses that indicate minor land use safety outcomes may only require qualitative assessment (Level 1). The emphasis in such instances should be on the identification of key risk elements and optimising safety management controls, therefore fulfilling Objective 1 above.
- Preliminary hazard analyses that indicate significant potential risk impacts to surrounding land uses should be subjected to a more detailed level of analysis including partial or total quantification (Levels 2 and 3). For such cases there should be increased emphasis on Objective 2 above, relating to land use safety and risk tolerability.

3.5 Qualitative Analysis

Qualitative analysis uses words and descriptive scales to determine the likelihood of each identified hazard and its consequences. This provides an estimate of the likely rate of occurrence of hazardous events and their severity, from which a measure of the risk may be obtained through a simple matrix format of the equation:

$$\text{Risk} = \text{Likelihood} \times \text{Consequence}$$

The risk associated with a proposed development is determined by combining the likelihood of the potentially hazardous events and the magnitude of their consequences. This is illustrated in Table 3.1, which has been adapted from Australian/New Zealand Standard 31000:2009 Risk Management[6]. The process of combining consequences and frequencies gives appropriate weight to the range between small consequence events (which are relatively frequent) and events of major consequence (which are very infrequent).

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Table 3.1 - Consequence and Likelihood [6]

Consequence Scale					Likelihood				
					E - Rare	D - Unlikely	C - Possible	B - Likely	A - Almost Certain
	Assets	Production	Environment	People	May occur only in exceptional circumstances (million to 1)	Could occur at some time (10,000 to 1)	Might occur at some time (100 to 1)	Will probably occur in most circumstances (even money)	Is expected to occur in most circumstances (odds-on)
1 - Insignificant	Slight Damage <$5,000	Slight Loss < 1 hour	Environmental Nuisance	Slightly Injured (FAC)	L	L	L	M	M
2 - Minor	Minor Damage <$50,000	Minor Loss < 12 hours	Material Environmental Harm	Minor Injury/Occ. Illness (MTC)	L	L	M	H	H
3 - Moderate	Localised Damage <$500,000	Localised Loss < 1 day	Serious Environmental Harm	Significant Injury/Occ. Illness (LTI-PPD)	M	M	H	H	E
4 - Major	Major Damage <$5,000,000	Major Loss < 1 week	Major Environmental Harm	Single Fatality Permanent/Total Disability	M	H	E	E	E
5 - Catastrophic	Extensive Damage >$5,000,000	Extensive Loss > 1 week	Extreme Environmental Harm	Catastrophic Multiple Fatality	H	E	E	E	E

Legend
E: extreme risk; immediate action/ control measure required
H: high risk; senior management attention required
M: moderate risk; management responsibility must be specified
L: low risk; manage by routine procedures

3.6 Quantitative Analysis

Quantitative analysis is conducted using numerical data values for both likelihood and consequences. This data has been gathered from a variety of sources including mathematical risk modelling, extrapolation from experimental studies or past data. A quantitative analysis can be used to estimate:

- Thermal radiation distances;
- Explosion overpressure;
- Toxic exposure levels; and
- Fatality risk levels.

3.7 Risk Assessment

Risk assessment involves comparing the level of risk found during the qualitative and quantitative analyses to previously established risk criteria, thereby ascertaining if that level of risk can be accepted or not. Such decisions take into account the wider context of the risk and include consideration of the tolerability of the risks borne by external parties.

Low and acceptable moderate risks can be allowed with minimal further treatment; however, they should be monitored and periodically reviewed to ensure they remain at this level. Higher-level risks should be treated using safeguards (see Section 3.8).

3.8 Risk Treatment

A complete range of safeguards should be incorporated into the design and operation of the proposed development as prevention or protection measures for higher-level risks. These measures may include plant design features, organizational safety controls, emergency and counter disaster principles and approval processes. Options should be evaluated on the basis of the extent of risk reduction and the extent of benefits or opportunities they create. In general, the cost of managing risks should be commensurate with the benefits obtained.

3.9 Monitoring and Review

Risks and the effectiveness of control measures need to be continually monitored to ensure changing circumstances do not alter risk priorities. Factors that may affect the likelihood and consequences of an outcome may change, as could the factors that affect suitability or cost of various treatment options. Ongoing review is, therefore, essential to ensure that risk management activities remain relevant.

4. Facility Description

4.1 Location and Surrounding Land Uses

The project will be located on industrial land within the Tomago Industrial Area approximately 6 km from the Port of Newcastle and immediately adjacent to the Tomago Smelter (Figure 1). This land comprises Lot 5 and 6 in DP 270328 which has an area of approximately 2.8 ha and is subsequently referred to as 'the site'.

The site has previously been used for industrial purposes and parts of the site and adjoining lands have been subject to sand mining activities.

The site is located within the Tomago Aluminium Corporation (TAC) Buffer Zone. The buffer zone was established as a condition of consent for the development approval of the Tomago Aluminium facility. The zone acts as an environmental management zone which aims to reduce land uses that are incompatible with the operations of the smelter through controlling the uptake of land.

Land immediately to the west is occupied by a large industrial facility, land immediately to the east is currently vacant but has previously been used for industrial activities, land to the north has previously been subjected to sand mining and is part of the Tomago Aluminium Company Buffer area and a small area of bushland lies immediately to the south separating the subject land from further industrial development.

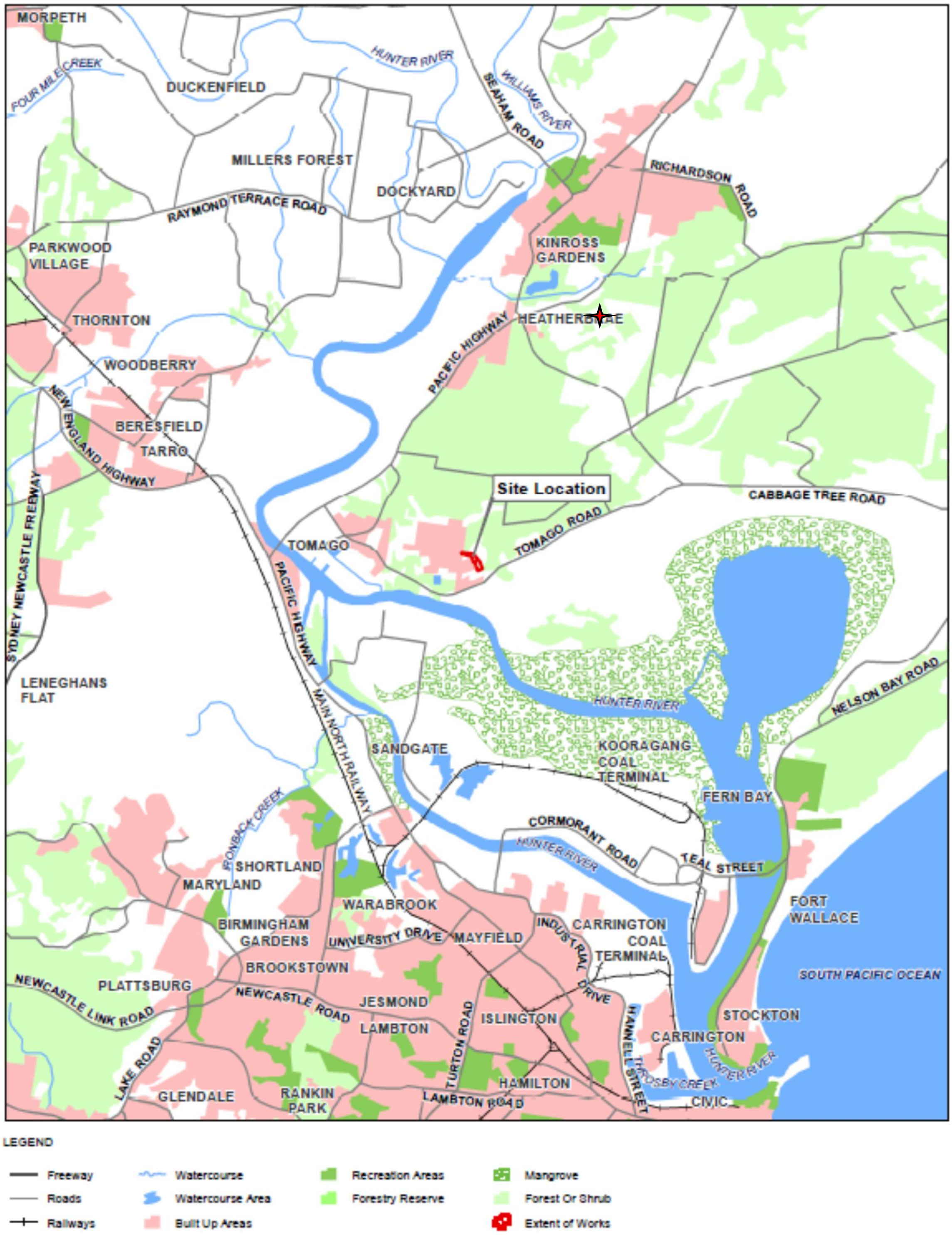
The surrounding development comprises a wide range of Industrial activities dominated by the Tomago Aluminium Smelter. In all cases the surrounding activities are compatible with the existing industrial environment and, in a large number of cases, comprise substantial buildings similar in scale to that proposed for the Midal facility

Access to the site is provided by a private road connecting from School Drive.

The closest distances to other land uses are:

- Varley Kitchens facility is immediately adjacent to the West of the proposed development;
- 200 metres West is the Tomago Aluminium Smelter;
- Immediately to the East is a vacant industrial land with further industrial activities approximately 1 kilometre to the East; and
- Additional industrial activities are located approximately 400 metres to the South.

Figure 1 - Site Location



4.2 Site Process Description and Layout

The proposed manufacturing facility requires direct access to a molten metal source. The project has been developed to take advantage of an opportunity to source molten metal from Tomago Aluminium in an efficient and cost-effective manner. The facility will produce approximately 50,000 tonnes of Aluminium wire and conductors per year. The project uses only virgin molten metal sourced directly from smelters to manufacture their products. The process will also produce about 1,000 tonnes of aluminium dross per year.

The site is located on 2.8 ha of industrial land (refer to Figure 2) within the Tomago Industrial Area, approximately 6 km north of the Port of Newcastle and immediately adjacent to the Tomago Smelter (refer to Figure 1). The northern and central portions of the site consist of grasses, scattered shrubs and trees.

The project includes;

- Construction of an approximately 150m long dedicated haul road from the Tomago Aluminium Smelter to the project.
- Two large buildings to accommodate the rod and conductor manufacturing processes and storage of finished products.
- Several smaller buildings providing workshop facilities and storage.
- Provisions for car parking.
- Provisions for efficient drainage, water reuse and sewage treatment.

There will be three associated manufacturing activities undertaken within the facility. These are the formation of aluminium rod within Building No 1 and aluminium wire and aluminium conductors within Building No 2.

