



**REVISED PRELIMINARY HAZARD ANALYSIS,
MODIFICATION APPLICATION TO MP06-0228 MOD 16 & 17,
SHOALHAVEN STARCHES EXPANSION PROJECT,
PROPOSED NEW SPECIALTY PROCESSING FACILITY,
NEW GLUTEN DRYER AND OTHER ASSOCIATED WORKS
AT 22, 24 AND 171 BOLONG ROAD, BOMADERRY, NSW**

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**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**

Disclaimer

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Rev	Date	Description	Reviewed By
A	12/3/18	Draft for Comment	Shoalhaven Starches
B	15/5/18	Final Issue	Shoalhaven Starches
C	29/5/20	MOD 17 and Dryer 9 Added	Shoalhaven Starches
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EXECUTIVE SUMMARY

The Shoalhaven Starches factory located on Bolong Road, Bomaderry, produces a range of products for the food, beverage, confectionary, paper and motor transport industries including starch, gluten, glucose and ethanol.

In 2018, Shoalhaven Starches proposed modifications to the Shoalhaven Starches Expansion Project Approval (MP06_0228 MOD 16). These were assessed via a Preliminary Hazard Analysis (PHA) (Rev 1) and subsequently approved.

In April 2020, Shoalhaven Starches proposed:

1. An amendment to the siting and footprint of the Product Dryer building (Gluten Dryer No. 8) from that which was approved under Mod 16; and
2. An amendment to the footprint for the Specialty Products Building from that which was approved under Mod 16.

These two amendments (MOD 17) were assessed (Ref 2) with an assessment letter issued.

Shoalhaven Starches propose to construct an additional dryer (Dryer 9) within the Specialty Products Building. As this is a separate processing plant to the Specialty Products Plant (within the same building) then the original 2018 MOD 16 PHA, i.e. this report, has been updated with the Dryer 9 details and a corresponding assessment.

To facilitate easier reading and understanding, all new information in this report is shown in blue text. The text shown in black has not been changed as a result of the assessment for Dryer 9 and relates to already approved plant and equipment.

The risks associated with the proposed modifications to MP06-0228 at the Shoalhaven Starches Bomaderry site, including Product Dryer 9 and the MOD 17 changes, have been assessed and compared against the DoP risk criteria in this report.

The results are as follows and show compliance with all risk criteria.

Description	Risk Criteria	Risk Acceptable?
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year	Yes
Fatality risk to residential and hotels	1×10^{-6} per year	Yes
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year	Yes
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year	Yes
Fatality risk to be contained within the boundary of an industrial site	50×10^{-6} per year	Yes

Description	Risk Criteria	Risk Acceptable?
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m ² at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50 x 10 ⁻⁶ per year	Yes
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10 x 10 ⁻⁶ per year	Yes
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50 x 10 ⁻⁶ per year	Yes
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m ² or explosion overpressures of 14 kPa in adjacent industrial facilities	50 x 10 ⁻⁶ per year	Yes

Societal risk, area cumulative risk, environmental risk and transport risk is also concluded to be acceptable.

The primary reasons for the low risk levels from the modifications are that significant levels of impact from potential hazardous events are contained on-site.

The following recommendation is made from this review.

1. For all explosion vents that vent directly to atmosphere for the modifications, finalise the explosion vent modelling when the design details are known.
2. Review the option for installing initial screening, e.g. a magnetic separator, at the new intake pit to lower the likelihood of foreign objects entering the new bucket elevator and the downstream existing silos.
3. Ensure that all the proposed explosion vents are directed to a safe location to avoid injury to personnel or propagation to other adjacent equipment.
4. It is recommended that the floor of the new switchroom be fire-rated given the risk of a fire in the existing switchroom below. This will also help prevent a fire in the new switchroom propagating to the existing switchroom below.

In addition, there are also actions from the hazardous event identification exercise performed on the modified starches plant. These are shown in Appendix K of this report.

GLOSSARY

ALARP	As Low As Reasonably Practicable
AS	Australian Standard
ATEX	ATmosphères EXplosibles
BPCS	Basic Process Control System
CCPS	Center for Chemical Process Safety
DoP	NSW Department of Planning
DP	Differential Pressure
EPA	Environmental Protection Authority
GD	Gluten Dryer
HCl	Hydrochloric Acid
HEART	Human Error Assessment and Reduction Technique
HIPAP	Hazardous Industry Planning Advisory Paper
HSE	Health and Safety Executive (UK)
IBC	Intermediate Bulk Container
IDLH	Immediately Dangerous to Life and Health
IEC	International Electrotechnical Commission
IECEX	International Electrotechnical Commission Explosive
IPL	Independent Protection Layer
LEL	Lower Explosive Limit
LOPA	Layers of Protection Analysis
LTI	Lost Time Injury
MEC	Minimum Explosive Concentration
MIE	Minimum Ignition Energy
MTI	Medical Treatment Injury
NFPA	National Fire Protection Association
PFD	Probability of Failure on Demand
PHA	Preliminary Hazard Analysis

P&ID	Piping and Instrumentation Diagram
PM	Preventative Maintenance
PPE	Personal Protective Equipment
PRM	Pinnacle Risk Management
SD	Starch Dryer
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SO _x	Sulphur Oxides
STEL	Short-Term Exposure Limit
TDS	Total Dissolved Solids
TLV	Threshold Limit Value
TWA	Time Weighted Average
WWTP	Waste Water Treatment Plant

REPORT

1 INTRODUCTION

1.1 BACKGROUND

Shoalhaven Starches is a member of the Manildra Group of companies. The Manildra Group is a wholly Australian owned business and the largest processor of wheat in Australia. It manufactures a wide range of wheat-based products for food and industrial markets both locally and internationally.

The Shoalhaven Starches factory located on Bolong Road, Bomaderry, produces a range of products for the food, beverage, confectionary, paper and motor transport industries including starch, gluten, glucose and ethanol.

In 2018, Shoalhaven Starches proposed modifications to the Shoalhaven Starches Expansion Project Approval (MP06_0228 MOD 16). These were assessed via a Preliminary Hazard Analysis (PHA) (Rev 1) and subsequently approved.

In April 2020, Shoalhaven Starches proposed:

1. An amendment to the siting and footprint of the Product Dryer building (Gluten Dryer No. 8) from that which was approved under Mod 16; and
2. An amendment to the footprint for the Specialty Products Building from that which was approved under Mod 16.

These two amendments (MOD 17) were assessed (Ref 2) with an assessment letter issued.

Shoalhaven Starches propose to construct an additional dryer (Dryer 9) within the Specialty Products Building. As this is a separate processing plant to the Specialty Products Plant (within the same building) then the original 2018 MOD 16 PHA, i.e. this report, has been updated with the Dryer 9 details and a corresponding assessment.

To facilitate easier reading and understanding, all new information in this report is shown in blue text. The text shown in black has not been changed as a result of the assessment for Dryer 9 and relates to already approved plant and equipment.

The 2018 modifications to the Shoalhaven Starches Expansion Project Approval (MP06_0228) were as follows:

1. Utilise grain that is currently approved to directly feed the fermentation process in the ethanol production process to instead increase the amount of flour that is produced on site. This will also result in increased starch and gluten production. Shoalhaven Starches propose to install a third flour mill 'C' within the existing flour mill B building to further increase the proportion of flour that is manufactured on the site;
2. Undertake modifications to the existing flour mills A and B by modifying the type of ventilation used within the buildings from a vacuum to a pressurised system;
3. Construct a new industrial building that will be located between the remaining "Moorhouse" Maintenance Building and adjoining the Starch Dryer No. 5 building to the west of Abernethy's Creek. This new industrial building / complex will contain the following processes:
 - The resultant increase in starch and gluten production will require the conversion of two existing gluten dryers (No's 1 and 2) into starch production and the construction of a new gluten dryer (to replace the capacity lost by the conversion of Dryers No's 1 and 2 to starch). This new gluten dryer will be housed in the new industrial building;
 - Shoalhaven Starches propose to produce a range of specialised products as an extension to their existing product line. The specialty products will comprise a range of modified starches for both paper manufacturing as well as food production. The plant and equipment associated with the processing of these specialty products will be housed within the new industrial building;
4. Install a new baghouse filter for Starch Dryer No. 5;
5. Construct a coal-fired cogeneration plant to the south of the existing boilerhouse complex that will generate 15 MW of electrical power. This cogeneration plant will include the installation of a new coal fired boiler (No. 8). The construction of this new cogeneration plant and boiler (No. 8) will necessitate the relocation of the existing Boiler No. 7 to the northern side of the overall boilerhouse complex;
6. Construct an indoor electrical substation on the northern side of Bolong Road (No. 171), i.e. adjacent to the BOC Carbon Dioxide Plant, to provide an increase in electrical power to serve the power supply requirements associated with this Modification Proposal;
7. Install an additional rail intake pit for the unloading of rail wagons;
8. Construct an extension to an existing electrical sub-station (second storey extension) that is located within the main factory site. The additional

substation is to enable increased power supply to the site to also accommodate the requirements for the modification proposal; and

9. The extension to the height of the Interim Packing Plant building to accommodate additional sifting equipment to enable Shoalhaven Starches meet customer requirements who now require smaller particle size for dried product.

The MOD 17 changes are detailed as follows:

1. Amend the siting and footprint of the Product Dryer building (Gluten Dryer No. 8) from that which was approved under Mod 16. This is required for a change in the equipment orientation as well as additional processing equipment to that which was originally envisaged due to constraints in the existing plant; and
2. Amend the footprint for the Specialty Products Building from that which was approved under Mod 16. This is required to allow improved mobile equipment access at the north end of the building. Also, the chemical storage tanks (caustic soda, hydrochloric acid and cationic reagent) are to be relocated to the south of the GD8 building (i.e. further away from Bolong Road).

Shoalhaven Starches propose to install a Product Dryer (No. 9) within the footprint of the Specialty Products Building as approved under Mod 16.

Shoalhaven Starches are undertaking a staged approach to implementing the construction and installation of plant associated with Mod 16 to better meet market demand:

- Stage 1 will involve construction of the Specialty Products Building which will include installation of the proposed Product Dryer 9; and
- Stage 2 will involve construction of the Product Dryer Building which will house Gluten Dryer 8.

Product Dryer 9 will be a smaller Product Dryer comprising about 20% of the size and production capacity of the approved but yet to be constructed Gluten Dryer 8. It is envisaged that Product Dryer 9 will be used on an interim basis to process gluten allowing an incremental increase in processing of gluten until such time as the new Product Dryer Building (approved under Mod 16) is completed and Gluten Dryer 8 is commissioned.

Once the New Product Dryer Building is constructed and Gluten Dryer 8 is commissioned, it is envisaged that the smaller Product Dryer 9 will revert to processing starch as part of the Specialty Products production processes.

The proposed Product Dryer 9 will sit entirely within the footprint of the approved Specialty Product Building footprint. An emissions stack associated with Product Dryer 9 will rise above and through the roof of this building to a height of 35.6 metres. This structure will have a similar height to adjacent approved structures including the approved baghouse which has a height of 36 metres and approved product silos which will have a height of 35 metres above ground level.

The proposed Product Dryer 9 will not result in any increase in production above the current approval limitation for flour processing under Mod 16 of 25,400 tonnes per week.

As part of the project requirements, a Preliminary Hazard Analysis (PHA) is required. Shoalhaven Starches requested that Pinnacle Risk Management update the 2018 PHA for MOD 17 and Dryer 9. This PHA has been prepared in accordance with the guidelines published by the Department of Planning (DoP) Hazardous Industry Planning Advisory Paper (HIPAP) No 6 (Ref 3).

1.2 OBJECTIVES

The main aims of this PHA study are to:

- Identify the credible, potential hazardous events associated with the proposed modifications;
- Evaluate the level of risk associated with the identified potential hazardous events to surrounding land users and compare the calculated risk levels with the risk criteria published by the DoP in HIPAP No 4 (Ref 4);
- Review the adequacy of the proposed safeguards to prevent and mitigate the potential hazardous events; and
- Where necessary, submit recommendations to Shoalhaven Starches to ensure that the proposed modifications are operated and maintained at acceptable levels of safety and effective safety management systems are used.

1.3 SCOPE

This PHA assesses the credible, potential hazardous events and corresponding risks associated with the Shoalhaven Starches proposed modifications to MP06_0228 MOD 16 with the potential for off-site impacts only.

As there are no significant quantities of Dangerous Good involved with these modifications then off-site transport risk assessment for acute hazardous events is not warranted to be assessed.

1.4 METHODOLOGY

In accordance with the approach recommended by the DoP in HIPAP 6 (Ref 3) the underlying methodology of the PHA is risk-based, that is, the risk of a particular potentially hazardous event is assessed as the outcome of its consequences and likelihood.

The PHA has been conducted as follows:

- Initially, the proposed modifications and their location were reviewed to identify credible, potential hazardous events, their causes and consequences. Proposed safeguards were also included in this review;

- As the potential hazardous events are located at a significant distance from other sensitive land users, the consequences of each potential hazardous event were estimated to determine if there are any possible unacceptable off-site impacts;
- Included in the analysis is the risk of propagation between the proposed equipment and the adjacent processes; and
- If adverse off-site impacts could occur, assess the risk levels to check if they are within the criteria in HIPAP 4 (Ref 4).

2 SITE DESCRIPTION

The Shoalhaven Starches factory site is situated on various allotments of land on Bolong Road, Bomaderry, within the City of Shoalhaven (see Figure 1). The factory site, which is located on the south side of Bolong Road on the northern bank of the Shoalhaven River, has an area of approximately 12.5 hectares.

The town of Bomaderry is located approximately 0.5 km to the west of the factory site and the Nowra urban area is situated 2.0 km to the south west of the site. The “Riverview Road” area of the Nowra Township is situated approximately 600 metres immediately opposite the factory site across the Shoalhaven River.

The village of Terara is situated approximately 1.5 kilometres to the south east of the site, across the Shoalhaven River. Pig Island is situated between the factory site and the village of Terara and is currently used for cattle grazing.

There are a number of industrial land uses, which have developed on the strip of land between Bolong Road and the Shoalhaven River. Industrial activities include a metal fabrication factory, the Shoalhaven Starches site, Shoalhaven Dairy Co-op (formerly Australian Co-operative Foods Ltd – now owned by the Manildra Group) and the Shoalhaven Paper Mill (also now owned by the Manildra Group). The industrial area is serviced by a privately-owned railway spur line that runs from just north of the Nowra-Bomaderry station via the starch plant and the former Dairy Co-op site to the Paper Mill.

The Company also has an Environmental Farm of approximately 1,000 hectares located on the northern side of Bolong Road. This area is cleared grazing land and contains spray irrigation lines and wet weather storage ponds (total capacity 925 Mega litres). There are at present six wet weather storage ponds on the farm that form part of the waste water management system for the factory. A seventh pond approved in 2002 was converted into the biological section of the new wastewater treatment plant has now been commissioned.

The Environmental Farm covers a broad area of the northern floodplain of the Shoalhaven River, stretching from Bolong Road in the south towards Jaspers Brush in the north. Apart from its use as the Environmental Farm, this broad floodplain area is mainly used for grazing (cattle). The area comprises mainly large rural properties with isolated dwellings although there is a clustering of rural residential development along Jennings Lane (approximately 1 kilometre from the

site), Back Forest Road (approximately 500 metres to 1.2 kilometres to the west) and Jaspers Brush Road (approximately 1.2 kilometres to the north).

Security of the site is achieved by a number of means. This includes site personnel and security patrols by an external security company (this includes weekends and night patrols). The site operates 7 days per week (24 hours per day). Also, the site is fully fenced and non-operating gates are locked. Security cameras are installed for staff to view visitors and site activities.

There are approximately 311 staff employed across the Shoalhaven Starches site. However, as the factory operates 24 hours a day with varying shift times, there are typically a maximum of 157 employees on-site during the period between 8:00am and 2:00pm. This can increase to 185 employees on-site for short, peak periods typically coinciding with new infrastructure coming on-line. Information provided by Manildra indicates that an additional 30 contract staff can also be on-site at any one time.

The main natural hazard for the site is flooding. No other significant external events are considered high risk for this site.

See Figure 2 for a site layout drawing showing the locations of the proposed changes including Dryer 9 and the MOD 17 changes.