Figure 2 – Midal Site Layout

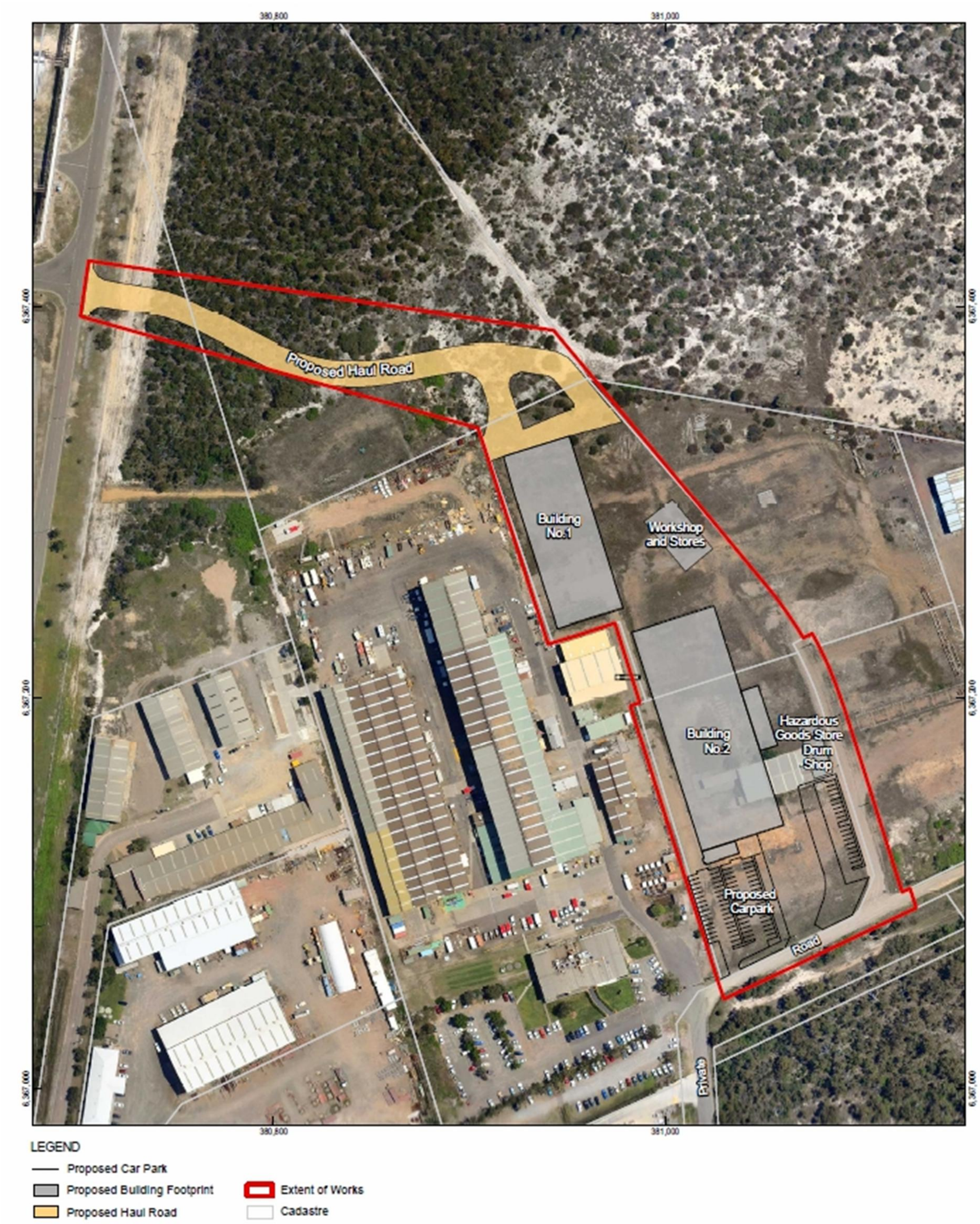


Figure 3 – Local Context of Midal Site

4.2.1 Rod Production

Liquid aluminium is produced at the Tomago smelter and delivered to the site in crucibles with a capacity of approximately 10 tonnes that are mounted on specialised small articulated trucks. These are the same trucks and crucibles used in operations at the smelter. Each crucible is accompanied by an analysis certificate. Once the certificate is checked and the quality of the molten metal is found to be within the desired limits, the crucible is lifted from the truck and the metal is poured into the holding furnace. All furnaces will be gas fired.

When the holding furnace is full, the temperature of the metal is maintained at between 650ºC and 820ºC. The metal in the furnace is degassed if required, and any floating oxides removed (called drossing). The dross is aluminium oxide taken off the molten ponds in the furnaces. The hot dross is placed in a designated dross storage area and solidifies when cooled. It is then removed from the area and placed in open top bins. The dross is taken by road transport off site to a third party specialised recycling facility.

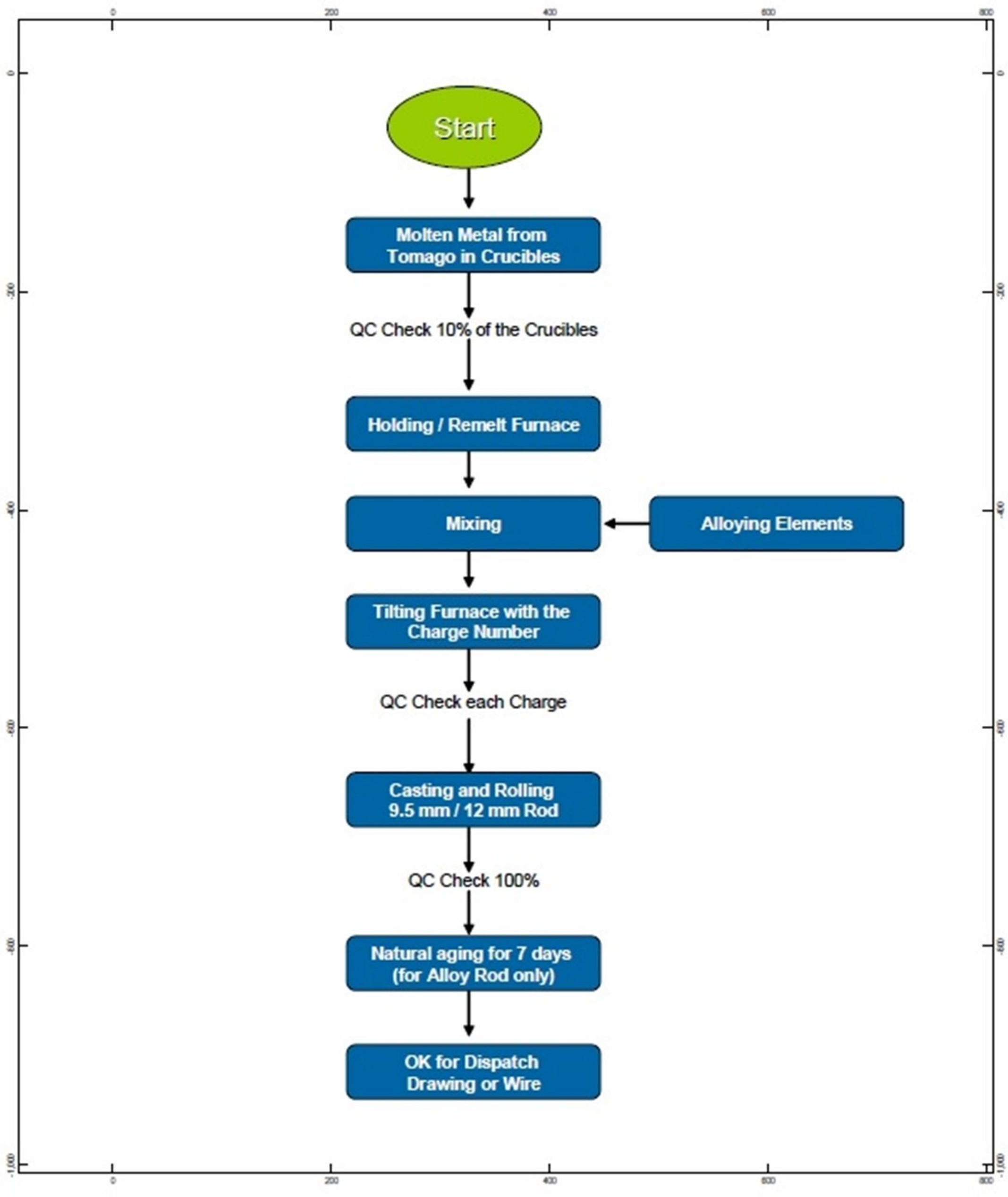
After the metal has been cleaned, samples are taken from the two furnace doors for spectro-analysis. If the analysis confirms the metal meets the specification, the metal is transferred to the tilt furnace. During transfer the alloying elements are added and further analysis of the metal is undertaken.

When the tilt furnace is full, the metal is maintained at between 700ºC and 820ºC and is further degassed and drossed.

From the tilt furnace, the liquid metal is transferred to the casting wheel and cast at a maximum temperature of 715ºC. The incoming cooling water for the casting wheel is maintained between 20ºC and 40ºC. Following this the bar is rolled through the rolling mill where the cross-section of the bar is gradually reduced until the bar forms a 9.5mm diameter rod. The rod is coiled by automatic coilers onto drums of approximately 2,000kg.

Once the rod is produced, it is checked and tested for quality, weighed and packed with shrinkable polyethylene sheets and palletised. The finished product is either transported by truck to domestic markets or to the Newcastle port for export, or moved into the wire drawing and stranding building to where it will be used to produce conductors. The process for rod production is presented in Figure 4 and the process flow diagram is schematically depicted in Figure 6.

Figure 4 – Rod Production Process



4.2.2 Wire Production

The 9.5mm diameter aluminium rod coils from the automatic coilers are accompanied by a work order which states the tensile and conductivity of the rods. The wire diameter to be drawn is determined from the work order and programmed into the wire drawing machine. Wire drawing involves the rod being pulled through varying sizes of die series which reduces the diameter of the rod to the desired size. Once the rods are drawn to the prescribed diameter, the wire is then drawn onto bobbins.