Figure 1 - Site Locality Plan

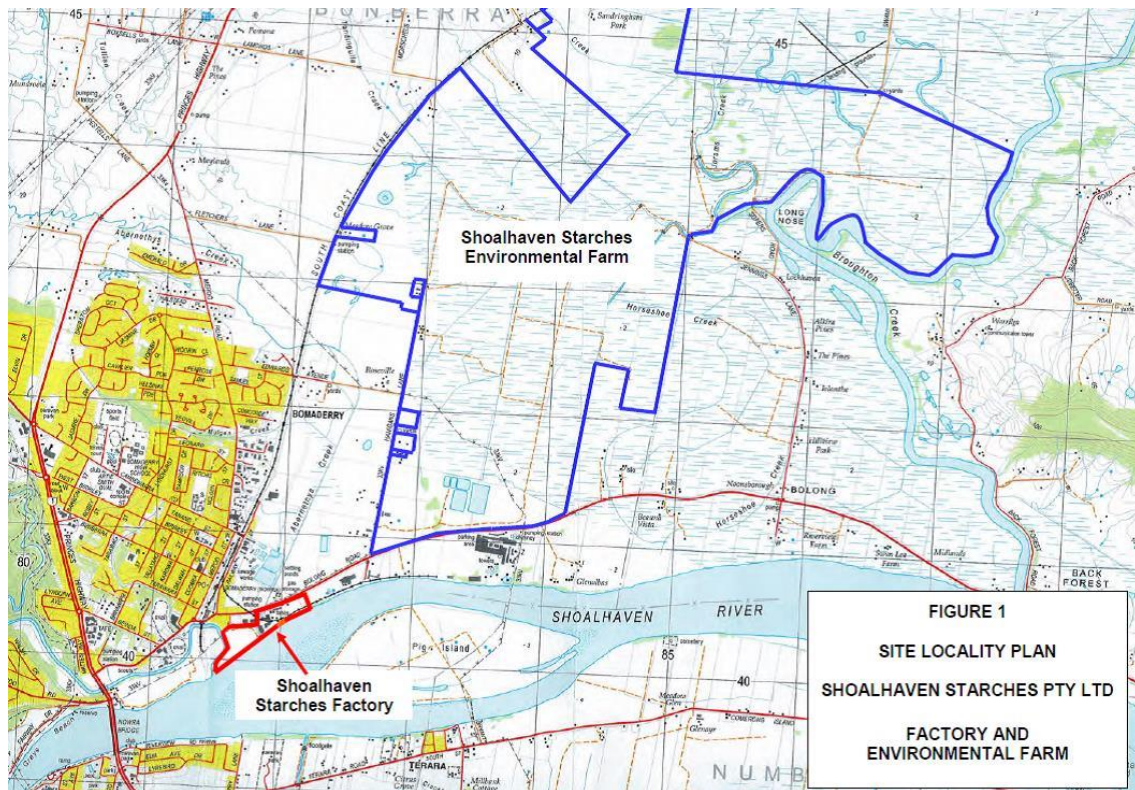
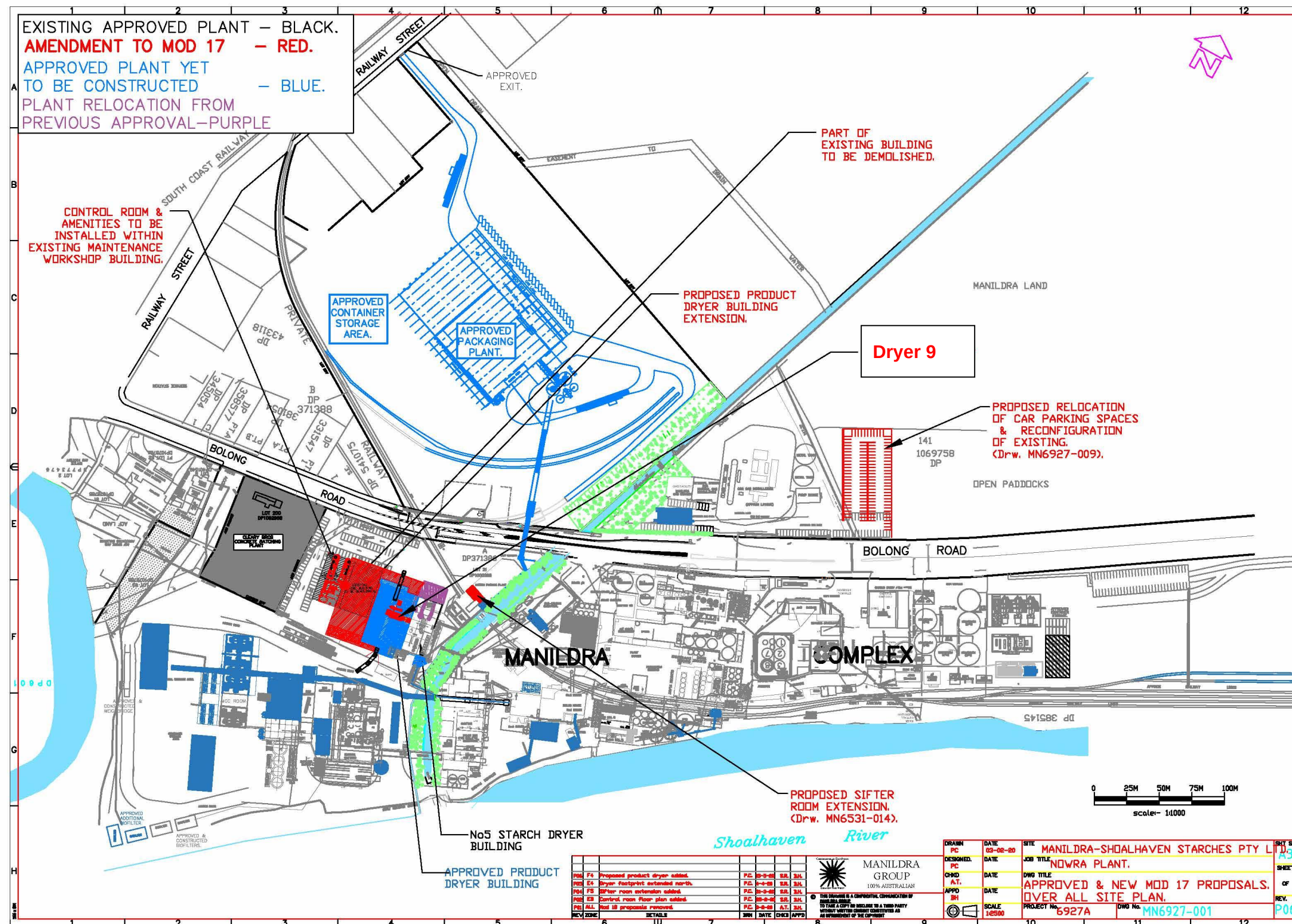


Figure 2 – Site Layout – Shoalhaven Starches



3 PROCESS DESCRIPTION

A process flow block diagram showing the changes to the existing operations is shown in Figure 3.

3.1 RAIL INTAKE PIT CHANGES

At present when rail wagons are unloading grain, given the size of the existing intake pit, only part of a wagon can unload at any one time. The additional intake pit will allow the whole of a wagon to be unloaded at the one time enabling the unloading process to be completed quicker and more efficiently.

The proposal will involve:

- The installation of an additional intake pit adjacent to the existing intake pit;
- A new bucket elevator (height 43 m) that will transport grain to the existing silos; and
- Associated transfer conveyors and chutes to enable the grain to be taken from the new intake pit up the bucket elevator and distributed to the existing silos.

Existing Grain Intake System Details:

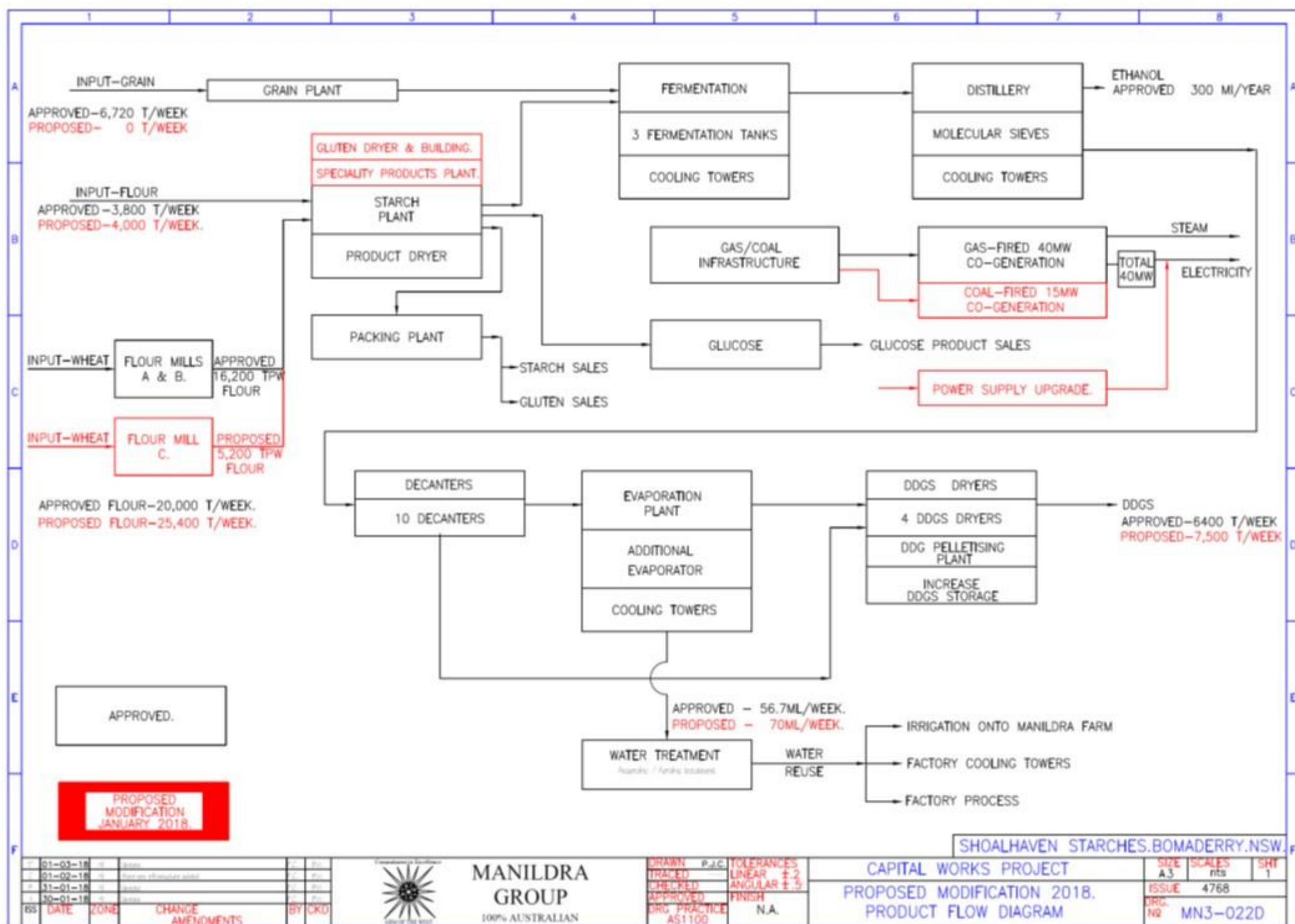
Grain (wheat) trains are unloaded, wagon-by-wagon, during a 6.5 hour window on a one train per day basis.

Each wagon has four gates for unloading. The unloading system comprises a hopper wide enough for only three gates to open, i.e. the wagon is tipped into the hopper with only three gates open. The wagon is then shunted along approximately two metres where the last gate is opened and the remainder of grain in the wagon is unloaded.

Two inclined screw conveyors convey grain out of the hopper and to a vertical bucket elevator. The elevator conveys grain to the first of three drag chain conveyors mounted at the silo top level. The first conveyor can tip grain into the largest silo 101 via a slide gate mounted mid-way along. If grain is not fed to silo 101, it continues on to a traversing conveyor. This traversing conveyor can tip grain into silo 103, the next (third) drag chain or to silo 102. Grain that is delivered to the third drag chain can feed into silos 104 or 105.

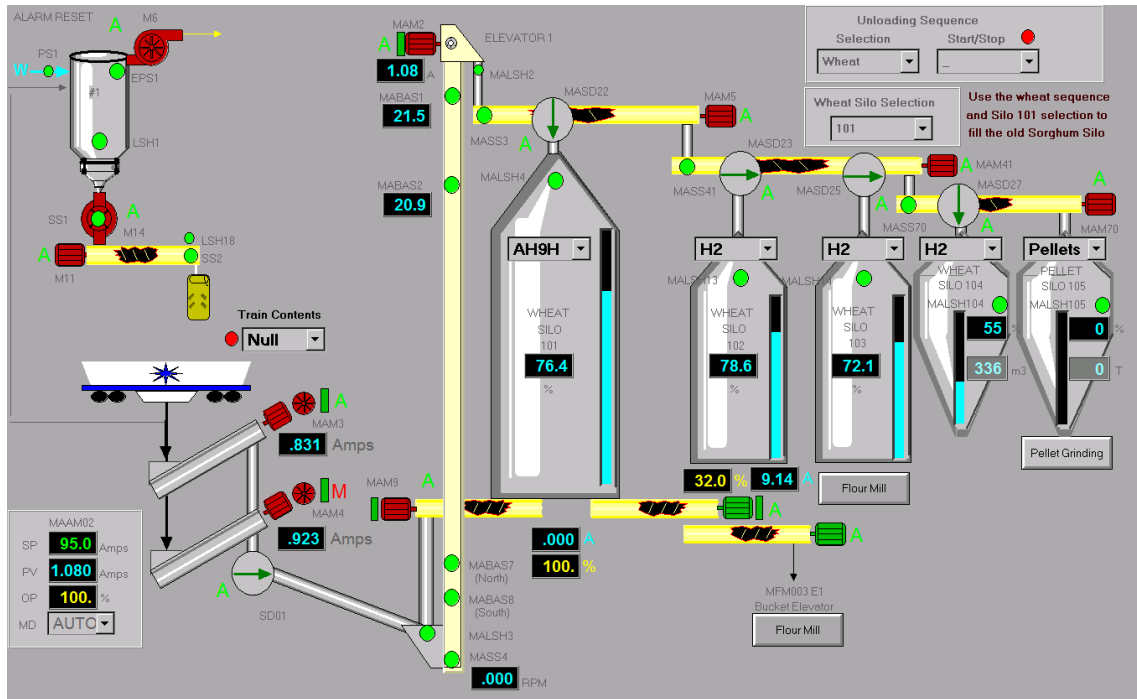
The existing storage capacities are: Silo 101 is 2,200 te, and silos 102, 103, 104 and 105 are each 1,500 te.

Figure 3 – Process Flow Block Diagram Showing Changes



The existing grain intake process is shown in the following schematic.

Figure 4 – Existing Grain Intake Process



Proposed Grain Intake System Details:

A drawing of the proposed intake system is provided in Appendix A.

A duplicate pit will be installed beside the existing pit. This will allow a wagon to be fully tipped (unloaded) without shunting. Two gates on each wagon will tip into a single hopper. Two new screw conveyors will transfer grain from the new hopper.

Grain will be conveyed to a new bucket elevator erected at the base of silo 103. The new bucket elevator will include belt temperature sensors.

The new bucket elevator will feed grain to silos 101, 102, 103 or the existing final drag chain conveyor (via distributors and spouts). The existing drag chain can then feed to silos 104 or 105. This would only occur if the existing grain unloading system feeds to silos 101, 102 or 103.

The intake system will be started by an operator at the commencement of unloading of the train and will remain running until unloading is completed. Selection of the storage destination can be made by the operator at any time in the unloading process.

The throughput of the new rail intake system is approximately 500 te/hr. The existing operations involve a train every day, i.e. 40 of the current wagons equals 2,340 te per day (16,380 te per week).

The future operations may include one rake of 92 te wagons which, at 40 wagons, allows 3,680 te. Therefore, for 3 trains per week (11,040 te) plus 3.5 services (7 per fortnight) of the current wagons (8,190 te) equals 19,230 te per week, i.e. similar to the existing grain intake to the site.

3.2 MILL C

When flour Mill B was designed, the building dimensions allowed for a future mill to be installed, i.e. Mill C. There are no proposed changes to the building structure; all changes are the additional equipment for the Mill C operations within the existing building.

The flour mill will be used to produce industrial grade flour as a raw material feed to the starch plant.

The conversion ratio of wheat to flour is approximately 80%. 6,500 tonnes per week of wheat will be required to produce 5,200 tonnes per week of flour.

The flour mill equipment required for Mill C will include two wheat conditioning silos (already approved under previous Mill B Mod). The process is a duplicate of the Mill B process and will run in parallel to the Mill B process.

The flour process consists of the following unit operations:

- Receiving wheat from rail wagons via the grain intake system;
- Wheat transfer from the silos to the mill building via existing infrastructure, i.e. chain conveyors, bucket elevators and dust collectors;
- Tempering of hard wheat with water in conditioning silos / tempering bins (two new silos are to be installed which will be identical to the existing two Mill B conditioning silos);
- Cleaning of wheat to remove foreign objects and husk (using Combi cleaners);
- Wheat husk (mill feed) is separated in the cleaning stage and transferred to the existing mill feed silo in Mill A for distribution to the main storage silo (adjacent to the DDG (dried distillers grain) drier building) via existing transfer systems;
- Progressive milling of wheat to fine powder (via roller mills, impact detachers, vacuum transfer systems, sifters, cyclones and dust collectors);
- Vacuum transfer systems operate via lift pipes connected to the suction side of the dust collector ductwork (through cyclones). The cyclones are aspirated to the dust collector inlets; and
- Finished product (flour) will be gravity fed to the existing flour transfer system.

Drawings showing Mill C are provided in Appendix B.

Protective measures for dust explosions include:

- All process lines are aspirated to dust collectors to prevent dust accumulation within the processing equipment;
- Dust collectors to have explosion vents fitted;
- Static earthing for all pipework and equipment;
- Magnetic separators installed to capture tramp metal in the feed material;
- Overflow sensors on chain conveyors and screw conveyors are proximity type which are designed to prevent dust release;
- Fully enclosed process eliminates entry points for ignition sources;
- Bucket elevators are to have belt drift sensors fitted;
- Transfer systems are vacuum based, not pressurised, to minimise dust escape;
- Hazardous area zoning performed to identify zoned areas within the plant;
- All electrical equipment in zoned areas will be compliant to the ATEX European standard for dust explosion protection;
- The mill design (from Buhler, i.e. the designers for Mill B) will be ATEX compliant.
- Fire engineering design for building completed; and
- Housekeeping procedures within the existing mills are mature and well managed, e.g. daily cleaning.

As part of the process, three new filters will be installed; two of which will have explosion vents that will vent externally from the building (the other filter will have a flameless vent given the proximity to the ventilation ducting). These explosion vents will be positioned at the same elevation as the existing Mill B explosion vents, i.e. at 30 m above ground level, and will vent to the north of the building.

There will also be new baghouse filters installed on top of the building roof, i.e. at 36.4 m above ground level. These filters will be fitted with explosion vents that vent directly to atmosphere.