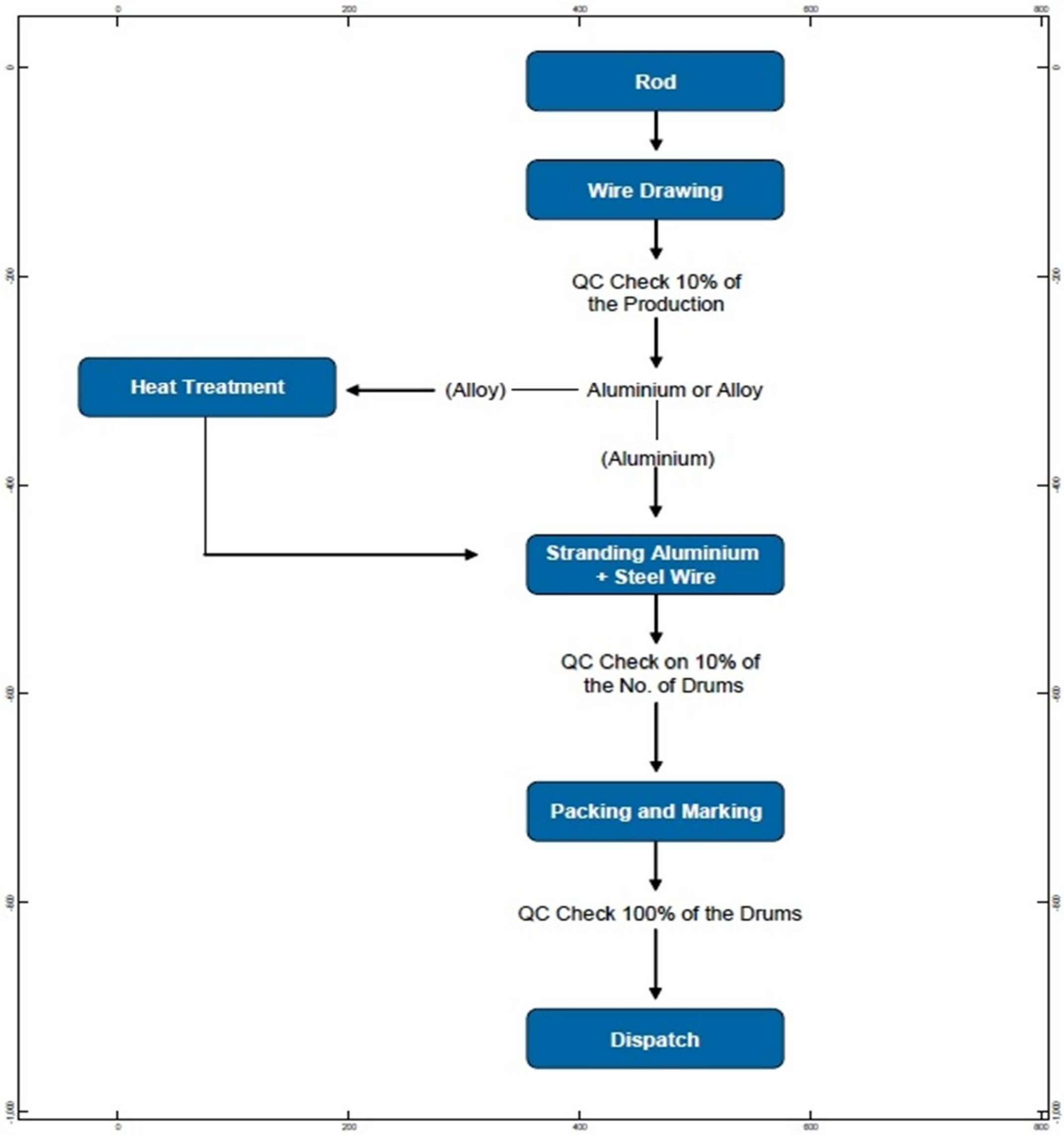
The temperature of the coiled rods during the drawing process should not exceed 70ºC for aluminium and 55ºC for alloy. The lubricant temperature should not exceed 130ºC.

Quality assurance processes sample every tenth bobbin and test the failure of wire. If testing indicates the wire does not meet the specifications, failed wires are removed and rejected tags are attached.

Alloy wires are taken to the heat ageing oven to receive thermal treatment. Ageing parameters of time and temperature depend on the diameter and quantity of wire charged into the oven in a single batch.

Once aluminium wire has been drawn and alloy wire has received thermal treatment, the wire is tested to ensure it meets specified values and then is taken for stranding. The process for wire production is presented in Figure 5 and the process flow diagram is schematically depicted in Figure 7.

Figure 5 – Wire Drawing Process



4.2.3 Conductor Production

Bobbins from the wire production process described in Section 4.2.2 are loaded into stranding carriages. The stranding carriages within the stranding machine are rotated in an alternate direction so the wires are stranded in a close helix. Tension between the stranding carriages must be kept uniform to maintain a uniform circular surface.

Once the bobbins are in place, the wires are strung up to the forming die. Roller settings are adjusted to minimise the spring back of the wire when the conductor is cut. During the stranding process, care is taken to ensure that the forming die is set so that the conductor is tight and not loose in the groove of the forming die. During multiple layer stranding, care is taken to ensure that the direction of each lay is in accordance with the requirements of the work order.

Once the wire has been stranded to the required length, the completed conductor drum is removed. The following types of conductors will be produced:

- All Aluminium Conductor (AAC). In this conductor, all the wires in all layers will be Electrical Conductor (EC) Grade Aluminium.
- Aluminium Conductor Steel Reinforced (ACSR). In this conductor, the core will be high tensile galvanized steel wire. The outer layer will always be aluminium.
- Aluminium Conductor Aluminium Clad Steel Reinforced (ACSR AS). In this conductor, the core will be aluminium clad steel wire. The outer layer will always be EC Grade Aluminium.
- All Aluminium Alloy Conductor (AAAC). In this conductor, all the wires are aluminium alloy wires.
- Aluminium Conductor Alloy Reinforced (ACAR). In this conductor, the inner core will be aluminium alloy wire and the outer layers will be EC grade aluminium wire.

The main features of the facility include:

- Truck weighing station at site entry;
- Dross recovery system;
- Casting;
- Water cooling tower
- Air cooling;
- Product handling and outloading; and
- Control, workshop and amenities buildings.

The nearest natural gas supply to the site is Jemena Gas delivered at a pressure of 1MPa by an underground pipe rising up to a metering station adjacent to the main building via a 100 mm secondary main pipeline. The furnace is also supplied at a pressure of 100 kPag through a 100 mm line). Power to the site is supplied via 11 kV electrical supply to the site, with two 2.5MVA (11/0.433kV) transformers with physical dimensions of 4190 (L) x 2000 (W) x 2770 (H). It is estimated that the facility will consume approximately 3.72 MVA of power during normal operation.

The melting and casting operations do use water and cooling towers. All sewerage is treated on-site, with the waste water used for irrigation of on-site gardens.

Figure 6 –Casting and Rolling Process

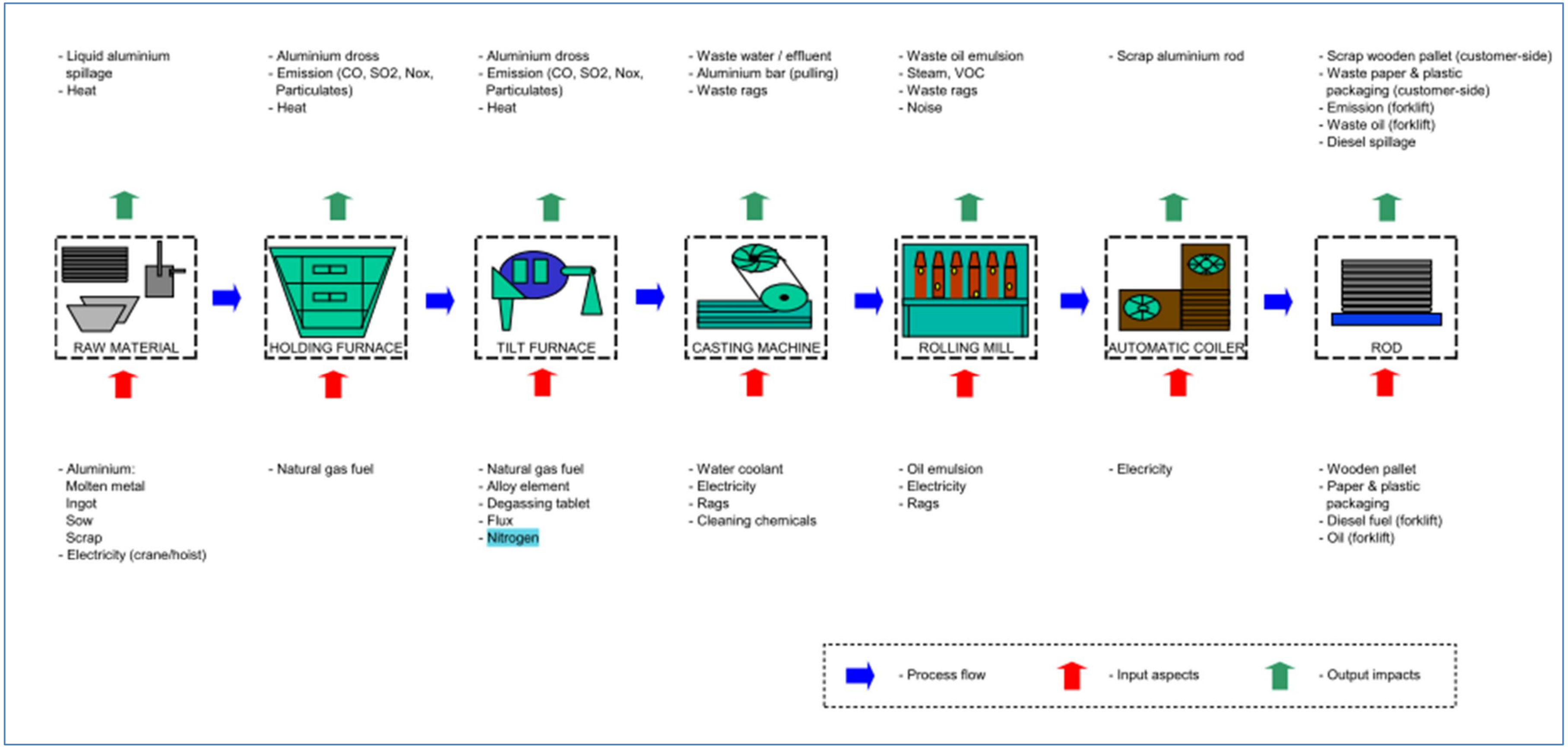
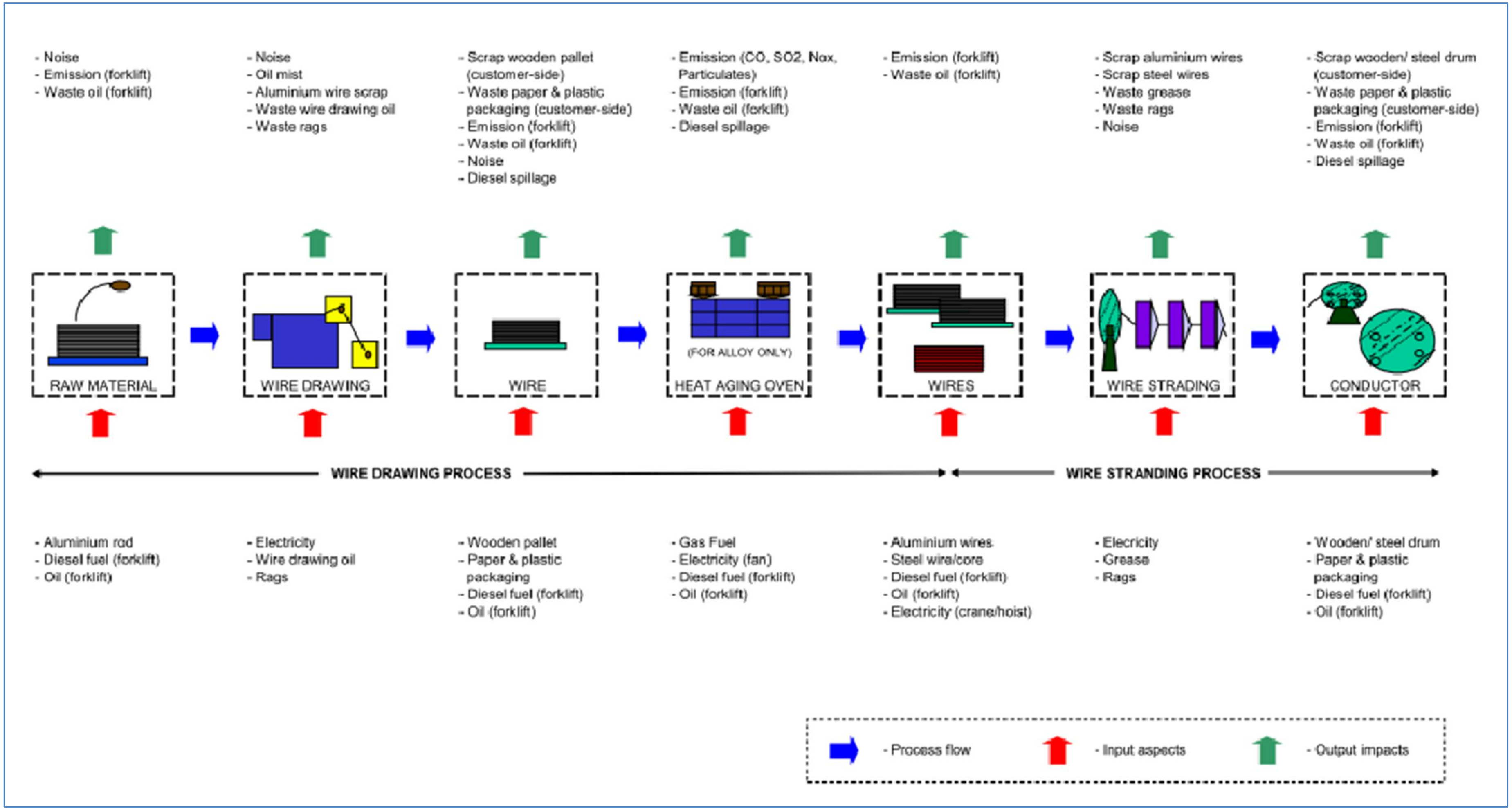