3.3 MILLS' BUILDINGS VENTILATION

It is proposed to replace the natural induced draft ventilation system with a forced ventilation system for both the flour Mill A and B buildings. A drawing showing the new buildings' ventilation systems is shown in Appendix C.

The forced ventilation system will comprise of a fan enclosure mounted on the roof of the respective buildings:

- Mill A building air requirement: 1,810 m³/min (based on the dust collector filtration fan capacity); and
- Mill B building air requirement (includes the Mill C capacity): 2,890 m³/min.

The existing Mill A building was constructed in 2010 and includes acoustic louvers on three walls fitted with food standard filtration panels. The total filter area for the building is approximately 30 m². As part of the Mill B installation, a large proportion of these vents were sealed to create a fire wall between the Mill A building and the Mill B building (to meet fire engineering building safety requirements).

The proposal is to install a forced ventilation system to both Mill A and Mill B buildings, with fan rooms mounted on the roofs of each mill, ducted through air ducts on the northern face of Mill B and the eastern face of Mill A.

The fan rooms are designed to include appropriate filtration of the air to meet food manufacturing requirements.

The fans will be centrifugal type and the ducting will be designed to deliver the appropriate amount of air to each level in each of the mill buildings.

From a process perspective, the use of positive pressure in the building will assist in minimising dust escape into the building and maintain a higher level of cleanliness and good manufacturing practice.

As there are no process safety hazards with this component of the proposal then no further analysis is included in this PHA.

3.4 GLUTEN DRYERS 1 AND 2 CONVERSION TO STARCH DRYING AND GLUTEN DRYER NUMBER 8

The resultant increase in flour and hence starch and gluten production will require the conversion of two existing gluten dryers (numbers 1 and 2) into starch production and the construction of a new gluten dryer (GD8) to replace the gluten capacity lost by the conversion of dryer numbers 1 and 2 to starch.

The dryers on-site are designed to be switched from gluten to starch and vice versa. The dryers will be operated within the same design envelope and the explosion protections remain unchanged, i.e. the K_{st} values used are valid for both gluten and starch.

The conversion of the dryers to starch does not introduce any new process safety hazards to the dryers and hence the site. Therefore, these approved dryers are not analysed any further in this PHA.

There are, however, changes to the existing gluten and starch processes that deliver the wet products (i.e. the gluten and starch are in water) to the dryers. The following changes describe dryer number 2 (for information):

- Reinstall the chute between the dryer blender and the starch decanter number 2 so that starch can be fed to the dryers;
- Remove/blank off the gluten feed pipework/fishtail assembly;
- Remove the existing connections for the product blowline to the gluten packing silos;
- Reinstall the connection to the existing blowline to the starch packing silos;
- Change the pulley/belt arrangement on the existing blower to suit the blowline to the starch packing silos; and
- The transfer screw conveyor and rotary seal speeds on the dryers conveying equipment will need to be adjusted to suit starch.

The new gluten dryer (GD8) will be housed in a new industrial building. This building will be located between the remaining “Moorhouse” Maintenance Building and adjoining the Starch Dryer No. 5 building to the west of Abernethy’s Creek. See Figure 2 for the location of the new gluten dryer and specialties products building.

Flour will be transferred from the existing flour storage systems to a silo in the new building. The flour will be transferred via a 300 m long blowline. The silo will be fitted with a top-mounted bag filter as per standard designs.

The flour and water will be mixed within a large dough mixer. The wet dough is then transferred to a tricanter. This machine separates the wet feed into wet starch, wet gluten and waste/pentosans (polysaccharides) which will be sent to the ethanol plant for processing.

The wet gluten from the tricanter will be screened. The screened wet gluten will flow to GD8 whilst the waste liquid from the screening stage will also be sent to the ethanol plant for processing.

The wet gluten will flow to the wet gluten hopper and then a screw press. Free moisture will drain from the screen sides and base of the hopper. A conical screw will squeeze and extrude the gluten before discharging into the gluten feed hopper.

De-watered gluten will then be pumped (via a progressive cavity positive displacement type pump) at constant rate into the disintegrator through a fishtail feeder, which extrudes a thin sheet of material over the full disintegrator width and feeds it into a re-circulating stream of hot air and dry powder. The wet material will be dispersed and coated with dry powder before being dried and transported around the ring duct by the drying air.

At the dryer manifold, an adjustable blade allows a predetermined fraction of circulating material to be selectively removed from the system, whilst oversize and semi-dried material is returned to the disintegrator. The disintegrator is a fixed beater impact mill, which breaks down agglomerates and disperses the circulating mass into the drying airstream. This combination of manifold and disintegrator gives screen-less grinding and even moisture distribution to the product.

Gluten is then separated from the exhaust air stream in a reverse jet baghouse filter, complete with a pre-separator section, which ensures that material is quickly removed from the hot airstream when it is dry (to minimise thermal degradation).

Dried material will be discharged through a system of screw conveyors and rotary valves, allowing control of the recycle of coarse material from the pre-separator and fine material from the baghouse filter, or a combination of the two, with the remainder being discharged as final product to the milling system.

An induced draught fan at the baghouse filter outlet will draw process air and gluten through the drying system and will maintain circulation within the ring duct. The air will flow to atmosphere via a stack.

The dryer air is drawn through filters to remove foreign objects. It is heated by hot condensate, steam (10 barg) and then a gas fired burner (to approximately 185°C).

After the air passes through a hot air box (used to collect large objects such as product clumps), the air and gluten combine and flow up through the dryer.

Product gluten from the dryer will be held in a buffer hopper, with a variable speed screw discharge, designed to eliminate surges and maintain a constant feed rate to the milling system. Material discharged from the buffer hopper will be passed over a magnet to remove ferrous material and transferred to the classifier mill by an induced draught pneumatic conveyor (using filtered ambient air).

The aspirated grinding mill will incorporate an internal classifying wheel with independent drive. Through varying the speed of this wheel, oversize particles will be deflected back into the mill for further grinding. Milled product will then be transported to the final collection within a second pneumatic conveyor.

Finished product gluten will be separated from the mill exhaust by a dedicated reverse jet baghouse filter and discharged by a rotary valve.

The ground product is then conveyed via a blowline to the existing packaging area. The product is either stored in a buffer bin or sent to truck loadout.

The product gluten is filled into bags, e.g. 1 te bulkabags, at dedicated existing bag filling stations. The bags are stored in 20 foot containers until being loaded onto trucks or trains for delivery to the market.

Cleaning chemicals such as sodium hypochlorite will be used on a batch basis.

A process flow schematic for the flour feed system and a representative gluten dryer process flow diagram are provided in Appendix D.

3.5 MODIFIED STARCH PRODUCTION

Dry starch (containing approximately 12 wt% moisture) will be conveyed from SD5 (Starch Dryer 5) via a screw conveyor to the modified starch process. This new process will be installed within the new industrial building as per GD8. The starch feed quantity will be measured via a loss-in-weight feeder.

The following steps summarise the process:

Step 1: Add starch, the cationic reagent 188 and sodium hydroxide into a paddle mixer. This is a batch process. These raw materials are then mixed together. The caustic day tank will be approximately 5 m³ (20wt%) and the reagent (188) will be kept in IBCs (intermediate bulk containers). Dosing pumps will be used to transfer the caustic and reagent to the mixer.

Step 2: The mixture is fed through a heater (with a continuous mixer). The mixture's temperature is increased from 25°C to 70°C. The heater will be a steam jacketed vessel. Heating activates the reagent over the 20 minutes residence time.

Step 3: The mixture is transferred from the heater to one of two insulated 50 m³ silos. The mixture flows through the silo (as plug flow) with a residence time of 4 or 6 hours so that the reaction can be completed. While the first batch is continuing to react in the silo, the subsequent batch is initiated.

Step 4: After the first batch reaction has been completed, the mixture is transferred (screw conveyor and scales) to another mixer and then neutralised with 33wt% hydrochloric acid (HCl). In this step, the water content is again increased in the product. The HCl will be stored in a relatively small (3 m³) day tank.

Step 5: The main stream flow is transferred to an intermediate hopper (nominally 5 m³) and then fed to a dispersion dryer to reduce the moisture as per the product specification, i.e. to 12%. Air to the dispersion dryer is heated. The equipment within the dryer includes a cyclone, baghouse filter and induced draught fan.

Step 6: The product modified starch is sieved (i.e. through a plan sifter). Off-specification material is collected and sent to the ethanol plant for fermentation. The modified starch product is stored in two 70 m³ silos and then sent via a blowline to the existing packaging plant (silo 18). It will be packed as per existing equipment and practices.

The chemicals involved in this process are:

- The cationic reagent;
- Sodium hydroxide (to catalyse the cationic reagent); and

- Hydrochloric acid (to neutralise the batch).

A process flow diagram for the dry starch cationic process is shown in Appendix E. Layout and elevation drawings of the new industrial building are also provided for information.

Chemical usage rates are approximated as 450 kg/hr or 10.8 te/day (each) for caustic (at 20wt%) and the reagent (the HCl rate is currently unknown). This equates to an additional caustic road tanker (carrying 50wt%) every 4 to 5 days (approximately).

3.6 STARCH DRYER 5 MODIFICATIONS

It is proposed to replace the secondary cyclones in the starch dryer number 5 plant with a baghouse filter. This baghouse will be a standalone structure on the northern end of starch dryer building.

The baghouse will separate approximately 500 kg per hour of starch (12% moisture content) from the air stream (250,000 m³/minute air flow).

The dimensions of the baghouse filter are roughly 20 m wide, 24 m tall and 6 m long. The final design is yet to be completed.

There will be 1 m x 1 m explosion panels on the eastern face of the baghouse (set pressure of 10 kPa). These panels are currently on the secondary cyclones on the existing starch dryer, i.e. they will be transferred to the baghouse filter.

Process flow diagrams showing the existing design, i.e. with the secondary cyclones, and the proposed design, i.e. with the baghouse filter, are provided in Appendix F.

3.7 COAL BOILERS AND CO-GENERATION PLANT

It is proposed to construct a coal-fired cogeneration plant to the south of the existing boilerhouse complex that will generate 15 MW of electrical power. This cogeneration plant will include the installation of a new coal fired boiler (No. 8). The construction of this new cogeneration plant and boiler (No. 8) will necessitate the relocation of the existing Boiler No. 7 to the northern side of the overall boilerhouse complex.

Existing Coal Supply System and Boilers:

Black coal is used at the Shoalhaven Starches site. The coal size is 10 to 25 mm and contains approximately 15% ash.

Trucks deliver the coal to the existing large coal stockpile on the western side of the Shoalhaven Site.

It is reclaimed from the large coal stockpile using a frontend loader and trucked via site roads to a smaller coal stockpile adjacent to the boilerhouse. A frontend loader reclaims the coal from this smaller stockpile, when needed, and feeds the

coal into an existing hopper and denseveyors (pneumatic transfer machines) that transfer the coal to each of the boilers. Compressed air is used within the denseveyors to transfer the coal to the boiler feed bins.

The coal is used in Boilers 5 and 6. Currently, Boilers 2 and 4 are being converted back to coal use.

All the coal-fired boilers are designed for limited attended operation in compliance with the requirements of AS2593, however, they are operated as attended boilers.

Each of the four existing coal boilers (2, 4, 5 and 6) has an existing feed bin which is level controlled. The coal is gravity fed onto a grate for delivery into each boiler. A door at the coal inlet to each boiler can be closed (manually) to stop the coal and hence the source of heat, e.g. in the event of an emergency.

Boiler 8:

The coal delivery system to Boiler 8 will be identical to Boilers 2, 4, 5 and 6.

The coal (on the moving grate) passes through a guillotine door that maintains the desired bed depth. After about 1 m of travel, the coal will be ignited by the heat from the existing coal that is burning. The heat from the burning coal raises the required steam.

The boiler will be ignited during start-up by natural gas burners. These burners can also be used for additional heat load in the furnace and are to be designed to AS3814.

The flue gas containing fly ash from Boiler 8 will pass through a multi-cyclone, steam superheater, economiser (for preheating the boiler feed water) and air heater (for the forced draft, combustion air to the furnace) before passing through a baghouse filter, an induced draft fan and then to the stack.

The baghouse filter socks will be pulsed with air to remove the fly ash (which falls to the bottom of the baghouse). This fly ash, along with the fly ash collected by the multi-cyclones, steam superheater, economiser and air heater, and ridlings ash from the grate, will be conveyed (screw conveyors and a denseveyor) to a receiving hopper located above a pug mill (produces a paste by forcibly combining fly ash with water). This paste will then be dropped directly into the existing ash bin. Ash from this bin is removed from site by truck and disposed of as per the EPA's (Environmental Protection Authority) approval to the Manildra farm.

Combustion gas will be vented to atmosphere via a 40 m high exhaust stack.

The new boiler will be designed to the Australian Standards (e.g. AS2593). It will contain a steam drum and a mud drum.

The steam drum will be fitted with:

- Redundant low level protection;
-

- Means for sampling the boiler water;
- Overpressure protection (pressure relief valves);
- Means to allow boiler dosing chemicals to be injected into the boiler water; and
- Temperature and pressure monitoring.

The steam pressure will be controlled by varying the amount of coal and air feed, i.e. by vary the coal grate speed and the air fan speed, respectively. A boiler trip will stop the coal feed grate and also the forced-draught fan.

The proposed boiler dosing chemicals are:

- BT3000; a trisodium phosphate chemical. The dosage rate concentration and rate are approximately 1.55 ppm and 1,168 kg/year, respectively. There will be approximately 6 x 200 litre deliveries/year; and
- Surgard1700 Erythorbate. The dosage rate concentration and rate are approximately 3.2 ppm and 2,383 kg/year, respectively. There will be approximately 12 x 200 litre deliveries/year.

Both chemicals will be stored in a self-bunded tanks.

BT3000 is a non-flammable, corrosive material (1 to 5% caustic soda). It is a Dangerous Good Class 8, Packing Group III, material.

Surgard1700 Erythorbate is not legislated as a Dangerous Good. It is not flammable.

Boiler water blowdown will be done manually and automatically from the mud drum.

The new boiler will produce 75 tonnes per hour of steam. The steam pressure will be 63 barg. This steam will be superheated to 510 C in the steam superheater. It will then flow through the steam turbine that will drive a 15 MW generator. The produced power will be used within the Shoalhaven Starches site.

The steam turbine will have both mechanical and electric overspeed protection.

The mechanical protection will be via an industry-standard eccentric bolt design, i.e. the eccentric bolt is held in position by a spring during normal speeds but changes position (by increased centrifugal forces) when the speed is too high. When it changes position, it strikes a linkage assembly that closes the turbine steam trip valve.

The electrical overspeed protection device will be designed to safely shut down the steam via closing of the inlet steam turbine trip valve. This device monitors turbine rotor speed and acceleration via magnetic pickups and issues a shutdown

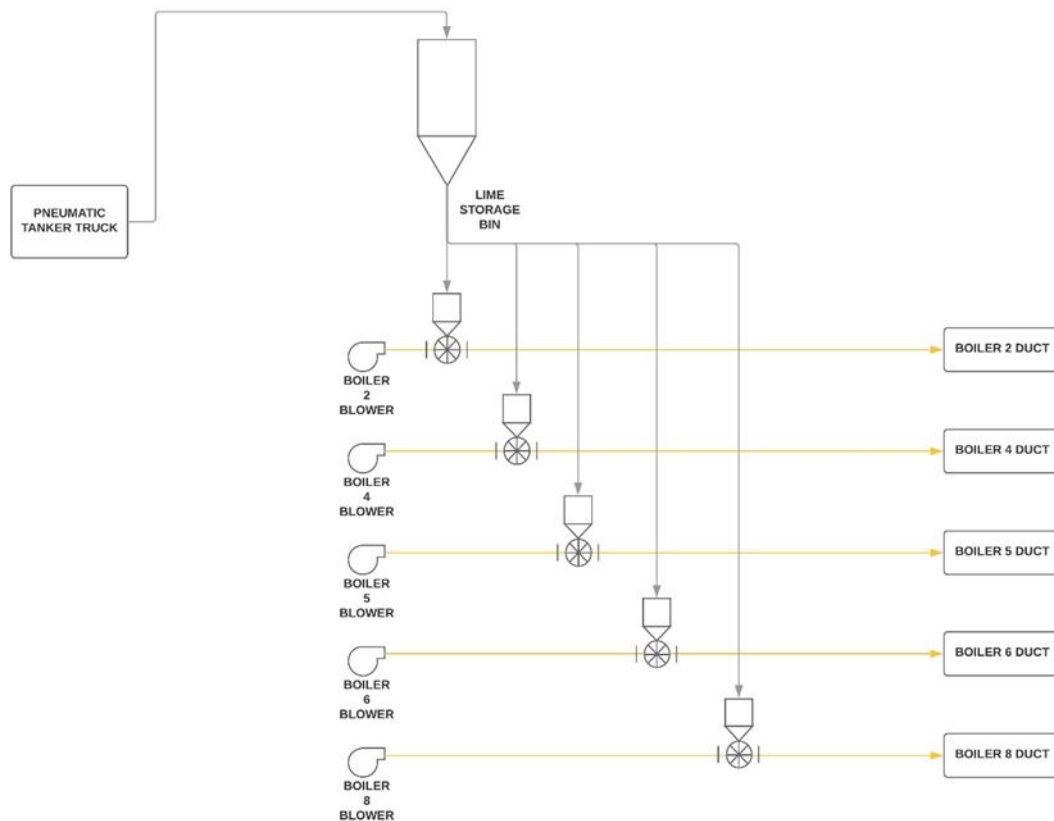
command to the turbine's trip valve(s) when speed is too high. The device is certified as an IEC61508 SIL-3 (Safety Integrity Level Three) safety device.

Boilers Flue Gases Desulphurisation:

To meet the new EPA requirements for sulphur oxides (SO_x) emissions, flue gases from Manildra's coal fired boilers will be required to implement flue gas desulphurisation technology. The proposed technology is called dry sorbent injection (DSI), which is the injection of hydrated lime (Ca(OH)₂) into the ductwork between the economiser and the baghouse to reduce the SO_x emissions.

The process is shown in Figure 5 below.

Figure 5 – Boilers Flue Gases Desulphurisation Schematic



The lime will be delivered to site via a truck and pneumatically conveyed into the silos (x2). The silos will be fitted with a baghouse filter to prevent dust being emitted to atmosphere. The silos will also have over and under pressure protection plus level measurement.

The lime will be metered from the silos into a blowline. It will then enter the relevant ducting where the following reaction will take place:



CaSO₄, i.e. gypsum, is a naturally occurring mineral and is used as a fertilizer and is also the main constituent in many forms of plaster, blackboard chalk and wallboard.

The solid calcium sulphate is then collected in the downstream baghouse filters for disposal via the Manildra WWTP (waste water treatment plant).

It is estimated that the lime usage will be approximately 320 kg/hr. It is expected that the storage facility will have a capacity of 120 te to give approximately two weeks of operation without needing to be refilled.

Boiler 7 Relocation:

Boiler 7 is a conventional natural gas fired boiler. The fuel gas train is compliant with AS3814. It consists of a main gas and pilot gas supply.

The boiler is started automatically via a dedicated boiler management system. The furnace is purged for a predetermined time, the pilot burner is ignited and then the main burners.

Steam is generated similar to the description provided above for Boiler 8, i.e. via a steam drum and mud drum. The boiler protections are also similar. The steam supply pressure is 10 barg (saturated).

To make room to install Boiler 8 in the proposed location, Boiler 7 will need to be moved to the north side of the boilerhouse.

See the drawings in Appendix G for layout and elevation details for Boilers 7 and 8.

3.8 ELECTRICAL MODIFICATIONS

There are two proposed significant electrical modifications:

Electrical Project 1:

The Shoalhaven Starches site is currently fed from an Endeavour Energy 33kV outdoor substation located adjacent to the two main 33/11kV transformers and the main 11kV switchroom. With the ongoing expansion of the site, a third 33/11kV transformer will be required to maintain the integrity of the incoming power supply.

This proposal is to install the third transformer in the location of the existing 33kV outdoor substation. An indoor 33kV substation will be built to Endeavour Energy requirements on the north side of Bolong Road to supplement the existing outdoor substation and suitable for the supply of three main 33/11kV

transformers. The location of this substation is adjacent to the existing BOC carbon dioxide plant.

Electrical Project 2:

The existing main 11kV switchboard has a capacity of 50MVA. With the ongoing expansion of the site, the power supply to the site needs to be capable of supply beyond this capacity. The scope of this project is to install a second main HV switchboard in a new switchroom located above the existing main switchroom. One of the two supplies to the existing main switchboard will be relocated to supply the new switchboard. The existing ring main feeds from the main switchboard will be reconfigured to enable supply from any ring main from either the old or new main switchboard.

Drawings showing the designs for these electrical equipment items are provided in Appendix H.

As there are no process safety hazards with this component of the proposal then no further analysis is included in this PHA.

3.9 ADDITIONAL SIFTING EQUIPMENT FOR THE PACKING PLANT

It is proposed to install a larger sifter in the feed stream to the existing starch packer in the Steel Shed. To fit the larger sifter into the shed, the roof (in the immediate area to the sifter) will need to be extended.

The existing design involves product (starch) being blown to silo 18 via pneumatic transfer lines from other parts of the factory (approximately 35 m³/min of air along with 25 tonnes per hour of product). The existing receiving silo has a dust collector which is designed to extract 150 m³/min.

The product will then be transferred via a screw conveyor from the base of the silo at a rate of 20 tonnes per hour to the larger (new) sifter.

The product will then be sifted at 425 micron within a plansifter. This type of sifter is installed elsewhere on site. The sifter will have a design capacity of 30 tonnes per hour.

The product will be collected at the base of the new sifter and transferred into a magnetic separator and then to the packer hopper to be packed in 25 kg bags (as per the existing practice).

The safety control measures include the following:

- There are high level instruments which detect blockages and trip the process;
- Laser probes will be installed to detect if there is a broken sock at the base or the top of the sifters;

- The screw conveyors are designed with a low tip speed, i.e. less than 1 m/s;
- The sifters are earthed to prevent sparks; and
- There are check sifters on the outlet of the starch dryers to prevent foreign objects from being transferred to silo 18.

Figure 6 shows a photograph of the plansifters. The plansifter is also shown in the layout and elevation drawing in Appendix I (the plansifter is shown in the darker blue colour).

Figure 6 – Plansifter Photograph



3.10 PRODUCT DRYER 9

Product Dryer 9 will be designed to be switched from gluten to starch and vice versa. The dryer will be operated within the same design envelope (e.g. same operating temperature range) and the explosion protections remain unchanged, i.e. the K_{st} values used are valid for both gluten and starch. Construction materials are primarily carbon and stainless steels.

The new Dryer 9 will be housed in the Specialty Products Building (see Figure 7). Dryer 9 will be enclosed by fire walls to separate it from the other plant and equipment within the same building, i.e. to avoid incident propagation.

The wet product feed is initially screened using a contrashear rotary dewatering screen. The screened product will then flow into a hopper and be pumped through strainers to a screw press for further dewatering. Waste filtrate will be processed on-site, e.g. via the ethanol plant.

De-watered product will then be pumped (via a progressive cavity positive displacement type pump) at constant rate into the disintegrator (hammer mill) through a fishtail feeder, which extrudes a thin sheet of material over the full disintegrator width and feeds it into a re-circulating stream of hot air and dry powder. The wet material will be dispersed and coated with dry powder before being dried and transported around the ring duct by the drying air.

Product is then separated from the exhaust air stream via cyclones and then in a baghouse filter. An induced draught fan at the baghouse filter outlet will draw process air and product through the drying system and will maintain circulation within the ring duct. The air will flow to atmosphere via a stack.

The dryer air is drawn through filters to remove foreign objects. It is heated by steam (10 barg). Heating can also be performed in the future via a gas fired burner.

After the air passes through a hot air box (used to collect large objects such as product clumps), the air and product combine and flow up through the dryer.

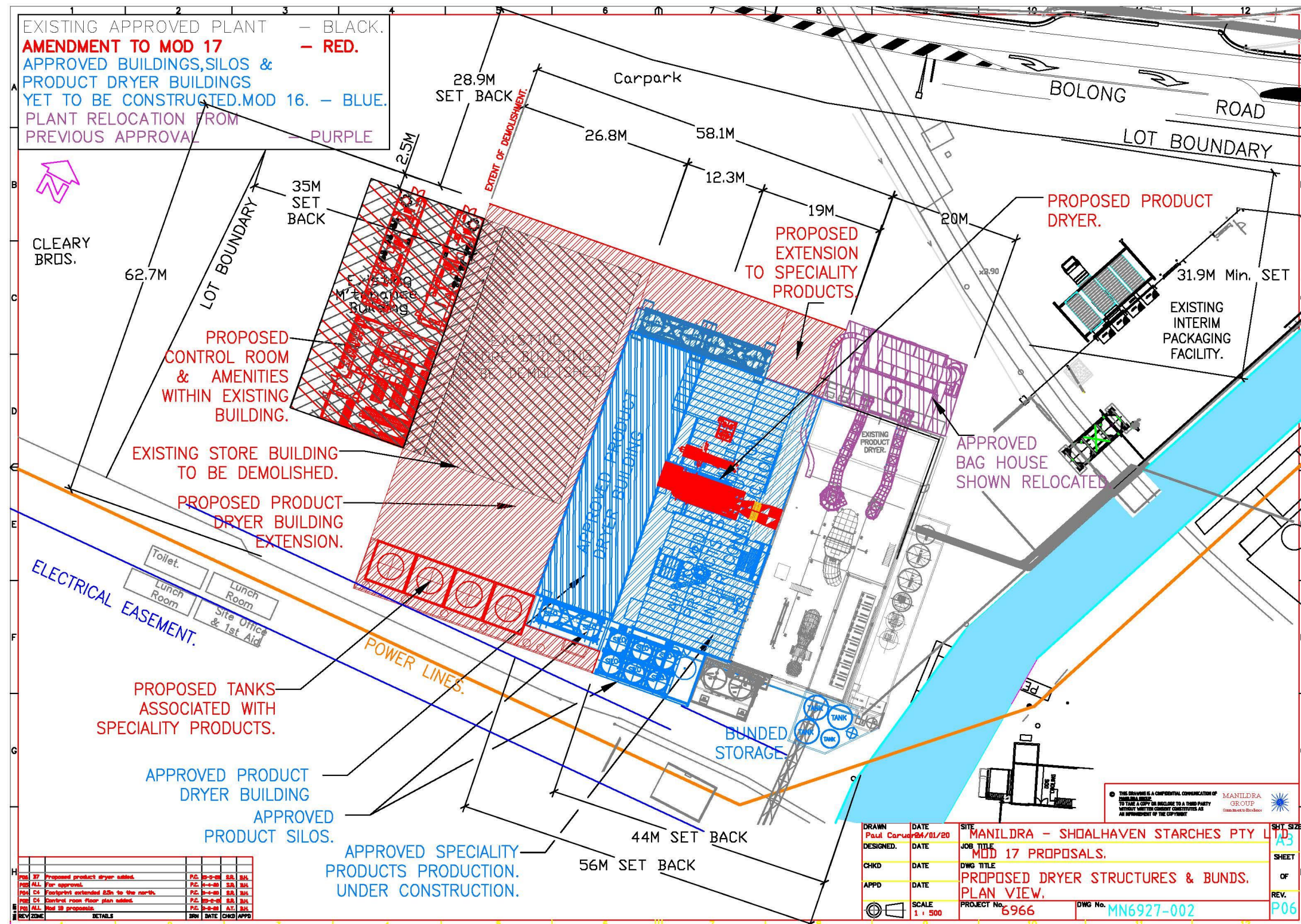
Dried material from the cyclones and baghouse filter will be discharged through a system of conveyors and rotary valves, allowing control of the recycle of coarse material and fine material from the baghouse filter, or a combination of the two, with the remainder being discharged as final product. The final product is milled in a rotating Turbomill prior to be transported to the packing plant via a blowline. The product is either stored in a buffer bin or sent to truck loadout.

The product is filled into bags, e.g. 1 te bulkabags, at dedicated existing bag filling stations. The bags are stored in 20 foot containers until being loaded onto trucks or trains for delivery to the market.

Cleaning chemicals such as sodium hypochlorite will be used on a batch basis.

Any spills and material captured inside the plant (e.g. washdown and emptying of equipment for maintenance) will be collected via a sump system and pumped to the Manildra Waste Water Treatment Plant. The preliminary Piping and Instrumentation Diagrams (P&IDs) are provided in Appendix M.

Figure 7 – Specialty Products Building Layout (with MOD 17 changes)



4 HAZARD IDENTIFICATION

4.1 HAZARDOUS MATERIALS

The hazardous materials associated with this proposal are:

1. Wheat including flour, gluten and starch. The main hazard being dust explosions;
2. Natural gas that will flow to burners for heating purposes. Natural gas is flammable, i.e. if released and ignited, there is a risk of jet fires, flash fires and explosions (if confined);
3. Sodium hydroxide (caustic) which will be stored in a 5 m³ tank at 20wt%. Caustic is a corrosive liquid;
4. Hydrochloric acid (33wt%). The HCl will be stored in a 3 m³ tank. It is a corrosive liquid. HCl vapour is also toxic to the body if inhaled;
5. The cationic starch reagent is not deemed to be a Dangerous Good;
6. Cleaning liquid for sanitisation, e.g. 5% sodium hypochlorite solutions;
7. Hydrated lime; and
8. Coal (a combustible solid).

Further details of these materials hazardous properties are provided in Appendix J.

4.2 POTENTIAL HAZARDOUS INCIDENTS REVIEW

In accordance with the requirements of *Guidelines for Hazard Analysis*, (Ref 3), it is necessary to identify hazardous events associated with the facility's operations. As recommended in HIPAP 6, the PHA focuses on "atypical and abnormal events and conditions. It is not intended to apply to continuous or normal operating emissions to air or water".

In keeping with the principles of risk assessments, credible, hazardous events with the potential for off-site effects have been identified. That is, "slips, trips and falls" type events are not included nor are non-credible situations such as an aircraft crash occurring at the same time as an earthquake.

The potential hazardous events have been identified via workshops involving Manildra personnel from process, mechanical, electrical / instrumentation, operations and maintenance. These workshops were facilitated by Pinnacle Risk Management and either held as part of this project or for previous projects.

The identified credible, significant incidents (in particular, with the potential for off-site impacts) for the proposed modifications are summarised in the Hazard

Identification Word Diagrams shown in Appendix K. As the potential hazardous events for Dryer 9 are identical to Dryer 8 then these are identified in the Hazardous Event Identification Word Diagram for Dryer 8 (see Table 12).

These diagrams present the causes and consequences of the events, together with major preventative and protective features that are to be included as part of the design.

5 RISK ANALYSIS

5.1 HIPAP 4 CRITERIA ANALYSIS

The assessment of risks to both the public as well as to operating personnel around the proposed modifications requires the application of the basic steps outlined in Section 1. As per HIPAP 6 (Ref 3), the chosen analysis technique should be commensurate with the nature of the risks involved. Risk analysis could be qualitative, semi-quantitative or quantitative.

The typical risk analysis methodology attempts to take account of all credible hazardous situations that may arise from the operation of processing plants etc.

Having identified all credible, significant incidents, risk analysis requires the following general approach for individual incidents:

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

The risks from all individual potential events are then summated to get cumulative risk.

The risk criteria applying to developments in NSW are summarised in Table 1 (from Ref 4).

Table 1 - Risk Criteria, New Plants

Description	Risk Criteria
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year
Fatality risk to residential and hotels	1×10^{-6} per year
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year
Fatality risk to be contained within the boundary of an industrial site	50×10^{-6} per year
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year

Description	Risk Criteria
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50×10^{-6} per year
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50×10^{-6} per year

The consequences of the potential hazardous events in Appendix K are initially assessed to determine if any events have the potential to contribute to the above-listed criteria and hence worthy of further analysis.

5.2 FIRES

5.2.1 Smouldering Fires

Wheat (and its products) and coal, if ignited, produce smouldering fires. There are flames, however, these are relatively small compared to flammable liquids where the flame height can be up to twice the pool diameter.

The following photographs show typical coal fires, i.e. limited flames and hence limited radiant heat emitted at distance.

Figure 8 – Small Coal Fire



Figure 9 – Large Coal Stockpile Fire

Given the large distances to the nearest off-site receptors (i.e. approximately 48 m for the new industrial building and 150 m for Boiler 8 to Bolong Road) then it is not credible that significant levels of radiant heat will affect these receptors. Therefore, the risk criteria in Table 1 with respect to radiant heat from potential wheat and coal fires are satisfied.

5.2.2 Natural Gas Releases – Fires and Explosions

Releases for the natural gas piping can form a jet fire if ignited. The natural gas pressure throughout the site is 210 kPag.

The analysis of potential jet fires is shown in Table 2. The mass rates were estimated using TNO's EFFECTS program and the flame length via the Considine and Grint equation (Ref 5). The pipe length used was 100 m. An 80 mm diameter pipe is assumed.

Table 2 – Natural Gas Jet Fires

Stream	Estimated Release Rate, kg/s	Estimated Length of Jet, m
Full bore failure (80 mm)	0.71	9
50 mm hole	0.55	8
13 mm hole	0.053	3

Notes: Jet flames modelled using methane.

As expected for these size jet fires, no adverse radiant heat levels will be imposed off-site as the nearest natural gas pipe to Bolong Road (for Gluten Dryer 8) is approximately 105 m away.

Potential vapour cloud explosions and flash fires can occur from the natural gas line failures, i.e. delayed ignition.

The effects from explosion overpressures (Ref 4) are summarised in Table 3.

Table 3 – Effects of Explosion Overpressure

OVERPRESSURE, kPa	PHYSICAL EFFECT
3.5	90% glass breakage No fatality, very low probability of injury
7	Damage to internal partitions & Joinery 10% probability of injury, no fatality
14	Houses uninhabitable and badly cracked
21	Reinforced structures distort, storage tanks fail 20% chance of fatality to person in building
35	Houses uninhabitable, rail wagons & plant items overturned. Threshold of eardrum damage, 50% chance of fatality for a person in a building, 15% in the open
70	Complete demolition of houses Threshold of lung damage, 100% chance of fatality for a person in a building or in the open

For flash fires, any person inside the flash fire cloud is assumed to be fatally injured. As flash fires are of limited duration (typically burning velocity is 1 m/s, Ref 6) then those outside the flash fire cloud have a high probability of survival without serious injury.

The analysis of the potential vapour cloud explosions and flash fires from the natural gas pipe failures is shown in Table 4. The mass calculated in the flammable range is assumed to be 100% confined, i.e. all this gas is involved in the explosion calculations. As methane is not a high reactive flammable gas and the quantities involved are relatively small then a medium deflagration (Curve 5) is assumed in the explosion calculations (multi-energy method – TNO).

Table 4 - Natural Gas Vapour Cloud Explosions and Flash Fires

Stream	Mass of Natural Gas in the Flammable Range, kg	Radius of Flash Fire, m	Distance (m) to 14 kPa Explosion Overpressure	Distance (m) to 7 kPa Explosion Overpressure
Full bore failure (80 mm)	6.5	33 m	13 m	26 m
50 mm hole	4.2	27 m	11 m	22 m

Notes: 1. Pipeline failures assumed to be isolated within 30 minutes.