Figure 7 – Wire drawing and Wire Stranding Processes



5. Preliminary Risk Screening

5.1 Hazardous Materials on Site

Hazardous materials encompass both dangerous goods and dangerous substances. Dangerous goods are classified on the basis of immediate physical or chemical effects such as fire, explosion, corrosion and poisoning that may affect property, people or the environment, whilst hazardous substances are classified only on the basis of health effects - both medium and long term. The proposed hazardous materials at the Midal manufacturing facility are

- Chromic acid – DG Class 8. Causes severe burn upon contact, toxic if inhaled and carcinogenic. It is used for wiping of the casting wheel in the casting area, once daily, but is not essential for operations;
- Hydrocloric acid and Sulphuric acid – DG Class 8. Causes tissue burn upon contact. It is used in the laboratory for testing purposes;
- Nitrogen – DG Class 2.2 (non-flammable and inert). Non-toxic but may act as an asphyxiant in an oxygen deficient environment. Nitrogen is used in the tilt furnace (nitrogen wand to stir the molten aluminium);
- Alumol 195 – DG Class 8. It is a low hazardous material with low flammability. It is used as a lubricant during the wire drawing process;
- Molten aluminium – DG Class 9 and is excluded from risk screening (see Table 1: Screening Method to be used, "Applying SEPP 33", p17), but considered in transportation screening (See Table 2: Transportation Screening Threshold, "Applying SEPP 33", p18). It poses high explosion risk upon contact with water;
- Dross aluminium – DG Class 4.3. Potential for emission of a flammable gas when the dross is wet and reacts with water to produce ammonia or acetylene.

5.2 Dangerous Goods Storage Screening

A preliminary screening of the proposed development is required by SEPP 33, so as to determine if there is a need for a PHA. The methodology is described in the DoP's Applying SEPP 33 – Hazardous and Offensive Development Application Guidelines (2011)[1].

The proposed inventories of hazardous substances and dangerous goods to be stored and utilised in the proposed development are listed below in Table 5.1. Some of these are defined as Dangerous Goods (DG) in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code). The SEPP 33 screening threshold value for each item is also included. Highlighting is used to indicate inventory items that exceed the screening threshold.

Table 5.1 - Dangerous Goods Storage Screening[1]

Hazardous Material	Maximum Inventory	Threshold	% of Threshold	Comments
Chromic Acid	1.25 kL	50	2.5%	Stored in hazardous good store
HCl & H_2SO_4	0.103 kL	25	0.5%	Stored in hazardous good store
Nitrogen	10 kL	#		Stored in hazardous good store
Wire drawing lubricant Alumol 195	20.5 kL	100	21%	Stored in hazardous good store and bunded
Molten Aluminium	140 tonnes	*	N/A	In furnaces and crucibles
Aluminium dross	4 tonnes	1 tonne	400%	Stored indoor to solidify, then outdoor in a skip for recycler collection

*Molten Metal (UN code 3257) is a Class 9 dangerous good and is excluded from risk screening.

Class 2.2 gases are excluded from risk screening.

Table 5.1 shows that with the exception of aluminium dross, all other hazardous materials do not exceed the threshold for storage. Molten aluminium, being Class 9 dangerous goods is excluded from the storage screening process as per SEPP 33. The maximum inventory of molten aluminium shown in Table 5.1 includes inventories in 2 holding furnaces of 38 tonnes each, 2 tilt furnaces of 22 tonnes each, and 2 crucibles of 10 tonnes each (taken as worst case quantity).

Aluminium dross (UN3170) is classified by the ADGC as a Class 4.3 dangerous good. This classification implies that there is a potential for emission of flammable or toxic gases when the dross is wetted and reacts exothermically with water. It is possible for dross to react with water to form acetylene, hydrogen, ammonia and methane. The estimated inventory of aluminium dross out of the tilt and holding furnaces is 3 tonnes per day with a daily pickup so an allowance for a maximum 4 tonnes storage is assumed, which exceeds the one tonne threshold for storage of Class 4.3 dangerous goods. Therefore the Midal facility is considered to be potential hazardous and a PHA is required to be submitted with the development application. It is important to note that Midal does re-process some of the dross but sends the lower metal value dross offsite for re-processing. Therefore, storage on site is considered for gas evolution.

5.3 Transportation Screening

The proposed movement of hazardous materials (both incoming and outgoing [19] is assessed in Table 5.2 against the transportation screening thresholds in Table 2 of Applying SEPP 33 [1].

Table 5.2 - Estimated Vehicle Movements of Dangerous Goods

Class Packaging Group	Substance	Peak Weekly (Movements)	Threshold (Movements)	Min Qty per load (Tonnes)	Threshold Load (Tonnes)
Class 8, PGII	HCl UN Code 1789	0.04	30	0.103	2
Class 8, PGII	H_2SO_4 UN Code 1830	0.04	30	0.103	2
Class 8, PGIII	Chromic Acid UN Code 1755	0.04	30	0.60	2
Class 2.2, PG--	Nitrogen UN Code 1066 (compressed)	0.24	n/a	2.0	n/a
Class 4.3 PG II or III	Aluminium Dross UN Code 3170	7	12	5	n/a
Class 9	Molten Metal (Aluminium) UN Code 3257	>100	60	No limit	No limit

5.4 Level of Risk Assessment

According to SEPP 33, if any of the screening thresholds are exceeded then the proposed development should be considered potentially hazardous and a PHA is required to be submitted with the development application.

Also, if the quantities are close to the screening threshold values and the development site is near a sensitive receiver then the proposed development is also considered to be potentially hazardous and a PHA is required.

Based on the above assessments, the proposed development exceeds the storage threshold for Class 4.3 dangerous goods (aluminium dross). Aluminium dross can react with water to produce low levels of ammonia and acetylene. The dross generated at the Midal site is expected to contain 1-4% aluminium chlorides, 2-40% of Aluminium Carbide (Al_4C_3), and 1-4% of Aluminium Nitride (AlN) of which the last two are the more active components seen in aluminium dross from smelting processes such as that at Tomago. The remainder is aluminium or aluminium oxides.

Table 5.2 shows that the estimated vehicle movements for liquid aluminium (Class 9 under the Transportation Screening) also exceed the transportation screening threshold. Hence according to SEPP 33, the proposed facility is also considered to be potentially hazardous with respect to transportation. Although the transfer of liquid aluminium from the Tomago smelter to the Midal manufacturing facility involves a direct and designated route, SEPP 33 does not differentiate between industrial (private roads) and gazetted routes. If the proposed facility is found to be potentially hazardous, according to SEPP 33 a route evaluation study should be completed in accordance with HIPAP No. 6. It is argued here that SEPP 33 does not apply for this proposed facility with respect to transportation screening based on the following analyses/qualifications:

- Transfer of liquid aluminium involves most direct route within the Tomago Aluminium Corporation Buffer Zone. The buffer zone was developed to ensure that only land uses/activities that are compatible with the operation of the smelter are permitted within the zone;
- Proposed route does not use public roads, and will not pass any residential, public areas, schools etc.;
- Proposed route is designated for Tomago and Midal transport activities only, road is fenced, restricted trucks speed, and crucibles secured to trucks.

Based on the above qualifications, the proposed Midal manufacturing facility is not considered as potentially hazardous with respect to transportation screening. However, the proposed facility is considered potentially hazardous with respect to storage screening due to the quantity/inventory of aluminium dross (Class 4.3 dangerous goods) exceeding the screening threshold.

Therefore a PHA is required to be submitted with the development application with a medium potential for harm requiring a Level 2 – Partially Quantitative Approach.

6. Hazard Identification

6.1 General

Hazard identification represents a Level 1, or qualitative risk assessment and involves documenting all possible events that could lead to a hazardous incident. It is a systematic process listing potential causes and consequences (in qualitative terms). Reference is also made to proposed operational and organisational safeguards (and their basis) that would prevent such hazardous events from occurring, or should they occur, that would mitigate the impact on the plant, its equipment, people and the surrounding environment. This process enables the establishment, at least in principle, of the adequacy and relevancy of proposed safeguards.

The aim of the hazard identification study process is to highlight any residual risks associated with the interaction of the facility (as a whole) with the surrounding environment. A range of possible hazard scenarios was developed and ranked in terms of consequence and likelihood in consultation with the relevant stakeholders.

6.2 Hazard Identification Tables

The hazard scenarios identified are presented in Table 6.1. Each hazard scenario was evaluated in terms of consequence and likelihood using the scoring methodology from Table 3.1. A qualitative assessment of the resultant risk was then made, again using Table 3.1. The hazards identified are a result of deviation from normal operations and the qualitative risk assigned to each scenario takes into account the inherent and proposed physical, operational and organisational safeguards designed to reduce the consequence and likelihood of these hazards. Risks identified as high or extreme by the risk ranking matrix were carried forward for further analysis if the incident posed significant off-site risk.

It is important to understand that the selection of the qualitative consequence score (Table 3.1) for each hazard identified is based on the most likely consequence given the existing physical safeguards only. It does not consider the soft barriers such as control systems, training or standard operating procedures.

The likelihood score (Table 3.1) is an estimation of the likelihood of the nominated consequence occurring. Alternatively, the likelihood score may be considered as an estimation of the effectiveness of the inherent and proposed physical, operational and organisational safeguards.