2. Radius of flash fires calculated to be the distance to LEL (lower explosion limit) at F weather stability and 2 m/s wind speed.

3. 13 mm holes not modelled as they are too small to generate gas clouds of any significant size.

For these releases of natural gas, choked flow exists and rapid jet mixing with air occurs. The result is a relatively small vapour cloud size with limited consequential impacts if ignited. The 30 minute release duration also has no significant impact on the release. Steady state conditions are reached soon after the release occurs (i.e. after approximately 4 minutes, the distance to the LEL does not change at steady state dispersion conditions).

Given these results for the natural gas vapour cloud explosions and flash fires, no adverse consequential impacts will be imposed off-site. The low likelihoods for these events are supported by the following data.

The following data has been published by the UK HSE (Ref 7).

Table 5 - Piping Failure Frequencies

Failure Rates (per m per year) for Pipework Diameter (mm)					
Hole Size:	0 - 49	50 - 149	150 - 299	300 - 499	500 – 1,000
3 mm diameter	1×10^{-5}	2×10^{-6}			
4 mm diameter			1×10^{-6}	8×10^{-7}	7×10^{-7}
25 mm diameter	5×10^{-6}	1×10^{-6}	7×10^{-7}	5×10^{-7}	4×10^{-7}
1/3 pipework diameter			4×10^{-7}	2×10^{-7}	1×10^{-7}
Guillotine	1×10^{-6}	5×10^{-7}	2×10^{-7}	7×10^{-8}	4×10^{-8}

Typical probabilities of gas ignition are shown in the following table (Ref 8).

Table 6 – Gas Ignition Probabilities

Leak	Probability of Ignition
	Gas
Minor (<1 kg/s)	0.01
Major (1 to 50 kg/s)	0.07
Massive (>50 kg/s)	0.3

For example, the frequency of catastrophic (guillotine) pipe failure for an 80 mm pipe is 5×10^{-7} / m per year. If a probability of ignition of 0.07 is used, i.e. a major leak, then the combined fire and explosion likelihood is:

$$0.07 \times 5 \times 10^{-7} \text{ / m per year} = 3.5 \times 10^{-8} \text{ / m per year.}$$

This is a low level of risk, it is below the risk criteria shown in Table 1 and not considered intolerable. The ALARP (As Low As Reasonably Practicable) principle is achieved; primarily due to compliance with the Australian Standards for piping.

5.3 DUST EXPLOSIONS

An analysis of the equipment where potential dust explosions could occur is summarised below.

- Baghouse filters with the associated piping systems, bins, hoppers and silos. Dust explosions are to be either vented via the fan housings or explosion vents (the larger volume filters are fitted with explosion vents). The explosion vents are to be either vented direct to atmosphere or flameless;
- Bucket elevators and conveyors. Prevention measures are listed in Appendix K, e.g. low belt speeds will be used to minimise the risk of ignition and belt tracking with limit switches will be installed;
- Processing equipment such as mill, rollers and impact detachers. Protection for these unit operations include magnetic separators, grounding and explosion propagation prevention devices;
- Silos, hoppers, bins, cyclones, separators and sifters. These are to be designed to IECEx standards; and
- Aspiration and pneumatic conveying systems. These are to be designed to IECEx standards.

As this is a preliminary hazard analysis and therefore only preliminary information is available then the only external explosion vents that can be modelled are the two associated with the Mill C filters. These are identical to the corresponding Mill B filters. Modelling of these explosion vents from the side of the Mill B and C building is shown in Table 7. All other Mill C explosion vents are to be flameless or at roof level. The modelling results were derived as follows.

From Ref 9, the damage radius of a dust explosion is usually limited to the building (or equipment item) in which it occurs and to a very short range outside. This is supported by the historical incidents involving dust explosions where the majority of fatalities involve on-site personnel.

The majority of dust explosion incidents detailed in Ref 10 resulted in no fatalities. For the incidents where fatalities occurred, these were to on-site personnel. Again, the greater risk for fatality or injury for dust explosions is to on-site personnel as stated in Ref 9.

The maximum explosion overpressures at a distance D (m) from a vent or point of release is given by (Ref 11):

$$P_{\text{blast}} = (P_{\text{max}} \times C1 \times C2) / D$$

Where:

P_{blast} is the overpressure (or peak blast pressure) at a distance D from the vent, kPag

P_{max} is the pressure within the vessel when the vent opens or the rupture pressure of the vessel (if no vent installed), kPag

$$C1 = 10^{((-0.26/A) + 0.49)}$$

A = vent area, m²

$$C2 = 1 \text{ m}$$

D = distance away from the vent, m

The rupture pressure of weak structures such as silos is typically less than 90 kPag (Ref 10). This reference quotes one experiment where a 500 m³ silo ruptured at 60 kPag with a hole size of 50 m².

To estimate the possible maximum horizontal flame length from a vented dust explosion, the following equation is used (Ref 11):

$$\text{Flame Length} = 10 \times V^{1/3} \text{ (m)}$$

Where:

V is the volume of the vessel, m³

However, no flame length has ever been measured greater than 37 m (even for large volumes) so this should be taken as the upper limit (Ref 11). Other studies

(Ref 12) also show that effects of thermal radiation from the fireball is limited to the fireball's volume given the short duration.

The flame diameter is typically taken as half the flame length.

Importantly, the proposed explosion vents must therefore be directed to a safe location to avoid injury to personnel or propagation to other adjacent equipment.

Table 7 - Dust Explosion Modelling Results

Equipment	Rupture Pressure, kPag	Volume, m ³	Vented Inside or Outside the Building	Vent Area, m ²	Flame Length, m	Distance (m) to the Selected Overpressures:		
						21 kPa	14 kPa	7 kPa
Mill C Filters	10	10	Outside	0.54	22	-	-	<10
SPB (16 vents for 29 m ³ , i.e. 1.8 m ³ per vent)	10	29 (total)	Outside	1 (x16)	10	-	-	<10

The effects of explosion overpressures were summarised in Table 3.

Given the estimated impact distances in Table 7 and the distances to off-site areas from the Mill B and C building and the SPB then no significant off-site impacts are expected from explosion overpressures or radiant heat from flames. Therefore, the risk criteria shown in Table 1 will be satisfied for potential dust explosions within the Mill C filters and the SPB.

The Mill C explosion vents will be positioned at the same elevation as the existing Mill B explosion vents, i.e. at 30 m above ground level, and will vent to the north of the building. The starch plant is the nearest structure; approximately 11 m away. The height of the starch plant is approximately 23 m. The flame diameter is typically half the length, i.e. approximately 11 m for this vent (or a radius of 5.5 m). Therefore, the flames are expected to be above the starch plant roof and propagation is not expected.

There will also be new baghouse filters installed on top of the Mill B and C building roof, i.e. at 36.4 m above ground level. These filters will be fitted with explosion vents that vent directly to atmosphere. This is the tallest structure in the area and hence no ground level or propagation impacts are expected.

5.4 PROPAGATION ANALYSIS

Fires were analysed in Section 5.2. The risk of propagation is low due to:

- The fires involving coal or wheat are local, smouldering fires; and
- The jet and flash fires from natural gas releases have acceptably low likelihoods, i.e. below 1×10^{-6} /year per metre.

There is a more credible risk of propagation from dust explosions; both to and from the proposed modifications.

As stated in Section 5.3, the damage radius of a dust explosion is usually limited to the building (or equipment item) in which it occurs and to a very short range outside (Ref 9).

The following table summarises the proposed and existing processes that are within a short range of each other. Based on anecdotal evidence of dust explosions (e.g. the reported dust explosions in Refs 10 and 12), this is taken to be within 20 m.

For Product Dryer 9, propagation from dust explosions will be mitigated by venting the explosion vents to a safe location outside the building and Product Dryer 9 will be surrounded by fire walls, i.e. protecting other plant and equipment within the same building and vice versa.

Table 8 – Propagation Analysis Summary

Proposed Modification	Potential Propagation Events	Comments
Rail Intake Pit	This process involves wheat grains from the field. Historically, bucket elevators have a relatively higher likelihood of internal dust explosions. These can propagate to the upstream and downstream equipment, e.g. the raw wheat silos. The proposed modifications are outside the 12.6 kW/m² radiant heat contours for fires in the distillery (Figures 7 to 12 in Ref 13). Therefore, distillery fires are not expected to propagate to this area. Note: As this is the closest modification to the distillery then propagation from a distillery to the other modifications is also a low risk	Bucket elevators are a known dust explosion hazard. There are numerous bucket elevators on-site with the following controls: Bearings are external. Belt drift / mis-alignment sensors. Aspiration system (with interlocks). Equipment designed to ATEX including hazardous area assessment Belt drift sensors. Belts are self-extinguishing, anti-static, flame retardant, oil resistant, very low elongation
Mill C	Given the closeness of the Mill A and Mill B/C buildings (they are connected) then a dust explosion within one building would be expected to propagate to the other. This propagation is likely to cause building damage. It may lead to a subsequent release of flour if equipment and piping is damaged. A dust explosion in the Mill B/C building is likely to cause damage to the surrounding plant and infrastructure, e.g. the Starch Plant Building to the north	Building dust explosions (both the primary and secondary explosions) are well-known events. The controls used to prevent these scenarios are summarised in the following section of this report

Proposed Modification	Potential Propagation Events	Comments
Gluten Dryer 8, Product Dryer 9 and the Modified Starch Plant Building	This new building is to be located between the Maintenance Building and the Starch Dryer 5 building. As with the mills' buildings, dust explosions in the new building have the potential to cause damage to the Starch Dryer 5 building and vice versa. It can also damage the Maintenance Building where there are offices, i.e. potential for harm to personnel.	As above, building dust explosions (both the primary and secondary explosions) are well-known events. The controls used to prevent these scenarios are summarised in the following section of this report
Coal Boilers / Co-gen / Boiler 7 Relocation	Natural gas releases with ignition have the potential for propagation (as discussed at the start of this section). Boiler ruptures and steam turbine catastrophic failures (from overspeed and blades being ejected) can result in propagation	The boiler and co-gen plant will be built to comply with the Australian Standards (as detailed in Appendix K). Being on the south side of the site, adjacent to the Shoalhaven River, then propagation from other on-site events to Boiler 8 and the co-gen plant is unlikely
Additional Sifting Eqt to the Packing Plant	This modification involves installing a larger sifter where there is an existing unit within the packing shed. There are no new causes for propagation from this change	As above, building dust explosions (both the primary and secondary explosions) are well-known events. The controls used to prevent these scenarios are summarised in the following section of this report

5.5 BUILDING EXPLOSIONS AND PROPAGATION

It is possible that dust explosions could occur in the new and existing buildings, e.g. deposited dust is not removed due to failure of the housekeeping program. This hazard exists at the site now for the existing buildings containing dust processing.

The primary means to prevent this event is to design for containment. This is the basis for the design of the existing dust processes and will be similarly for the proposed dust handling equipment.

The loss of containment likelihood within the flour mills will be lower due to the positive pressure ventilation system being installed, i.e. if a hole in the piping or equipment occurs, air flow will be into the process due to the positive pressure differential.

Should losses of containment of combustible dust occur then controls such as housekeeping, hazardous zoning and permits to work are required. These are discussed in more detail below but are important measures to lower the risk of dust explosions within the existing and new buildings. For the existing buildings containing combustible dust, cleaning is performed daily to help prevent the build-up of combustible dust. This includes sweeping and vacuuming.

Dust Explosion Safeguarding

For equipment processing a potentially explosive dust, it is generally not possible to always ensure the concentration of the dust is below the lower explosive limit. Rather, safeguarding is required to prevent and/or control the potential explosions as discussed below.

There are no mandatory standards or regulations that dictate the design criteria and features for equipment where dust explosions can occur. However, the main means for safeguarding against dust explosions are as follows. All of these safeguards are either existing and/or proposed for the Shoalhaven Starches site.

Dust Control

Measures to control dust and avoiding the explosive range include:

- Avoid large volumes as much as possible, e.g. to avoid equipment items running empty such as screw conveyors (normally operate with significant quantities of solids);
- Avoid dust formation by limiting the free-fall, e.g. chutes are as close as possible to bins and hoppers;
- Remove the dust at the point of production rather than convey it along ducts where it can accumulate (for example, the processes are aspirated);

- Buildings which contain plant handling combustible dusts are designed to minimise the accumulation of dust deposits, e.g. horizontal beams minimised and located outside the buildings, and to facilitate cleaning; and
- Regular housekeeping to avoid dust build-up. This is a daily occurrence at the site.

Control of Ignition Sources

Measures used to control ignition sources which could give rise to dust explosions include:

- Bonding and earthing for static dissipation;
- Permits to work, training and auditing;
- Regular housekeeping to avoid dusts overheating, e.g. on hot surfaces;
- Hazardous area determination with compliant electrics and instruments;
- Preventative maintenance on equipment to minimise the probability of fault conditions, e.g. rotating equipment bearings;
- Use appropriate electrical equipment and wiring methods;
- Control of smoking, open flames, and sparks; and
- Use separator devices to remove foreign materials capable of igniting combustibles from process materials, e.g. the magnetic separators in the flour mills.

Explosion Isolation

Explosion isolation at the site is achieved via:

- Material chokes such as rotary valves and screw conveyors with baffle plates;
- Spark arrestors; and
- One-way explosion valves are fitted where deemed necessary, e.g. on the inlet ducting to baghouse filters.

Explosion Venting

Explosion venting is an effective and economic way to provide protection against dust explosions. These are installed on higher-risk equipment items such as baghouse filters and large cyclones. Where explosion vents discharge to areas where people can be or onto sensitive equipment then flameless vents are used.

In practice (Ref 10), the assessment of dust explosion hazards is bound to be subjective because the problem is too complex for quantitative analytical methods to yield an indisputable answer. Therefore, the acceptable safeguards for any given design will vary from company to company. Ref 10 quotes work by Pinkwasser and Haberli who suggest most of the dust explosion hazards in the grain, feed and flour industry can be eliminated by soft means such as training, motivation, improving the organisation, good housekeeping and proper maintenance. As above, all of these safeguards are in-place at Shoalhaven Starches.

When these safeguards are combined with the additional measures proposed for the new equipment then further risk reduction is achieved.

The CCPS (Center for Chemical Process Safety) has developed a modified LOPA (Layers of Protection Analysis) methodology for assessing the risk of dust explosions (Ref 14).

LOPA is a simplified semi-quantitative risk analysis tool used to determine how many independent protection layers (IPLs) are needed and how much risk reduction should be applied to each layer. This is achieved by combining the effects of the independent protection layers and comparing the result to risk tolerance criteria.

An IPL is a device, system or action that is capable of preventing a scenario (i.e. not mitigation) from proceeding to its undesired consequence independent of the initiating event or the action of any other layer of protection associated with the scenario. Normally procedural controls such as housekeeping are not allowable as IPLs, however, some of these are taken into consideration in the CCPS dust hazard analysis methodology.

A description of the methodology is given in Appendix L.

For a dust explosion in a building, e.g. Mill B/C, the following initiating event and probabilities are used (see Appendix L for details).

Table 9 – Building Dust Hazard CCPS Likelihood

	Value	Comments
Initiating Event: Loss of containment of dust sufficient to cause a combustible atmosphere	0.01/yr	The value for “Existence of a combustible atmosphere at a bagging station” is used for other buildings, e.g. the mills
IPL 1: Area classification to lower the risk of ignition	0.1	All equipment is designed to Australian and ATEX Standards
IPL 2: Preventative maintenance (PM) to maintain bonding and grounding of the equipment	0.1	PM are allowed in addition to the design IPL (IPL 1 above)
Conditional Modifier 1: Occupancy: There are 2 or more people present 50% of the time	0.5	Based on site experience
Conditional Modifier 2: Probability of ignition	0.1	Agricultural dusts have a minimum ignition energy of more than 10 mJ. This conditional modifier allows for sources of ignition other than static, and faulty electrics and instruments (as included above)
Total:	5×10^{-6} /yr	

That is, use of the CCPS methodology yields a likelihood value of approximately 5×10^{-6} /yr. For a ‘Catastrophic’ consequence rating (i.e. two or more fatalities), the risk level is II.

This is a moderate level of risk. This area is the beginning of the ALARP region (i.e. as low as reasonably practicable). As the buildings and equipment are designed to the relevant Australian and International Standards then there are no further practical measures recommended to economically lower the risk.

No further safeguarding is recommended for this scenario and hence the risk of propagation from a building explosion is not intolerable.

5.6 EXTERNAL HAZARDOUS EVENTS

External events that may lead to propagation of incidents on any site include:

Subsidence	Landslide
Burst Dam	Vermin/insect infestation
Storm and high winds	Forest fire
Storm surge	Rising water courses
Earthquake	Storm water runoff
Breach of security	Lightning
Tidal waves	Aircraft crash

These events were reviewed and none of them were found to pose any significant risk to the proposed modifications given the proposed safeguards. Flooding can occur at this site, however, the structural design for the new buildings and equipment includes allowances for this hazard.

5.7 CUMULATIVE RISK

As analysed in this PHA, the proposed changes to the Shoalhaven Starches site will have negligible impact on the cumulative risk results for the local area as the significant radiant heat levels and/or explosion overpressures are local to the equipment and do not reach other sensitive land users.

Therefore, it is reasonable to conclude that the proposed changes do not make a significant contribution to the existing cumulative risk in the area.

5.8 SOCIETAL RISK

The criteria in HIPAP 4 for individual risk do not necessarily reflect the overall risk associated with any proposal. In some cases, for instance, where the 1 pmpy contour approaches closely to residential areas or sensitive land uses, the potential may exist for multiple fatalities as the result of a single accident. One attempt to make comparative assessments of such cases involves the calculation of societal risk.

Societal risk results are usually presented as F-N curves, which show the frequency of events (F) resulting in N or more fatalities. To determine societal risk, it is necessary to quantify the population within each zone of risk surrounding a facility. By combining the results for different risk levels, a societal risk curve can be produced.

In this study of the proposed modifications, the risk of off-site fatality is below the HIPAP 4 risk criteria. As the nearest residential area is approximately 400 m

away from the nearest modification (the GD8 building), the concept of societal risk applying to off-site populated areas is therefore not applicable for this project.

5.9 RISK TO THE BIOPHYSICAL ENVIRONMENT

The main concern for risk to the biophysical environment is generally with effects on whole systems or populations.

As there are limited quantities of Dangerous Goods associated with the proposed modifications, significant environmental impact is not expected. Whilst fires can also affect the environment due to combustion products, these events are low likelihood given the history of these types of processes. Importantly, any spilt material will be contained in the area or via the environmental farm.

Whereas any adverse effect on the environment is obviously undesirable, the results of this study show that the risk of losses of containment impacting the environment is broadly acceptable.

From the analysis in this report, no incident scenarios were identified where the risk of whole systems or populations being affected by a release to the atmosphere, waterways or soil is intolerable.

5.10 TRANSPORT RISK

There are limited quantities of Dangerous Goods involved with the proposed modifications, e.g. an extra caustic road tanker every 4 to 5 days. Therefore, transport risk has not changed significantly and is deemed broadly acceptable.

6 CONCLUSION AND RECOMMENDATIONS

The risks associated with the proposed modifications to MP06-0228 at the Shoalhaven Starches Bomaderry site, including Product Dryer 9 and the MOD 17 changes, have been assessed and compared against the DoP risk criteria in this report.

The results are as follows and show compliance with all risk criteria.

Description	Risk Criteria	Risk Acceptable?
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year	Yes
Fatality risk to residential and hotels	1×10^{-6} per year	Yes
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year	Yes
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year	Yes
Fatality risk to be contained within the boundary of an industrial site	50×10^{-6} per year	Yes
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50×10^{-6} per year	Yes
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50×10^{-6} per year	Yes

Societal risk, area cumulative risk, environmental risk and transport risk is also concluded to be acceptable.

The primary reasons for the low risk levels from the modifications are that significant levels of impact from potential hazardous events are contained on-site.

The following recommendation is made from this review.

1. For all explosion vents that vent directly to atmosphere for the modifications, finalise the explosion vent modelling when the design details are known.
2. Review the option for installing initial screening, e.g. a magnetic separator, at the new intake pit to lower the likelihood of foreign objects entering the new bucket elevator and the downstream existing silos.
3. Ensure that all the proposed explosion vents are directed to a safe location to avoid injury to personnel or propagation to other adjacent equipment.
4. It is recommended that the floor of the new switchroom be fire-rated given the risk of a fire in the existing switchroom below. This will also help prevent a fire in the new switchroom propagating to the existing switchroom below.

7 APPENDIX A - PROPOSED GRAIN INTAKE SYSTEM DETAILS

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**

EXISTING APPROVED PLANT – BLACK.
PROPOSED MODIFICATION TO RAIL UNLOADING –RED.

EXISTING RAIL INTAKE PIT AND UNLOADING AUGER

INTAKE PIT.

CHUTES.

BUCKET ELEVATOR.
4M x 4M.

PLAN VIEW

BUCKET ELEVATOR.

CHUTES.

43.30m

33.90m

00.00m

-3.95m

WESTERN ELEVATION

BUCKET ELEVATOR.

CHUTES.

Conveyor 2.

Conveyor 1.

SOUTHERN ELEVATION

BUCKET ELEVATOR.

CHUTES.

43.30m

33.90m

00.00m

-3.95m

Conveyor 2.

Conveyor 1.

EXTEND EXISTING AWNING.

INTAKE PIT.

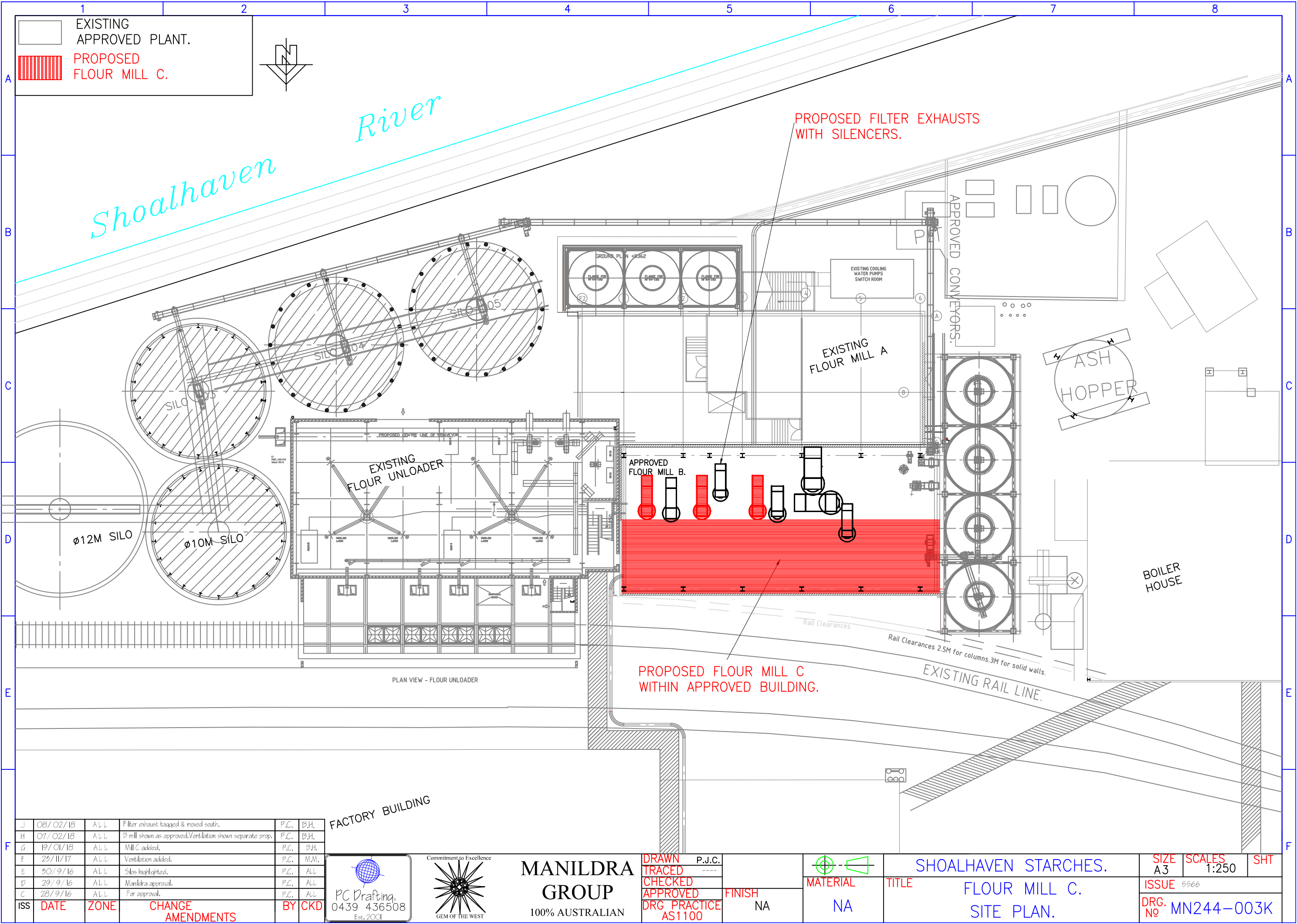
EASTERN ELEVATION

REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
REV1	ALL	PROPOSAL.	P.C.	22/02/18	M.H.	

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	DESIGNED	DATE	JOB TITLE PROP.SPEC.PRODUCTS,PROD.DRYER,BOILERS.	OF
	CHKD	DATE	DWG TITLE PROPOSED MODIFICATION TO RAIL UNLOADING.	REV.
	APPD	DATE	PROJECT No. 6531	DWG No. MN6531-012
SCALE 1 : 500				P07

8 APPENDIX B – MILL C DRAWINGS

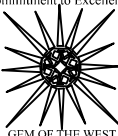
**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**



J	08/02/18	ALL	Filter exhaust tagged & moved south.	P.C.	B.H.
H	07/02/18	ALL	B mill shown as approved. Ventilation shown separate prop.	P.C.	B.H.
G	19/01/18	ALL	Mill C added.	P.C.	B.H.
F	25/11/17	ALL	Ventilation added.	P.C.	M.M.
E	30/9/16	ALL	Silos highlighted.	P.C.	ALL
D	29/9/16	ALL	Manildra approval.	P.C.	ALL
C	28/9/16	ALL	For approval.	P.C.	ALL
ISS	DATE	ZONE	CHANGE AMENDMENTS	BY	CKD

FACTORY BUILDING


PC Drafting
0439 436508
Est. 2001

Commitment to Excellence

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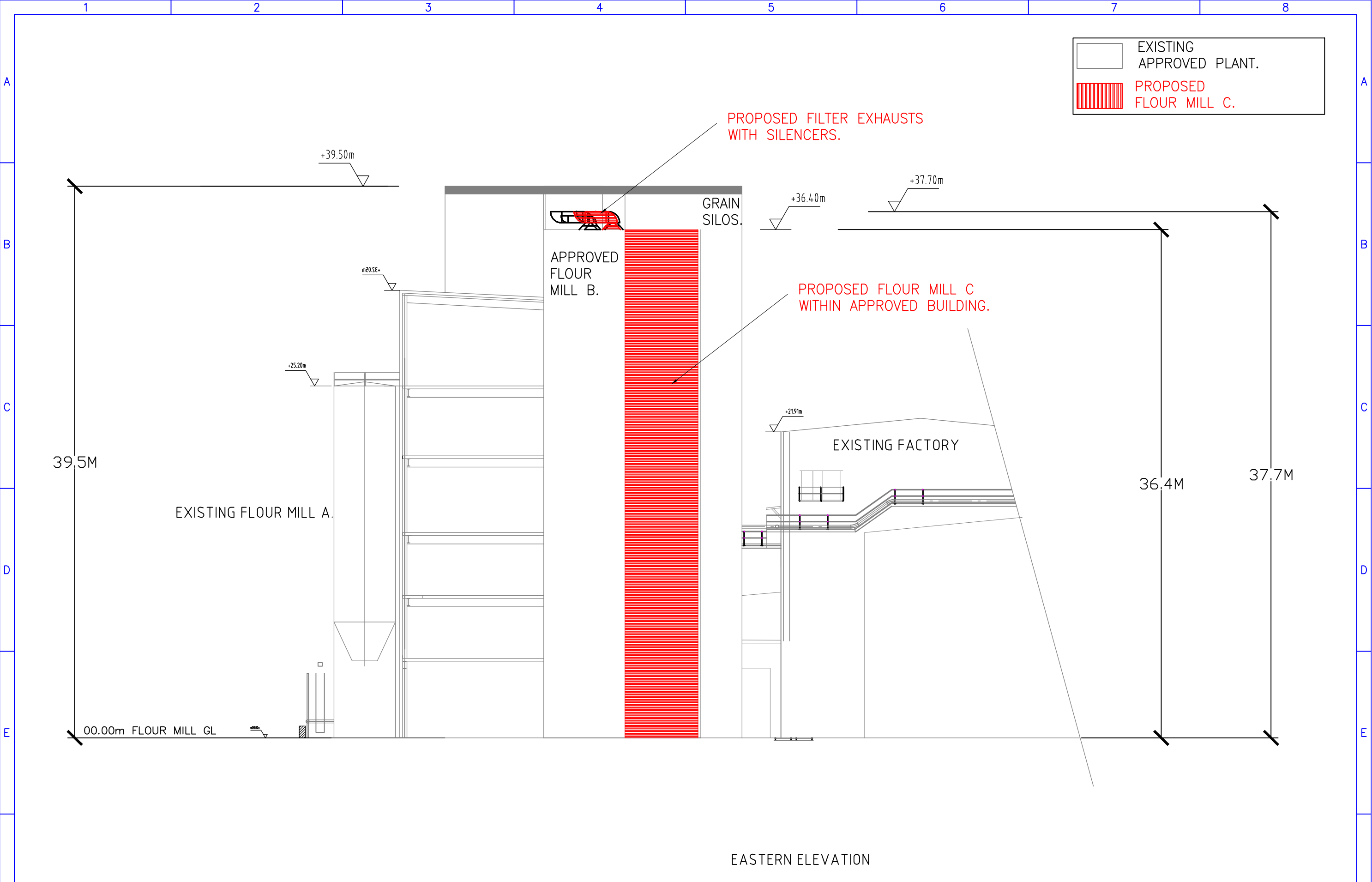
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TRACED
CHECKED
APPROVED
DRG PRACTICE
AS1100

P.J.C.
FINISH
NA


MATERIAL
NA

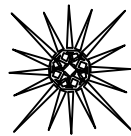
SHOALHAVEN STARCHES.
FLOUR MILL C.
SITE PLAN.

SIZE A3
SCALE 1:250
SHT
ISSUE 5566
DRG. NO. MN244-003K



EASTERN ELEVATION

J	08/02/18	ALL	Filter exhaust tagged & moved south.	P.C.	B.H.
H	07/02/18	ALL	B mill shown as approved. Ventilation shown separate prop.	P.C.	B.H.
G	19/01/18	ALL	Mill C added.	P.C.	B.H.
E	30/9/16	ALL	Wording added.	P.C.	ALL
D	29/9/16	ALL	Manildra approval.	P.C.	ALL
ISS	DATE	ZONE	CHANGE AMENDMENTS	BY	CKD



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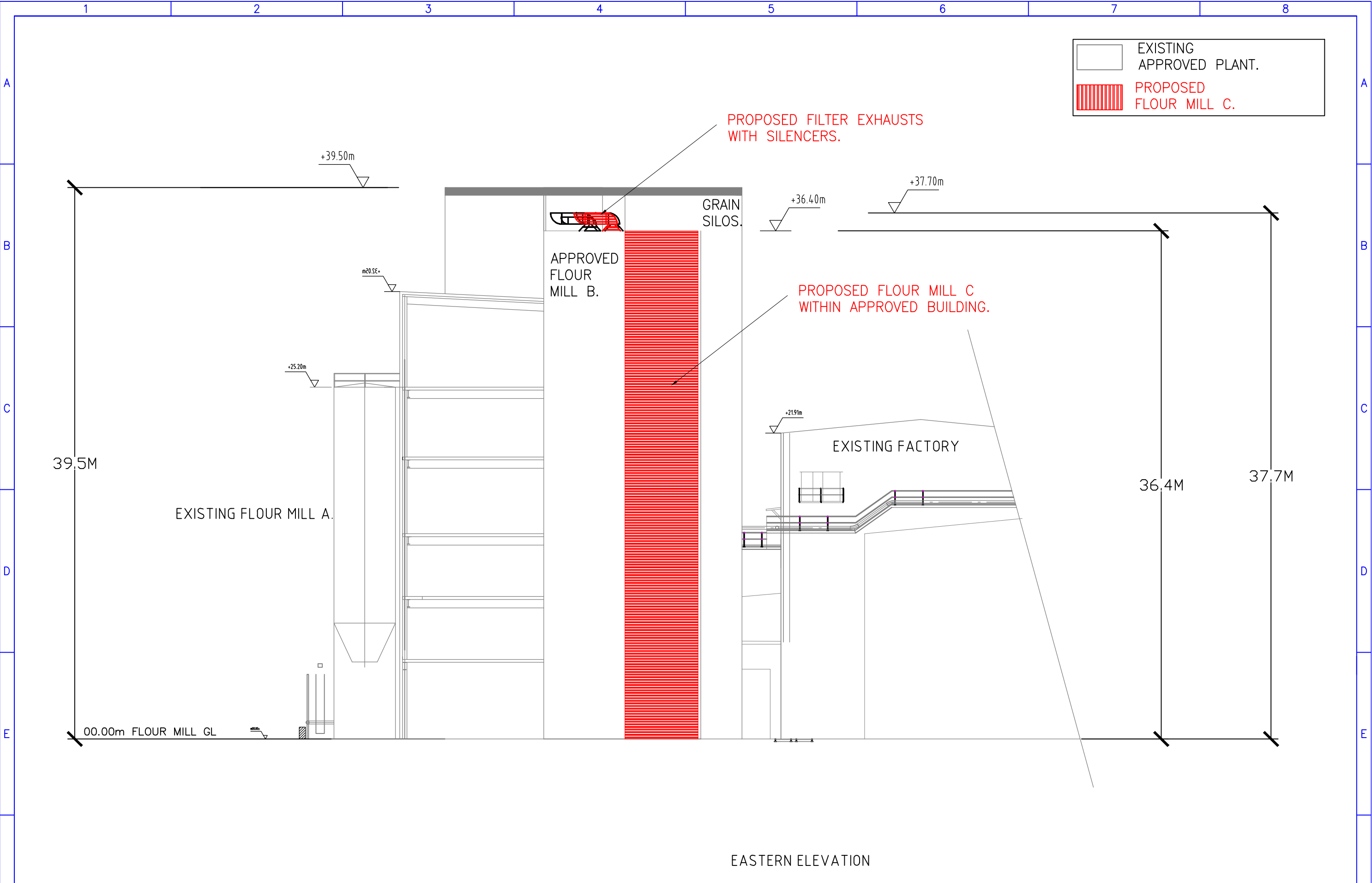
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TRACED
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APPROVED
DRG PRACTICE
AS1100

P.J.C.