6.3 Assumptions

In undertaking the Hazard Identification Study a number of assumptions were made. These include:

- All plant and equipment is installed and operated in accordance with appropriate Australian Standards, codes and guidelines;
- Dangerous goods quantities and locations are as notified to GHD Pty Ltd;
- Dangerous goods are stored in accordance with the ADG Code, relevant standards and guidelines even if not a licensable quantity; and
- All equipment and systems are designed to be inherently safe.

Table 6.1 - Hazard Identification

Plant	Hazard	Scenario	Consequence	Current Controls	C	L	R	Action
Metal Transfer Launder	Explosion	Some moisture left over after refractory repairs as the Caster will not have water cooled moulds	Possible explosion in contact with molten aluminium	Dry and cure all refractories before commissioning with aluminium. Prevent water in area from operations or roof leakage	3	C	H	Negligible off-site risk identified (incl damage, fatality or injury)
Crucible Transfer from Tomago	Spillage and Explosion	Hot metal spills onto wet ground	Possible explosion in contact with molten metal	Ensure transit path is high and dry and the crucible cannot spill or tilt. Rain is not a risk -	3	D	M	Negligible off-site risk identified (incl damage, fatality or injury)
Holding/Re-melt Furnace	Explosion	Air/fuel ratio Charging with Water leak into the pool of molten aluminium	Fuel control system Possible explosion in contact with molten Aluminium	AS3814 compliant gas fired system	3	C	H	Negligible off-site injury. Dry feed before usage.
Tilting Furnace	Explosion	Some non aluminium material/water charged into furnace with a molten heel.	Possible explosion in contact with molten aluminium	Screen all alloy feed to plant for water and similar liquids.	3	C	H	Negligible off-site risk identified (incl damage, fatality or injury). Limit use of water in area
	Explosion	Internal aluminium scrap with trapped moisture.	Possible explosion in contact with molten aluminium	Screen all internal scrap feed to plant for moisture containment. Scrap charge into the furnace when the furnace is empty.	3	C	H	Negligible off-site risk identified (incl damage, fatality or injury). Limit ingress of water into process
	Sudden emission of gases from impurity	Some contaminant in the feed to the plant	Possible offsite discharge	Pollution control equipment	2	C	M	Pollution control Equipment specified for likely event

Plant	Hazard	Scenario	Consequence	Current Controls	C	L	R	Action
Casting Wheel	Explosion	Water leakage from cooling water system into caster or from roof	Possible explosion in contact with molten aluminium	Ensure cooling water system is inspected and pressure tested regularly. Prevent water in area from operations or roof leakage	3	C	H	Negligible off-site risk identified (incl damage, fatality or injury)
Gas Supply		Rupture of pipe	Fire, explosion or personnel injury	Barriers erected around gas pipe in key areas. Main site gas reticulation line should be suspended from the wall or roof above and away from the reach of any Midal mobile equipment.	3	D	M	Possible off-site risk identified (incl damage, fatality or injury). Location of gas metering should be away from boundary to neighbours and away from vehicles. Bollards around metering station
Liquid Effluent.	Wastewater	Treated effluent is outside specification	Contamination of nearby water course.	On Site storage, and check before discharge	3	D	M	Some off-site risk to environment
Aluminium Dross	Potential for toxic or flammable gas emission (depending on dross make up)	Contact of dross with water on site during collection and internal transport	Generation of ammonia and/or acetylene below toxic or lower flammability limits.	Dross shall be kept away from water and under shelter. Storage of dross to be limited to a maximum of 4 tonnes.	2	C	M	Possible on site and off site odour/release
Lubricating oil - wire forming	Loss of Containment	Tank leakage or rupture	Leakage of contents into water courses	AS 3780 compliant bunding and tank to prevent loss of containment	1	E	L	Negligible off-site or on-site damage
Potable Water	Explosion	Pipe rupture	Water contacting molten aluminium	No water pipes in the furnace area	3	D	M	Negligible off-site or on-site damage

Plant	Hazard	Scenario	Consequence	Current Controls	C	L	R	Action
Stormwater Drainage	Contamination with chemicals	Pipe rupture or leakage	Leakage of contents into stormwater system	Roof water will be captured and used to supplement process water supply. Water will drain to existing site surface drainage at the south east of the site. General site hard stand and pavement storm water management details to be finalised. Infiltration systems are being considered.	2	D	L	Some off-site risk to environment
High Voltage Electrical System	Fire or explosion	Transformer fire or explosion	Plant shutdown, aluminium can be left in furnaces with no danger.	The transformer and sub-station are remote to the main plant, equipment and buildings (in its own enclosure). Regular servicing of switch gear and transformers are undertaken	2	C	M	No off-site risk identified (incl damage, fatality or injury)
Low Voltage Protection system	Electrical fire	Fire in sub station	Plant shutdown, aluminium can be left in furnaces with no danger.	Sub-station remote of plant equipment and buildings in its own enclosure. Regular servicing of switch gear are undertaken	2	C	M	No off-site risk identified (incl damage, fatality or injury)
Plant Control system	Loss of power	Plant shut down	Plant shutdown, aluminium can be left in furnaces with no danger.	Plant electrical controls housed in Control room and rated electrical cabinets rated to AS	1	C	L	No off-site risk identified (incl damage, fatality or injury)
Natural Hazards	Storm	Explosion	Water contacting molten aluminium	All furnaces housed inside buildings designed for high wind rating. Housed in covered storage.	3	D	M	Negligible off-site risk identified (incl damage, fatality or injury)
Natural Hazards	Storm	Explosion	Water contacting dross	The aluminium dross is recycled and transported out of the facility during the rod production step. Housed in covered storage.	3	D	M	Negligible off-site risk identified (incl damage, fatality or injury)

Plant	Hazard	Scenario	Consequence	Current Controls	C	L	R	Action
	Earthquake	Furnace rupture	Molten metal leaking out of the furnace	Metal spills contained within the metal casting building	3	D	M	No off-site risk identified (incl damage, fatality or injury)
	Fire	Plant shut down	Plant shutdown, aluminium can be left in furnaces with no danger.	Plant electrically isolated and no water sprayed into open furnaces.	3	C	H	No off-site risk identified (incl damage, fatality or injury)
	Aviation	Aircraft crash	Aircraft crashes into Metal casting building	None	4	E	M	No off-site risk identified (incl damage, fatality or injury)
	Flood	Plant shut down	Plant shutdown, aluminium can be left in furnaces with no danger.	Plant electrically isolated and no water sprayed into open furnaces.	3	C	H	No off-site risk identified (incl damage, fatality or injury)

6.4 Qualitative Analysis

Many of the scenarios identified in the hazard identification do not have a risk of off-site, or even on-site damage, fatality or injury. The following scenarios may have the potential for off-site impacts:

- Molten aluminium-water explosion;
- Fire, explosion or toxic exposure from the reaction of aluminium dross with water;
- Discharge of contaminated water from site;
- Fire/explosion from pipeline/fitting rupture/leak of natural gas supply;
- Fire/explosion at gas metering station; and
- Leakage of Caustic and entrainment within site runoff.

There were no plausible scenarios found for off-site events having potential on-site impacts:

Fire protection systems are required to protect plant buildings, equipment and personnel in the event of fire. Special application of AS 2444 and building fire suppression is required to ensure that fire extinguishers and water do not contact the aluminium in the process.

6.4.1 Molten Aluminium-Water Explosion

The scenario of a molten aluminium-water explosion resulting from water contacting molten aluminium in a furnace under certain conditions could conceivably occur if moisture was present in the scrap aluminium feed to the furnace. Water normally has to be trapped uner motlen aluminium for an effective explosion to occur. Aluminium Association data compiled in the past 19 years shows 25 severe molten aluminium-water explosions with 19 associated fatalities worldwide[7]. Impurities if present in scrap aluminium could also increase the risk of explosion. However, this risk is minimised as Midal will be using virgin molten aluminium from Tomago and will not be processing external aluminium scrap.

It is considered that most of the effect of the above scenarios would be limited to the site, however, given the possibility of overpressure and missile effects off-site, limited quantitative analysis was conducted.

6.4.2 Aluminium Dross – Water Reaction

This scenario could conceivably occur when the available aluminium carbides or aluminium nitrides in the dross held on site come in contact with water. This could potentially generate gas clouds of ammonia (toxic at low concentrations and flammable at high concentrations) and/or acetylene (flammable).

However the risk is minimised on the Midal site by limiting the storage of dross to four (4) tonnes with daily pickups for further processing at nearby dross processing facility.

6.4.3 Discharge of Contaminated Water from Site

This scenario could conceivably occur with the spillage of caustic and subsequent mixing with water. Given that the aluminium should not contact water and minimal additional chemicals are to be used, this is not considered likely.

The wastewater system proposed for the site is not associated with the aluminium processing. It would however be designed to engineering standards including adequate capacity for storm and contamination events.

6.4.4 Fire/Explosion at Branch Gas Supply Line

Fire/explosion resulting from leaks in the gas supply branch pipeline extending from the gas mains to the on-site gas metering station could result in high heat radiation levels with potential for off-site impacts. However, the likelihood of this occurring is considered to be low as the pipeline will be buried, fully welded and/or situated in a controlled industrial environment. As such it is not considered in the consequence analysis.

6.4.5 Fire/Explosion at Gas Metering Station

The branch gas pipeline rises from underground to aboveground at the gas metering station. Here the pressure is reduced from the feed pressure of 1,000 kPag to a proposed value of 100 kPag downstream in the reticulation system for gas appliance usage.

The worst-case scenario considered is that of an ignited gas release occurring at the gas metering station. The metering station is considered to have the highest potential risk because of the pressure and exposure to surrounding activities. Likely leak sources include piping connections and flanges. The potential for damage by impact from a vehicle crash on internal roads is also considered.

6.4.6 Leakage of Chemicals (Acids or oils)

The scenario of acids or oils leaking from an incident on-site was considered to have potential for off-site impacts. Such incidents could include seepage into the water system or into the drains and nearby watercourse. At this stage of the design, general site hard stand and pavement storm water management details are yet to be determined. It is expected that the water will drain to existing site surface drainage at the south east of the site. The standard bunding and piping system on-site is designed to minimize such incidents and to mitigate the impacts. Standard controls such as pipe inspections and containment approaches are also likely to be implemented.

7. Quantitative Risk Analysis

Based on the results of the Qualitative Risk Assessment, the following scenarios were identified as being worthy of a quantitative analysis:

- Damage to the above-ground section of the 100 mm NB branch gas pipeline at the gas metering station by vehicle impact;
- Flange leak in the above-ground section of the 100 mm NB branch gas pipeline at the gas metering station;
- Failure or damage to the 50 mm NB fuel gas piping connection on the gas metering station outlet; and
- Explosion resulting from the contacting of molten aluminium and water in a furnace.
- Reaction of the aluminium dross with water creating gas clouds of ammonia or acetylene.

7.1 Jet Fire

The worst-case scenario considered is that of an ignited gas release from the natural gas metering station. The metering station is considered to have the highest potential risk due to the elevated pressure and the likelihood of damage from surrounding activities. Modelling of a potential jet fire was performed for the above three scenarios.

The consequence analyses to determine the duration and magnitude of the potential jet fires and associated radiation levels are presented in Appendix I.