MATERIAL
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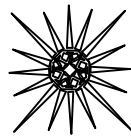
SHOALHAVEN STARCHES.
PROPOSED FLOUR MILL C.
SITE EASTERN ELEVATION

SIZE A3	SCALES 1:250	SHT
ISSUE 5566		
DRG. No MN244-005J		



EASTERN ELEVATION

J	08/02/18	ALL	Filter exhaust tagged & moved south.	P.C.	B.H.
H	07/02/18	ALL	B mill shown as approved. Ventilation shown separate prop.	P.C.	B.H.
G	19/01/18	ALL	Mill C added.	P.C.	B.H.
E	30/9/16	ALL	Wording added.	P.C.	ALL
D	29/9/16	ALL	Manildra approval.	P.C.	ALL
ISS	DATE	ZONE	CHANGE AMENDMENTS	BY	CKD



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GROUP
100% AUSTRALIAN

DRAWN
TRACED
CHECKED
APPROVED
DRG PRACTICE
AS1100

P.J.C.

MATERIAL
NA

SHOALHAVEN STARCHES.
PROPOSED FLOUR MILL C.
SITE EASTERN ELEVATION

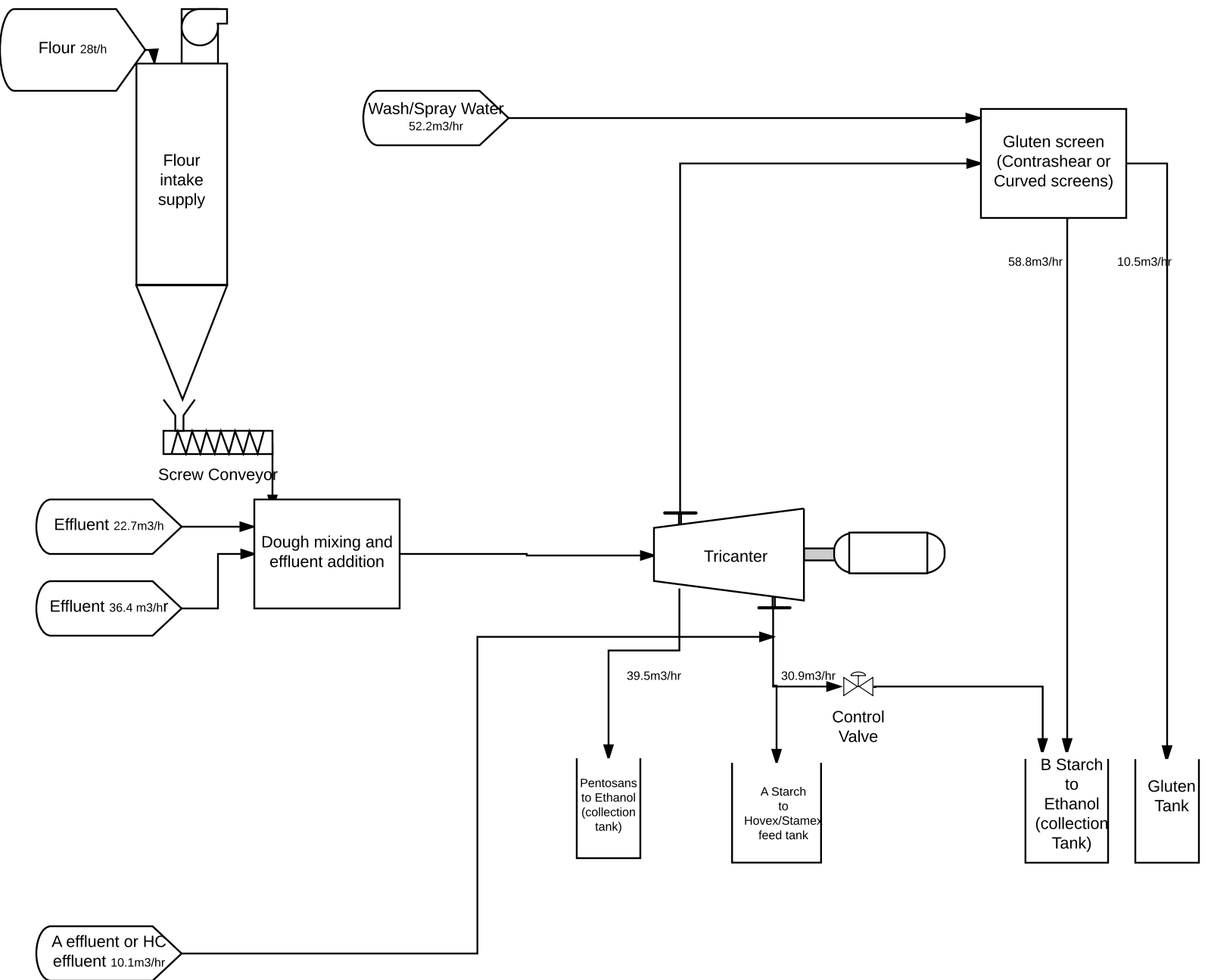
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ISSUE 5566		
DRG. No MN244-005J		

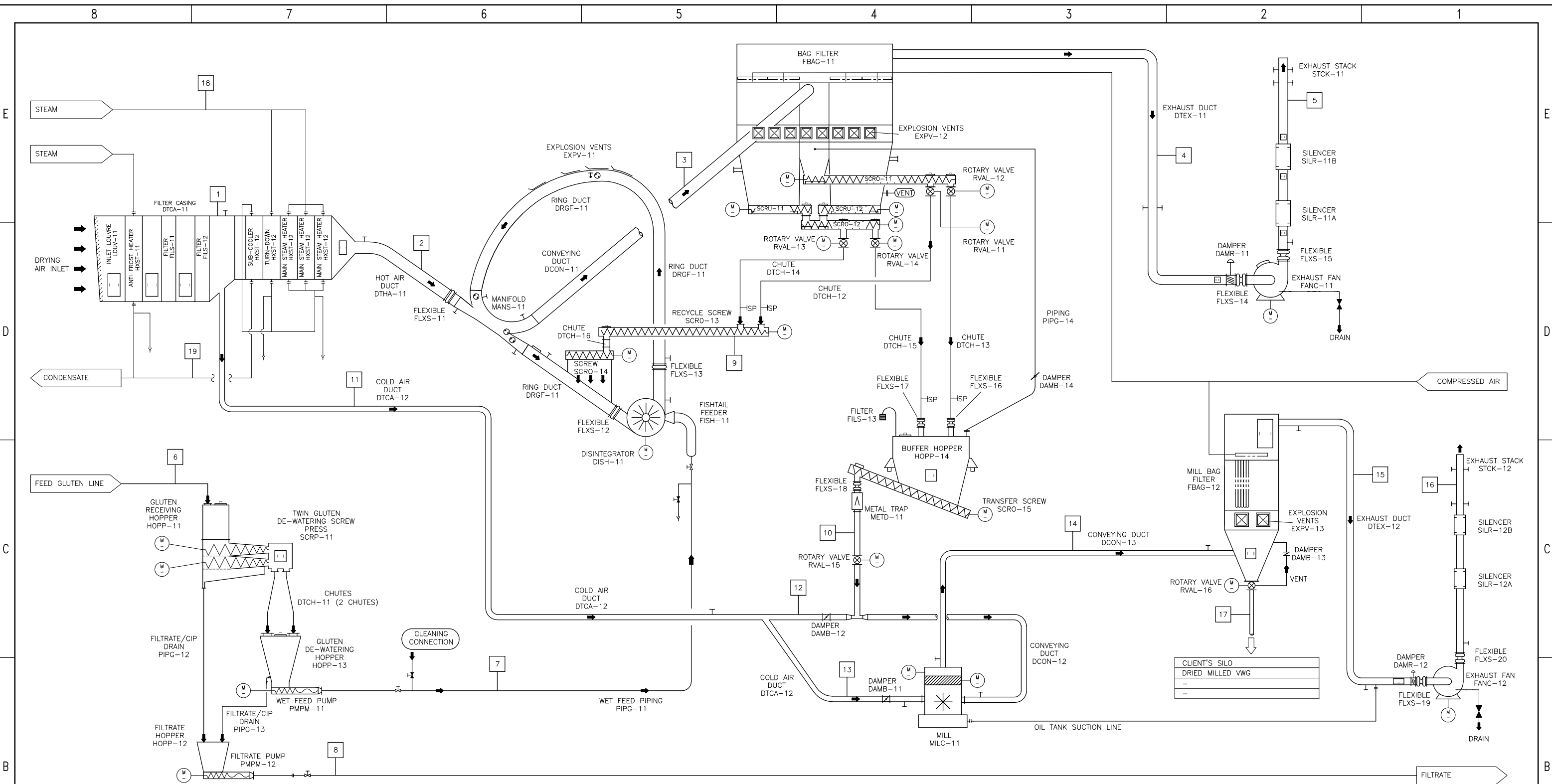
9 APPENDIX C – MILLS’ BUILDINGS VENTILATION SYSTEMS

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**

10 APPENDIX D – GLUTEN DRYER 8 DRAWINGS

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**





MAXIMUM CAPACITY AT MINIMUM AMBIENT TEMPERATURE (0°C) KEY * Dew Point in °C ** Maximum expected values

ITEM NO.		1	2	-	3	4	5	6	7	8	9	10	11	12	13	-	14	15	16	17	18	19	-
DESIGNATION	UNITS	DRYING INLET AIR	HOT AIR DUCT	LEAKS INTO DRYER	CONVEYING DUCT TO BAG FILTER	EXHAUST DUCT	EXHAUST STACK	GLUTEN FEED LINE	GLUTEN PIPEWORK TO FISHTAIL	FILTRATE RETURN	RETURN FEED SCREW	PRODUCT CHUTE	COLD AIR DUCT	COLD AIR DUCT TO VENTURI	COLD AIR DUCT TO MILL	LEAKS INTO MILL	EXHAUST DUCT TO MILL BAG FILTER	EXHAUST DUCT	EXHAUST STACK	PRODUCT CHUTE	STEAM	CONDENSATE	-
DRY SOLIDS	kg/h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WATER	kg/h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL SOLIDS	kg/h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DRY AIR	kg/h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WATER IN AIR	kg/h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL AIR MASS	kg/h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VOLUME	dm ³ /h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TEMPERATURE	°C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PRESSURE	mbar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

THIS IS A PRELIMINARY DRAWING
NOT FOR FABRICATION

DO NOT SCALE
IF IN DOUBT ASK

WEIGHTS SHOWN ARE APPROXIMATE AND INDICATIVE ONLY. THEY
MUST BE CHECKED BEFORE LIFTING OR FOR MATERIAL TAKEOFF, ETC

WEIGHT:- kg

PFD OF VITAL WHEAT GLUTEN DEWATERING,
RING DRYING & MILLING SYSTEM

Sheet 1 OF 1

GEA Barr-Rosin

SCALE

NTS at A1

DRAWN

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CHECKED

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APPROVED

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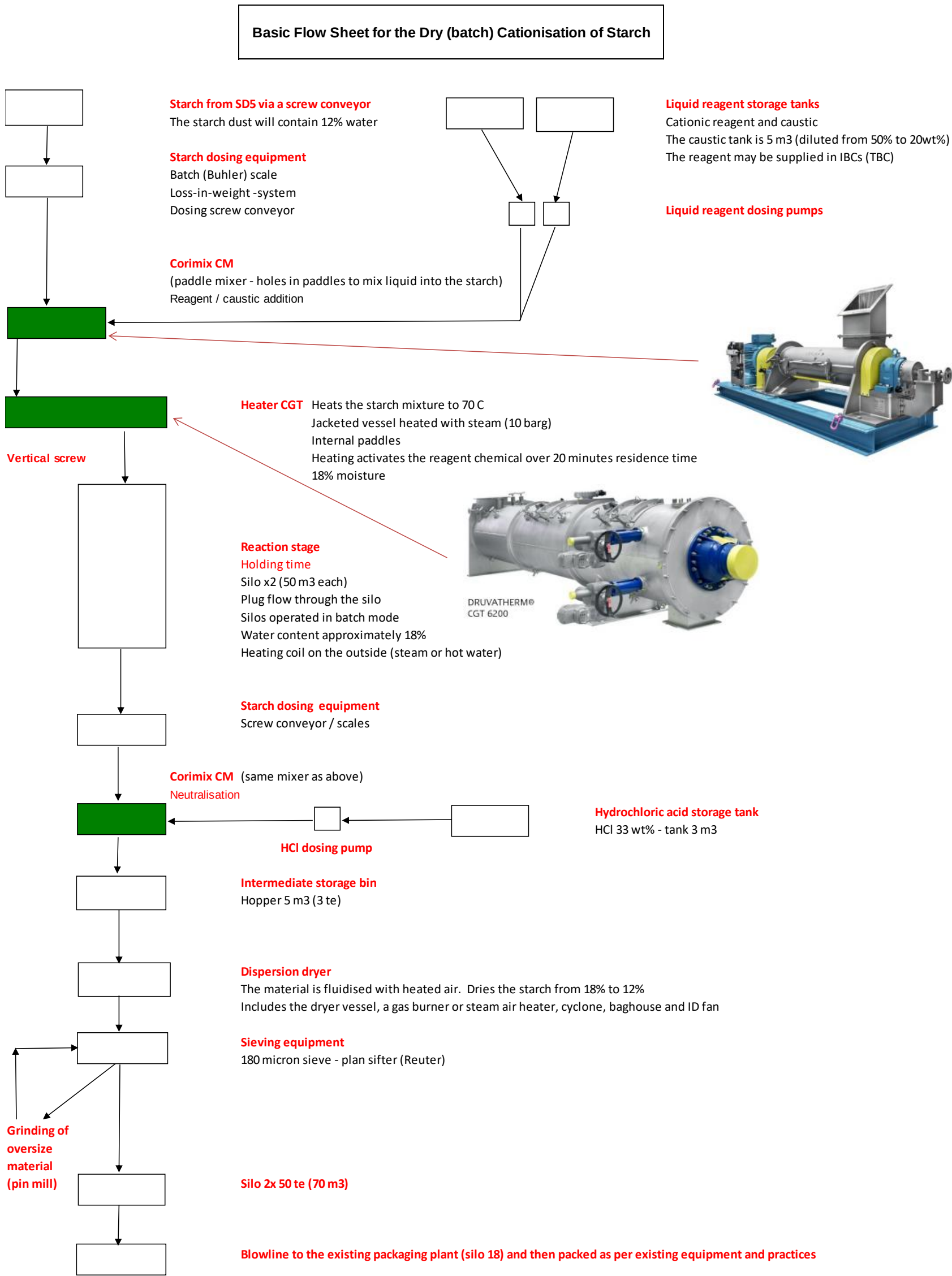
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11 APPENDIX E – CATIONIC STARCH PROCESS FLOW DIAGRAM

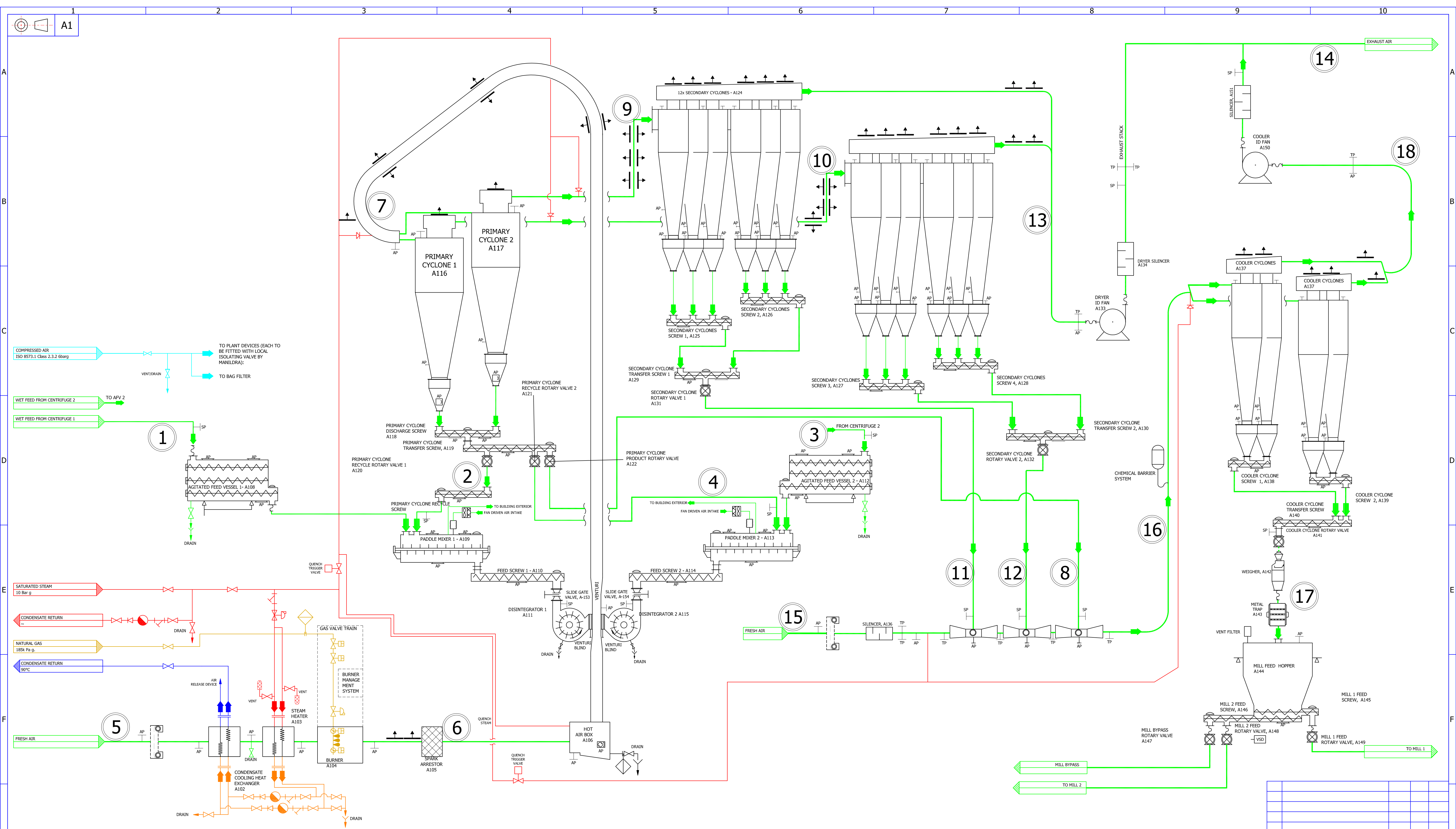
**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**