The expected frequencies of the hazard scenarios identified in Appendix I are calculated in Appendix II. These include flange leak, rupture of small bore connections and vehicle impact (with subsequent gas release).

7.2 Explosion

The scenario considered involving a molten aluminium-water explosion is that of 1 kg of water contacting molten aluminium. The effect of such an incident would be an explosive overpressure and the projection of missiles from the blast. For the projected missile to have off-site effect, the explosion would have to occur when the furnace lid were off, or through an open aperture of the furnace. Additionally, the projectile energy will be reduced by the surrounding melt material, air friction (drag) and penetrating the barrier of the surrounding building.

The consequence analysis to determine the likely overpressure of such a blast is presented in Appendix I. A semi-quantitative consideration of potential projectiles resulting from this blast is presented in Appendix II.

Given the calculated overpressure (2.5 kPa) at the site boundary (25m blast radius) is less than the lowest tabulated value (3.5 kPa) presented for the "Effects of Explosion Overpressure"[4], there is no perceived off-site risk generated by the overpressure of such a scenario. Additionally, given the low calculated probability ($<1 \times 10^{-8}$) of an off-site injury resulting from a projectile impact, the scenario of a molten aluminium-water explosion was not included in the calculation of off-site risk.

The scenario does pose an onsite risk and should be examined at an appropriate time in the design development phase of the project.

7.3 Reaction of Aluminium Dross

This scenario involves aluminium dross reacting with water from a rain event on the Midal site. This is examined semi quantitatively to initially understand the quantity and risk level posed by dross reaction to form ammonia and acetylene.

The key reactions are

$AlN + 3(H_2O) \rightarrow NH_3 + Al(OH)_3$, or

$2AlN + 3(H_2O) \rightarrow 2NH_3 + Al_2O_3$

These are exothermic reactions and so will heat up the water and thereby reduce the reaction rate by water evaporation to some extent. The key reaction properties are noted below to determine the potential rate of ammonia production.

Item	Value	Units	Reference/Assumption
Mass ratio of ammonia produced per kg of aluminium nitride	0.41	Ratio	Weston Aluminium PHA[20]
Mass ratio of ammonia produced per kg of water	0.32	Ratio	Weston Aluminium PHA[20]
Aluminium Nitride content in Dross	0.25	% w/w	Conservative figure from Weston Aluminium MSDS
Rainfall rate expected for region	24	mm/hr	Sustained rainfall[20]
Open area of bin	6	m^2	Estimated value
Mass of dross in bin	4	Tonnes	Estimated value
Mass of nitride in bin	100	kg	Average value

The theoretical rate of ammonia production per hour could be:

24mm/hr x 1 litre/m^2 x 1 kg/litre x 6m^2 bin area x 0.32kg ammonia per kg water = 45 kg/hr

This corresponds to a maximum release rate of about 9 grams per second. In reality, this would be a short peak rate, and not all of the active dross would react. The figure is therefore conservative. At this rate of release, the toxicity would extend for about 7 metres from the point source for a short period. The maximum quantity to produce is limited by mass content of the nitride. This corresponds to about 41 kg of ammonia. Not all of the water will convert to ammonia but a conservative assumption of 100% conversion to ammonia has been made.

The probability of a substantial rain event might be once every 10 years for this level of rainfall, and 1 in 40 for the dross to be exposed to the water at that time, either through roof leakage, or outside exposure. This could be in the order of a 1 in 400 year event.

Initial modelling on the conservative (high) values of release indicates a level of 47ppm at 7.3 metres away from the source. At 15 metres, the concentration is approximately 13ppm. Most boundary points would be about 20 metres away from the likely dross bin source. The occupational exposure limit for ammonia is 50 ppm TWA (Time Weighted Average) Current OSHA Permissible Exposure Limit, and IDLH (immediately dangerous to life and health) of 300-500 ppm are currently used as guidance.

It is possible that the release would be more of a nuisance odour issue at these projected levels of discharge than a toxic issue for personnel nearby. Immediately around a wetted dross bin, the concentrations would require respiratory equipment and adequate personal protective precautions.

This scenario was not modelled further due to the probability and consequence of offsite effects being fairly low. Controls used at Tomago are to keep the dross under cover, and only transport in the dry state. Similar controls should be used at Midal.

8. Risk Assessment

The PHA for the proposed aluminium rod casting and wire drawing facility was undertaken so as to satisfy the requirements of SEPP 33. SEPP 33 requires that the risk arising from a potentially hazardous development should be assessed against criteria presented in Hazardous Industry Planning Advisory Paper No. 4: Risk Criteria for Land Use Safety Planning[4]. The relative significance of quantified risk estimates can be assessed by comparison with other risks that people experience in everyday life. In setting risk criteria, the underlying principle is that people should not involuntarily be subject to risk from a development that is significant in relation to the background risk associated with the surrounding land use area classification.

8.1 Risk Evaluation – Qualitative Criteria

The methodology used to review the risks associated with the proposed aluminium rod and wire facility addressed the following qualitative criteria:

A All identified risks have been avoided and remaining risks have been reduced to as low as practicable.

The qualitative risk analysis has sought to identify all avoidable risks. Table 6.1 summarises how the design and installation of the proposed facility mitigates the risks through appropriate safeguards and barriers.

B Consequences of the more likely hazardous events are, wherever possible, contained within site boundaries.

The process of likely hazard scenario selection and quantitative assessment of consequence is described in Appendix I.

C Where there is an existing high risk, then the additional hazardous development does not add significantly to the risk.

The risk assessment process demonstrates that the proposed aluminium casting facility will not result in a significant increase in the risk off-site.

8.2 Risk Evaluation – Quantitative Criteria

A quantitative analysis as detailed in Appendices I and II was conducted for the following hazard scenarios:

- Gas release from the complete rupture of the above-ground section of the 100 mm NB branch gas pipeline at the metering station due to vehicle impact and consequent jet fire;
- Gas release from a 5 mm flange leak in the 100 mm NB branch gas pipeline at the gas metering station inlet and consequent jet fire; and

- Gas release from the complete rupture of a 100 mm NB piping connection on the outlet of the gas metering station and consequent jet fire.

The assessment criteria for individual fatality risk recommended by the DoP are summarised in Table 8.1. The criteria have been set on the basis that they represent very low risks compared to other everyday risks associated with the various land uses.

Table 8.1 - NSW Individual Fatality Risk Criteria[4]

Land Use	Acceptable Criteria (risk in millions per year)
Hospitals, schools, childcare facilities, old age housing	0.5
Residential, hotel, motels, tourist resorts	1
Commercial developments	5
Sporting complexes and active open space	10
Industrial	50

The heat radiation criteria used to identify various risk contours are shown in Table 8.2.

Table 8.2 - Effects of Heat Radiation[4]

Heat Flux (kW/m^2)	Effect
1.2	Received from the sun at noon in summer
2.1	Minimum to cause pain after 1 minute
4.7	Will cause pain in 15-20 seconds and injury after 30 seconds exposure (at least 2nd degree burns will occur)
12.6	Significant chance of fatality for extended exposure (10%, Technica, 1988) High chance of injury Thin steel may reach a thermal stress level high enough to cause structural failure
23	Likely fatality for extended exposure and chance of fatality for instantaneous exposure Unprotected steel will reach thermal stress temperatures that can cause failure.
35	Significant chance of fatality for people exposed instantaneously

It must be noted that the risk contour pertaining to property damage, individual fatality and personal injury are based on the heat flux contour of 23 kW/m^2, 12.6 kW/m^2 and 4.7 kW/m^2 respectively. It is assumed that the site boundary in closest proximity to the gas metering station is 25m WSW. The closest other land user is the Varley Kitchens facility which is adjacent to Midal on the south west side.

The results of the frequency and consequence calculations for the three scenarios are summarized in Table 8.3 below.

Table 8.3 - Calculated Frequency and Consequence Values

Scenario	1	2	3
Parameters	100mmNB Pipe (1000kPag)	5mm (1000kPag)	100mmNB Piping (100kPag)
	Pipe rupture	Flange Leak	Pipe Rupture
Gas Flow Rate (kg/s)	9.2	0.020	1.68
Release Duration (min)	Continuous	Continuous	Continuous
Jet Fire Length (m)	42	2.1	17.9
Jet Fire Diameter (m)	3.0	0.15	1.27
Distance to 23kW/m^2 (m)	44	2	19
Distance to 12.6kW/m^2 (m)	51	3	22
Distance to 4.7kW/m^2 (m)	70	4	30
Frequency of Gas Release (p.a.)	3.5 x 10^{-5}	2.3 x 10^{-5}	3.5 x 10^{-5}
Probability of Ignition	0.25	0.020	0.25
Frequency of Jet Fire (p.a.)	8.7 x 10^{-6}	4.6 x 10^{-7}	8.7 x 10^{-6}

8.2.1 Risk of Individual Fatality

As previously stated the calculated risk of individual fatality at the site boundary is based on the heat flux contour of 12.6 kW/m^2, the values relating to which are summarized in Table 8.4. The adjacent land use is known to be industrial.

Table 8.4 - Scenario Risk of Individual Fatality

Scenario	1	2	3
Parameters	100mmNB Pipe (1000kPag)	5mm (1000kPag)	100mmNB Piping (100kPag)
	Pipe rupture	Flange Leak	Pipe Rupture
Distance to 12.6kW/m^2 (m)	51	3	22
Frequency of Gas Release (p.a.)	3.5 x 10^{-5}	2.3 x 10^{-5}	3.5 x 10^{-5}
Probability of Ignition	0.25	0.020	0.25
Frequency of Jet Fire (p.a.)	8.7 x 10^{-6}	4.6 x 10^{-7}	8.7 x 10^{-6}
Probability of Fatality at Site Boundary	0.1	0	0.0
Risk of Fatality at Site Boundary (p.a.)	8.7 x 10^{-7}	0	0

It is noted that only scenario 1 presents an impact distance that could result in a fatality at the site boundary. The calculated risk of fatality at the site boundary (8.7 x 10^{-7}) is below the HIPAP criteria of 50 x 10^{-6} for the surrounding land uses (industrial). Additionally, given the extent of the buffer zone (150m) between the north eastern site boundary and the nearest other land user there is negligible risk of individual fatality at the nearest other land use site.

The individual fatality risk value at the property boundary is less than the HIPAP criteria for all adjacent land uses.

8.2.2 Injury Risk

The injury risk is based on the heat flux contour of 4.7 kW/m^2, at adjacent land uses. At this heat flux level 2nd degree burns may occur after 30 seconds exposure. It is expected that most individuals within this contour would take action to remove themselves from harm's way within 30 seconds. The results are summarised in Table 8.5.

Table 8.5 - Scenario Risk of Individual Injury

Scenario	1	2	3
Parameters	100mmNB Pipe (1,000k Pag)	5mm (1,000 kPag)	100mmNB Piping (100 kPag)
	Pipe rupture	Flange Leak	Pipe Rupture
Distance to 4.7kW/m^2 (m)	70	4	30
Frequency of Gas Release (p.a.)	3.5 x 10^{-5}	2.3 x 10^{-5}	3.5 x 10^{-5}
Probability of Ignition	0.25	0.020	0.25
Frequency of Jet Fire (p.a.)	8.7 x 10^{-6}	4.6 x 10^{-7}	8.7 x 10^{-6}
Probability of Injury at Site Boundary	1	0	1
Risk of Injury at Site Boundary (p.a.)	8.7 x 10^{-6}	0	8.7 x 10^{-6}

The impact distance of scenario 2 falls short of the site boundaries, however scenario 1 exceeds this distance. The radiation level from Scenario 3 would just reach the boundary. Hence the calculated risk of personal injury at the site boundary (p.a.) is 17.4 x 10^{-6}, well below the HIPAP criteria of 50 x 10^{-6} industrial land use. As with the case of individual fatality risk (given the extent of the buffer zone) there is negligible risk of injury at the nearest other land use site.

The personal injury risk value at the property boundary is less than the HIPAP criteria for all adjacent land uses.

8.2.3 Risk of Property Damage and Accident Propagation

The calculated frequency and consequence values (Table 8.3) were also used to estimate the risk of damage to property from heat radiation on unprotected steel, i.e. exposure to a heat flux of 23 kW/m^2. The results are summarised in Table 8.6.

Table 8.6 - Scenario Risk of Property Damage

Scenario	1	2	3
Parameters	100mmNB Pipe (1,000 kPag)	5mm (1,000 kPag)	100mmNB Piping (100 kPag)
	Pipe rupture	Flange Leak	Pipe Rupture
Distance to 23kW/m^2 (m)	44	2	19
Frequency of Gas Release (p.a.)	3.5 x 10^{-5}	2.3 x 10^{-5}	3.5 x 10^{-5}
Probability of Ignition	0.25	0.020	0.050
Frequency of Jet Fire (p.a.)	8.7 x 10^{-6}	4.6 x 10^{-7}	8.7 x 10^{-6}
Probability of Damage at Site Boundary	1	0	1
Risk of Damage at Site Boundary (p.a.)	8.7 x 10^{-6}	0	8.7 x 10^{-6}

Again, the impact distance of scenario 2 falls short of the site boundaries, however scenario 1 will potentially cause damage to property across the site boundary. Scenario 3 could just cause damage at the boundary. The risk of property damage caused by scenario 1 and 3 was calculated to be 17.4 x 10^{-6} (p.a.) and therefore below the HIPAP criteria of 50 x 10^{-6} adjacent industrial land use. With the addition of the buffer zone to residential areas there is negligible risk of property damage at neighbouring residential land use sites.

The calculated risk values for property damage on adjacent land is below the specified HIPAP criteria.

8.2.4 Societal Risk and Risk to the Biophysical Environment

The Australian Standard AS1940-2004 The Storage and Handling of Flammable and Combustible Liquids[8] states that "should alterations on the adjacent property result in a breach of the requirements for separation distance, the installation shall be modified or relocated to restore compliance or will be taken out of service."[8]

It is important to note that the quantitative risk assessment is not assessing the impact on sensitive land users, as there are currently no residential neighbours in close vicinity to the site. Therefore the site was assessed assuming industrial usage of the adjoining areas. The quantitative risk assessment was used to identify the potential zone of effect on the adjoining properties should a jet fire occur.

While this could appear to restrict neighbouring developments occurring within this zone in the future, it should be noted that the associated risks are all less than the respective 'sporting complexes and active open space' HIPAP criteria. Other potential high consequence/low frequency events have been reviewed in the hazardous scenario identification, described in Section 6. All credible hazard scenarios have been considered.

8.2.5 Risk Evaluation – On Site Risks

The intention of the DoP criteria from HIPAP 4 [4] is to quantify the acceptable level of externally generated risk. An individual fatality risk value of 50 x 10^{-6} per year is suggested for surrounding industrial sites. The quantitative risk level calculated for an individual fatality at the site boundary (refer Section 8.2.1) was well below this value, which would suggest an acceptable level of onsite risk. Along with utilising safety in design criteria during the design process, an onsite risk evaluation study should be conducted at the appropriate stage of project development to verify the level of onsite risk.

8.3 Management of Residual Risk

The qualitative risk assessment identified control measures, safeguards and procedures that will be put in place, as well as recommending additional actions to reduce the level of risk associated with the installation of the proposed Midal Cable aluminium rod casting and wire drawing facility. These actions are summarised in the Hazard Identification in Table 6.1.

In addition a HAZOP should be conducted on the proposed Midal aluminium facility at 85% design progress, and prior to construction so as to review the hazards, controls and associated risks in greater detail. The quantitative risk assessment has identified residual risk associated with the Midal aluminium casting and drawing facility. One of the most effective means of ensuring the ongoing safe operation of a facility is through implementing a comprehensive Safety Management System, such as those in place at existing facilities, as per Midal's Safety Management Procedure. Such a system will ensure that hazards associated with the site are identified and managed, so that all activities are undertaken in a safe manner.

The risks associated with the proposed Midal aluminium casting and wire making facility are within the HIPAP criteria for acceptable risk in industrial land use areas.

9. Conclusions and Recommendations

The proposed Midal aluminium casting and drawing facility and associated infrastructure will generate up to 50,000 tonnes of rod and wire aluminium annually.

Based on Table 5.1 the SEPP 33 threshold screening value was exceeded by the storage of aluminium dross, which are classified as Class 4.3 dangerous goods. The threshold quantity is 1 tonne and the proposed storage quantity of aluminium dross is 4 tonnes. Table 5.2 indicates the transportation screening thresholds for molten aluminium classified as Class 9 dangerous goods) exceeded the threshold on the basis of the maximum weekly delivery frequency. However, it was justified that transfer of molten aluminium between the Tomago smelter and the Midal manufacturing facility are within the established buffer zone, with no potential impact to residential or public areas and therefore the application of SEPP 33 with respect to transportation screening is not valid for the proposed facility. Overall, the proposed development is potentially hazardous with respect to storage of dangerous goods and hence a PHA is required to be submitted with the development application.

The qualitative risk assessment/hazard identification study identified a number of possible hazard scenarios of high risk due to unacceptable potential consequences and/or possible likelihoods that may result in risks to surrounding land users. These included:

- Discharge of contaminated water from site;
- Release of ammonia from wetted dross;
- Fire/explosion from pipeline/fitting rupture/leak of natural gas supply;
- Fire/explosion at gas metering station; and
- Leakage of Chemicals and entrainment within site runoff.

None of the other hazard scenarios identified had the potential to present an unacceptable risk to the surrounding land users. However, the high and medium risk scenarios identified with potential off site impact have confirmed the development to be both a potentially offensive and potentially hazardous industry in relation to SEPP 33. Consequently adequate safeguards are required to ensure any hazardous or offensive situations arising due to the development are contained or at least controlled to an acceptable level.

Based on the results of the qualitative risk assessment, the following scenarios associated with fire/explosion at the gas metering station were identified as being worthy of a quantitative analysis:

- Gas release from the complete rupture of the above-ground section of the 100 mm NB branch gas pipeline at the metering station due to vehicle impact and consequent jet fire;
- Gas release from a 5 mm flange leak in the 100 mm NB branch gas pipeline at the gas metering station inlet and consequent jet fire; and
- Gas release from the complete rupture of a 100 mm NB piping connection on the outlet of the gas metering station and consequent jet fire.

The cumulative risk values for off-site fatality, injury and damage at the site boundary were below the HIPAP criteria for the identified adjacent land uses (industrial). Further, given the extent of the buffer zone to existing neighbours there is no perceived fatality, injury or property damage risk at the closest other land users. Similarly the on-site fatality risk values for industrial sites were well below the suggested criteria.

The length of the potential jet fire resulting from damage to the 100 mm NB branch gas pipeline due to vehicle impact could extend off-site, which may restrict neighbouring developments occurring within this zone in the future. With correct passive controls, this risk is negligible. It should, however, be noted that the associated risks at the site boundary are all lower than the respective 'sporting complex and active open space, or industrial' HIPAP criteria.

It is recommended that safeguards be employed to ensure any loss scenario involving the failure of pipes and/or fittings at the gas metering station are kept to a minimum. There are three strategies for reducing risk: elimination, management and mitigation. The complete elimination of the potential loss scenario is not an option considered for this development as natural gas is the primary fuel source for the process. Therefore risk management and mitigation procedures need to be employed.

It is also recommended that management procedures be implemented that incorporate practices that will prevent risk scenarios occurring through:

- Minimising build-up of combustible materials on-site;
- Installing bollards/protective barriers around gas metering station;
- Screening for water containers of any sort before going to the aluminium casting facility;
- Drying all feed before melting in the recycling plant;
- Screening for water of all non internally generated scrap and alloying material from furnace feed;
- Providing closed skips, or under cover storage for aluminium dross;
- Separation of, or tightly controlled usage of water around the casting area; and
- Building design to avoid inadvertent water leakage into the casting area.

Mitigation measures are practices that control the impact after a risk scenario has occurred. It is recommended that emergency management procedures be developed for response to fire and explosion that may be initiated from either on-site or off-site sources.

The risk of the explosion of water in contact with molten aluminium mainly poses an on-site risk. It should therefore be examined in more detail during the design and construction phase of the project.

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11. Glossary

Term	Meaning
AAAC	All Aluminium Alloy Conductor
ACAR	Aluminium Conductor Alloy Reinforced
ACSR AS	Aluminium Conductor Aluminium Clad Steel Reinforced
ADG	Australian Dangerous Good Code
Degassing	The process by which dissolved gas is removed from water or other liquid solutions
ºC	Degrees Celsius
DG	Dangerous Good
DoP	Department of Planning
DP	Development Plan Number
Drossing	A process used in nonferrous pyrometallurgy for removing solid oxide deposits on the surface of a molten metal.
EC	Electrical Conductor Grade Aluminium
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EPA	Environment Protection Authority
Ha	Hectare
HIPAP	Hazardous Industry Planning Advisory Papers
IDLH	Immediately Dangerous to Life and Health
KL	Kilolitre
kPag	Kilopascal pressure (gauge)
kV	Kilovolt
m	metre
m^3	Cubic metre
mm	Millimetre
MVA	The unit of apparent power in a circuit
NB	Nominal Bore
PEL	Permissible Exposure Limit
PHA	Preliminary Hazard Analysis
PPM	Parts Per Million concentration
SEPP	State Environment Planning Policy
TAC	Tomago Aluminium Corporation
TWA	Time Weighted Average
UN Code	United Nations Code (for chemicals)

Appendix A

Consequence Analysis

AI.1 INTRODUCTION

The consequences of the hazard scenarios identified in Section 7 of the report are calculated in the following sections. These are:

- Jet fire resulting from gas release (vehicle impact, flange leak or connection failure);
- Molten aluminium-water explosion resulting from moisture in the aluminium scrap feed to a furnace.
- Reaction of aluminium dross with water.

AI.2 METHODOLOGY

The methodology is consistent with that presented by Lees (1996)[9] and used in previous GHD risk assessments.

AI.3 JET FIRE

The scenarios considered are those of an ignited gas release from; complete rupture of the aboveground portion of the 100 mm NB branch gas pipeline at the inlet to the gas metering station due to vehicular impact, leak in 5 mm flange on the 100 mm NB branch gas pipeline at the inlet to the gas metering station and the complete rupture of a 50 mm NB piping connection on the metering station outlet. Catastrophic failure of a pipe connection will result in a sustained release of gas under pressure, potentially resulting in a jet fire.

For the purposes of the calculations, it is assumed that the fire is based on the formation of an unobstructed, turbulent free jet.

The models used to calculate the magnitude and radiation levels of the resulting fire scenarios are presented in Lees (1996)[9].

AI.3.1 Jet Fire Gas Flow

Gas flow from both the high pressure sections of the facility (approximately 1 MPag on the inlet to the metering station and 0.1 MPag on the outlet respectively) will be critical, i.e. sonic or choked. The discharge rate (G) is calculated using the following formula from Coulson et al (1999)[10]:

$$G = C_d . A_r . P_1 . \left[\left(\frac{M.\gamma}{R.T_1} \right) . \left(\frac{2}{\gamma + 1} \right)^{\left(\frac{\gamma+1}{\gamma-1} \right)} \right]^{\frac{1}{2}}$$

Where:
C_d = discharge coefficient (assumed 0.61)
A_r = effective open area (m^2)
P_1 = initial release pressure (Pa)
M = molecular weight (assumed methane, 0.016 kg/mol)
R = universal gas constant (8.314 J/mol.K)
T_1 = initial release temperature
γ = Specific heat ratio, assumed 1.4

AI.3.2 Jet Fire Magnitude

It is generally assumed that the flame will have approximately the same length as an unignited jet[11].

The shape of the gas jet release and the resultant jet fire can be approximately predicted using models from TNO (1979 & 1992)[12]. The jet is modelled as a long cylinder at ambient conditions.

The jet diameter (df) is given by:

$$d_f = \frac{D_o}{2.K_1.\sqrt{b_2}}$$

Where: D_o = diameter of the rupture in gas flow calculations (m)

$$K_1 = \left(\frac{0.32.\rho_a}{\sqrt{\rho_o}}\right).\left(\frac{b_1}{b_1 + b_2}\right).j$$

$b_2 = 23 + 41.\ \rho_a$

ρ_o = density of gas at outflow conditions (kg/m^3)

ρ_a = density of gas at ambient conditions (kg/m^3)

$b_1 = 50.5 + 48.2.\ \rho_a - 9.95(\rho_a)^2$

j = composition at the end of the flare, assumed 0.05 vol fraction

The flow is assumed to reach ambient conditions instantaneously so the jet diameter can be considered as being coincident with the discharge point.

The jet length (Lf) is given by:

$$L_f = \frac{D_o}{K_1}$$

For radiative heat transfer calculations, Technica (1988)[11] recommends using a flare length based on a boundary concentration of the gas lower flammable limit divided by 1.5, as opposed to the LEL value of 0.05. The actual flare length is still calculated using the value of 0.05.

AI.3.3 Jet Fire Radiation

The model used for calculation of the radiation from the jet fire is from Lees (1999)[9] and is an extension of the model from API RP521 ‘Flare Radiation’.

The radiated heat from the midpoint on the flare centreline (Qp) is given by:

$$Q_p = n.G.H_c$$

Where: n = efficiency factor, assumed 0.35

G = total gas release rate (kg/s)

H_c = heat of combustion (kJ/kg)

The heat radiation (I) from the midpoint on the flare centreline to a receptor at distance r, is given by:

$$I = \frac{X_g . Q_p}{4.\pi .r^2}$$

Where: $X_g = 1 - 0.0565 \ln x$

A conservative assumption is that the total heat flux is radiated from the mid point of the flare to a receptor, e.g., for the horizontal jet fire it would be from the mid point of the flame.

AI.3.4 Results

The results of the consequence analysis are summarised in Table AI.1.

Table AI.1 - Jet Fire Consequence Analysis Results

Scenario	1	2	3
Parameters	100mmNB Pipe (1,000 kPag)	5mm (1,000 kPag)	100mm NB Pipe (100 kPag)
	Pipe rupture	Flange Leak	Pipe Rupture
Gas Flow Rate (kg/s)	9.2	0.020	1.68
Release Duration (min)	Continuous	Continuous	Continuous
Jet Fire Length (m)	42	2.1	17.9
Jet Fire Diameter (m)	3.0	0.15	1.27
Distance to 23kW/m^2	44	2	19
Distance to 12.6kW/m^2	51	3	22
Distance to 4.7kW/m^2	70	4	30

AI.4 Explosion

The scenario considered is that of 1kg of water (0.001m3) contacting molten aluminium in a furnace. The process is considered in two steps; firstly the water is heated at constant volume to 985K, resulting in a large pressure build up; secondly the resultant vapour undergoes a reversible isothermal expansion to atmospheric pressure. The initial pressure of the vapour after the first step is calculated using the ideal gas equation,

$$P = \frac{nRT}{V}$$

Where: P = pressure (Pa)
n = number of moles of gas
R = universal gas constant (8.314 J/mol.K)
T = temperature of the gas (K)
V = initial volume of gas (m^3)

The ideal work resulting from the second step is calculated using the following formula from Sandler (1999)[13];

$$W = \int_{V_B}^{V_E} P_E dV$$

$$W = nRT \int_{V_B}^{V_E} \frac{1}{V} dV$$

$$W = nRT \ln \frac{V_E}{V_B}$$

But: $$\frac{V_E}{V_B} = \frac{P_B}{P_E} = nRT$$

Hence: $$W = nRT \ln \frac{P_B}{P_E}$$

Where W = Work (KJ)
P_B = Initial pressure (Pa)
P_E = Final pressure (Pa)
V_B = Initial volume (m^3)
V_E = Final volume (m^3)
n = Number of moles of gas
R = Universal gas constant (8.314 J/mol.K)
T = Temperature of the gas (K)

The calculated maximum theoretical work is presented below.

Mass H_2O (kg)	1
Moles *n* (mole)	55.6
Temperature *T* (K)	985
Initial Pressure P_B (kPa)	455,325
Final Pressure P_E (kPa)	101.3
Total Work *W* (KJ)	3,829

Literature sources[14] suggest an explosive efficiency (energy transferred to shock wave) for a pressure burst explosion of 30% to 40% of the maximum theoretical reversible work output. Taking the worst-case efficiency (40%) the resultant blast energy is 1.5 MJ.

By utilizing the TNT equivalence method for the prediction of blast effects, presented by Tweeddale (2003)[15], it was calculated that the blast energy of 1.5 MJ is equivalent to 0.33 kg of TNT. The TNT mass equivalent was then used to calculate the “scaled distance”.

$$\text{Scaled distance } (\lambda) = \frac{radius\,(m)}{TNTmass\,(kg)^{0.333}}$$

Use of the scaled distance in conjunction with Figure 5-13 of Tweeddale (2003)[15] allows for calculation of incident overpressure for ground level explosions. The blast radii considered were 25 m (site boundary) and 50 m (off-site).

The results of the consequence analysis are presented below.

Blast Radius (m)	25	50
Overpressure (kPa)	2.5	1.5

Appendix B

Frequency Analysis

AII.1 INTRODUCTION

The frequencies of the hazard scenarios identified in Appendix I are calculated in the following sections. The expected frequency is needed to enable a calculation of the risk. The scenarios are:

- Vehicle impact and subsequent gas release
- Flange leak; and
- Small bore pipe rupture
- Missile projected from molten aluminium-water explosion striking an individual off-site

AII.2 METHODOLOGY

The methodology chosen is consistent with that used in previous GHD risk assessments.

AII.3 NUMBER OF RELEASE SOURCES

It is assumed that there is one release source for each scenario.

AII.4 LEAK FREQUENCIES

AII.4.1 Vehicle Impact and Gas Release Frequencies

The potential vehicle impact scenario leading to a gas release from pipe or tubing rupture considered was the impact of a vehicle with the gas metering station area.

Quantification of the likelihood of vehicle impact and subsequent gas release through rupture has been undertaken using the traffic accident methodology of the NSW RTA Road Design Guide, Section 6 (1993)[16].

AII.4.1.1 Internal Vehicle Impact

The expected frequency of vehicle collisions with the gas metering station can be calculated based on traffic density, speed and road geometry. The calculations determine the frequency of "run off the road" incidents that will impact an identified hazard:

Crashes per year (N) = 0.00037 x Q x (a + b) x r x g x w

where
Q = annual average daily traffic, estimated as 19 vpd
a = 0.011 from Figures 6.7
b = 0.007 from Figure 6.7
r = 1
g = 1
w = 1.4 (unsealed road)

Therefore, N = 1.8 x 10^{-4}. Additionally, the probability of an internal vehicle crash actually rupturing a gas line is considered to be 0.2. Hence, the frequency of gas release due to vehicle impact was calculated to be 3.5 x 10-5 per year.

AII.4.2 Flanges

Estimate of section leak frequency of flanges, from HSE (1997)[17], is 2.3 x 10^{-5} per year.

AII.4.3 Small Bore Connections

Estimate of rupture leak frequency of small-bore connections, from Cox et al (1990)[18], is 1 x 10^{-5} per year.

AII.4 IGNITION PROBABILITY

Once a gas leak has occurred for a jet fire to ensure the escaping gas must be ignited by an ignition source. Ignition probability is dependent on the extent of the gas leak as well as the position of the ignition source in the surrounding area.

HSE (1997)[17] suggests that the ignition probability of a gas release involving a vehicle impact is 0.25 due to the increased likelihood of ignition sources resulting from the impact.

The European Gas Pipeline Incident Data Group (1988)[17] suggests that the ignition possibilities of; pipe cracks (flange leak) and ruptures (<16 in) are 0.02 and 0.05 respectively.

AII.5 Results

The results of the frequency analysis are summarised in Table AII.1.

Table AII.1 – Jet Fire Frequency Analysis Results

Scenario	1	2	3
Parameters	100mmNB Pipe (1000kPag)	5mm (1000kPag)	100mm NB Pipe (100kPag)
	Pipe rupture	Flange Leak	Pipe Rupture
Frequency of Gas Release	3.5 x 10^{-5}	2.3 x 10^{-5}	3.5 x 10^{-5}
Probability of Ignition	0.25	0.020	0.050
Frequency of Jet Fire	8.7 x 10^{-6}	4.6 x 10^{-7}	8.7 x 10^{-6}

AII.6 PROJECTILE IMPACT OFF-SITE

The range of a projectile resulting from a molten aluminium-water explosion is considered to be 1 km. Hence the area of potential projectile impact is 3.14 km^2. Given the general design of furnaces and the presence of obstructions to the trajectory of any potential projectile, the probability of a projectile getting a clear trajectory from the furnace is considered to be less than 5%. The surrounding area has a low population density and it is therefore considered that there would typically be no more than 500 people within the 1 km radius. Assuming that each person has an exposed area of 0.5m^2 the total exposed area of people within 1 km is 250m^2. Most of these people will be within buildings or vehicles where some protection is offered; therefore the probability of a direct hit to an individual is considered 10%.

The cumulative probability of an off-site projectile impact without consideration of the probability of the initiating event (molten aluminium-water explosion) is 4 x 10^{-7}. When the probability of the initiating event is included the probability of an off-site projectile impact would reduce by at least an order of magnitude. Therefore, due to the very low relative probability of an off-site projectile impact, this scenario was not included when conducting the site risk analysis.

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