Appendix E - Cationic Starch Process Flow Diagram



12 APPENDIX F – STARCH DRYER 5 PROCESS FLOW DIAGRAMS

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**



Legend:

- TT FIELD INSTRUMENT
- TIA LOCAL PANEL INSTRUMENT
- TIRA CONTROL SYSTEM INSTRUMENT
- TIRA^{HH} ALARM HIGH HIGH / LOW LOW (SHUTDOWN)
- TIRA^H ALARM HIGH / LOW (WARNING ONLY)
- TTA^{HH} SAFETY RELATED PART OF CONTROL SYSTEM
- DO DIGITAL (DISCRETE) OUTPUT FROM CONTROL SYSTEM

Section		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Air Mass Flow																			
Dry Air	kg/h					222,893	222,893	222,893		114,790	114,790			229,580	274,380	44,800	44,800		44,800
Water Vapour	kg/h					670	670	10,586		5,303	5,303			10,607	11,107	500	500		500
Total	kg/h					223,563	223,563	233,479		120,093	120,093			240,186	285,486	45,300	45,300		45,300
Air volume Flow																			
Total	Am3/h					172,981	291,286	235,369		120,010	120,010			239,994	261,071	35,051	39,547		40,498
Solids Mass Flow																			
Dry Solids	kg/h	9,350	2640	9,350	2640			23,980	14,960	1,870	1,870	11,990	11,990				18,700	18,700	
Water	kg/h	6,233	360	6,233	360			3,270	2,040	255	255	1,635	1,635				2,550	2,550	
Total	kg/h	15,583	3000	15,583	3000			27,250	17,000	2,125	2,125	13,625	13,625				21,250	21,250	
Moisture	%	40	12	40	12			12	12	12	12	12	12				12	12	
Temperature	deg. C					0	180	75	55	65	65	52	52	58	50	0	25	35	25
Pressure	mbar g.					0	-15	-22	-25	-42	-42	-9	-17	-62	1	0	-33		-56

REVISION 0

30.09.2014

WH

REV

DESCRIPTION

DATE

BY

CHKD

VetterTec

A Moret Industries Company

Specialists in Drying Technology - www.VetterTec.co.uk

VetterTec Ltd, Suffolk House, 154 High St, Sevenoaks, Kent, TN13 1XE, England.
Tel: +44 (0) 1732 441440 Fax: +44 (0) 1732 458818 Email: info@vettertec.co.uk

TITLE:
WHEAT STARCH DRYER & COOLER PFD

PROJECT No: **DRP4785**

CLIENT: **MANILDRA**

DRAWN BY: **WH**

DRAWING No:

DRAWN DATE: **30.09.2014**

CHECKED BY:

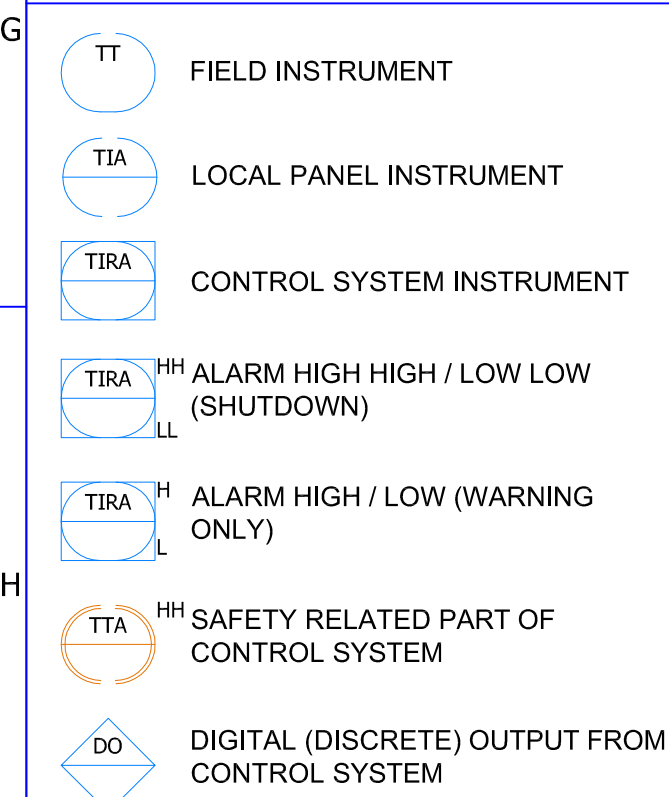
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SCALE: **NTS**

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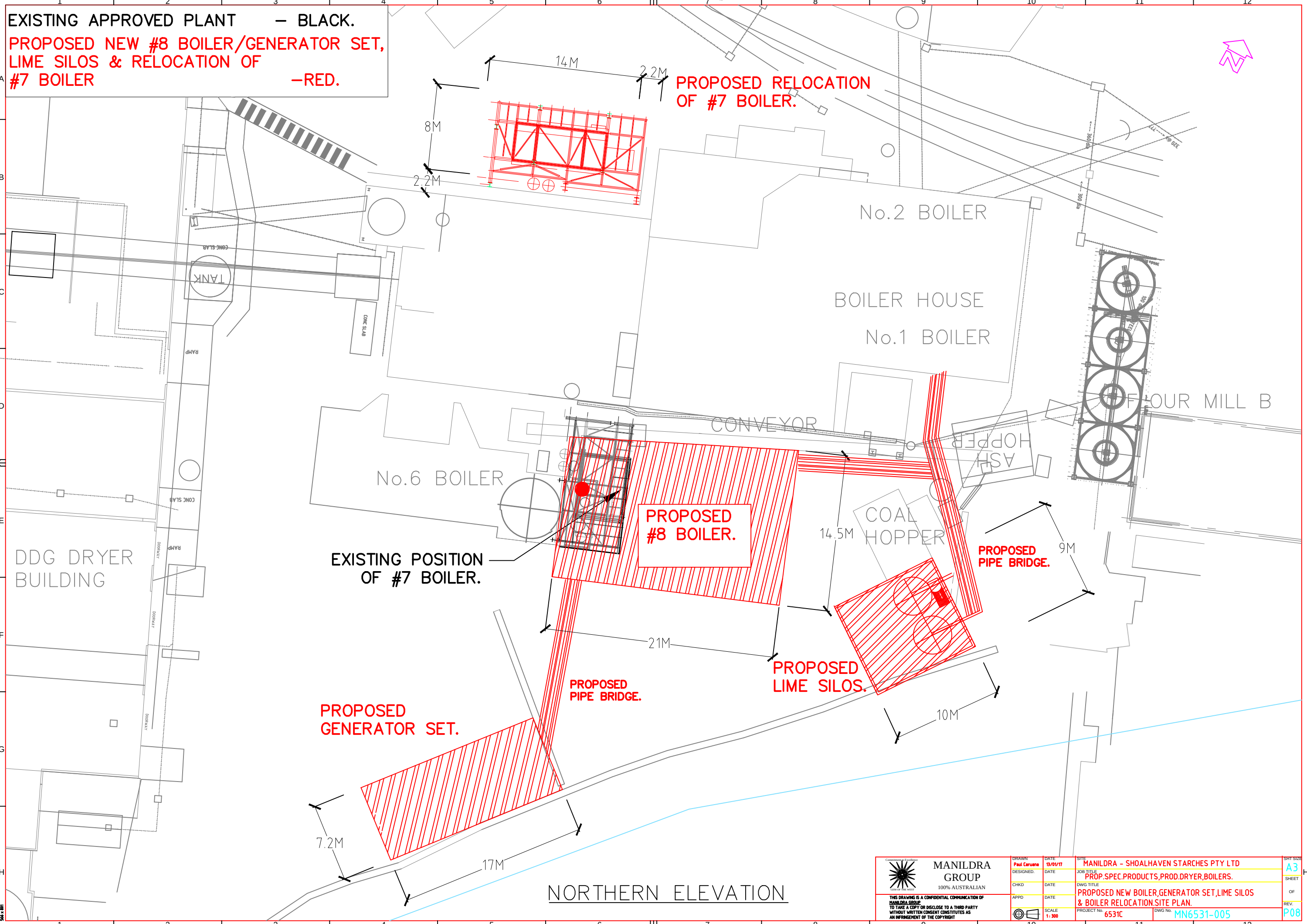
1 2 3 4 5 6 7 8 9 10

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13 APPENDIX G – BOILERS DRAWINGS

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**

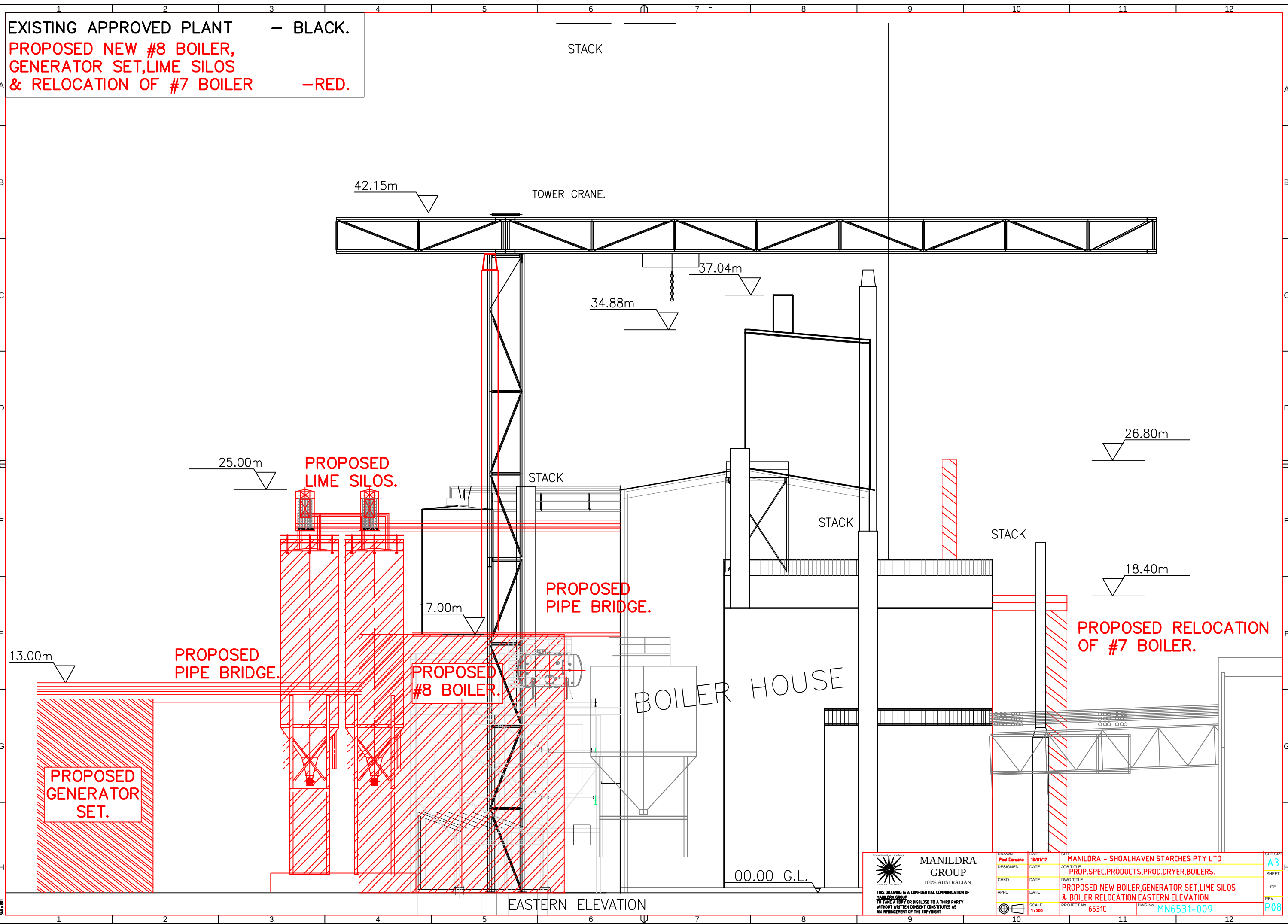
EXISTING APPROVED PLANT – BLACK.
PROPOSED NEW #8 BOILER/GENERATOR SET,
LIME SILOS & RELOCATION OF
#7 BOILER –RED.



NORTHERN ELEVATION

 MANILDRA GROUP 100% AUSTRALIAN	DESIGNED	DATE	13/01/17	SITE MANILDRA – SHOALHAVEN STARCHES PTY LTD JOB TITLE PROP. SPEC. PRODUCTS, PROD. DRYER, BOILERS. DWG TITLE PROPOSED NEW BOILER, GENERATOR SET, LIME SILOS & BOILER RELOCATION SITE PLAN. PROJECT No. 6531C DWG No. MN6531-005	SHEET A3 OF P08
	CHKD	DATE			
	APPD	DATE			
	SCALE	1:300			
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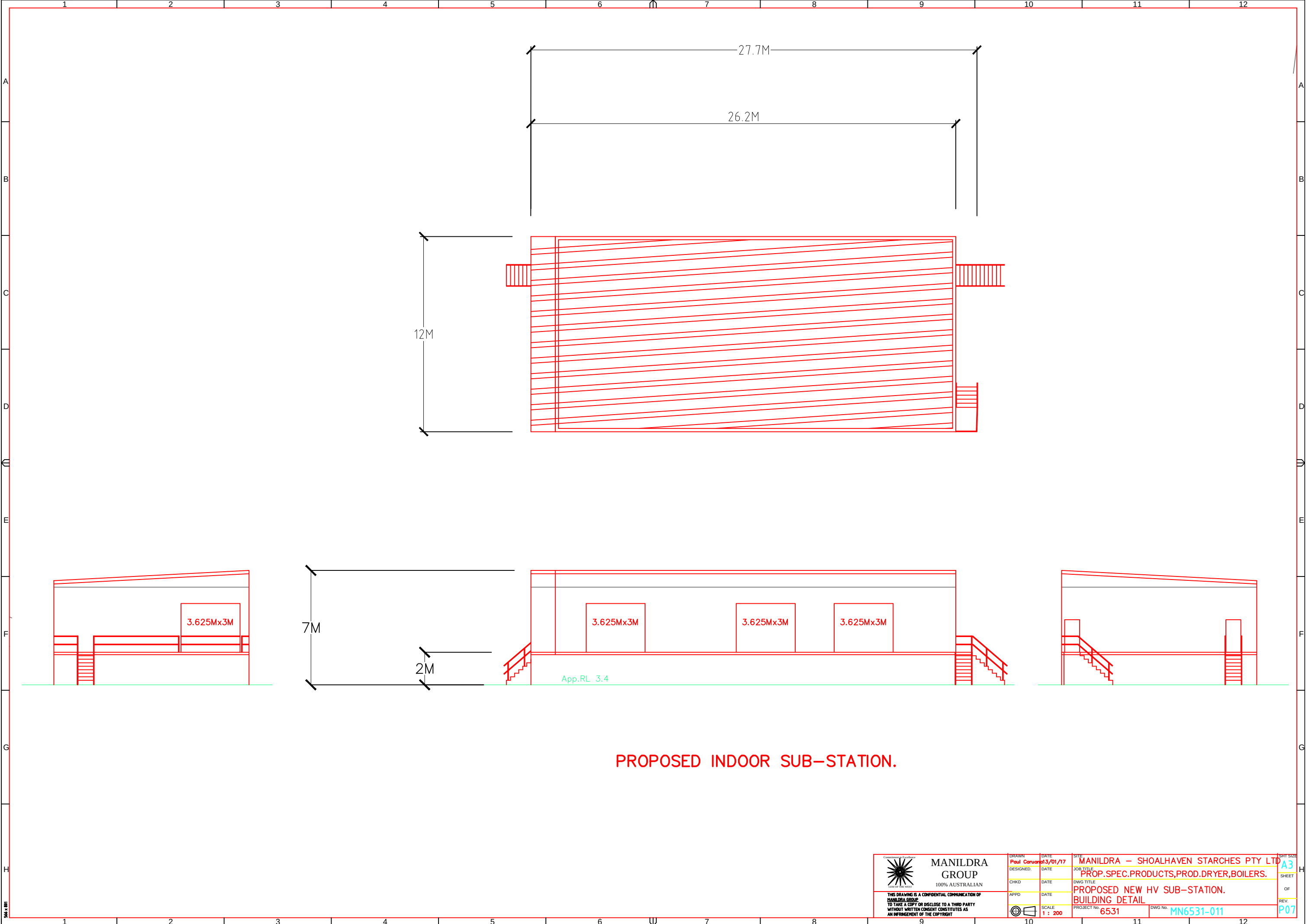
EXISTING APPROVED PLANT — BLACK.
PROPOSED NEW #8 BOILER,
GENERATOR SET,LIME SILOS
& RELOCATION OF #7 BOILER —RED.



 MANILDRA GROUP 100% AUSTRALIAN	DATE	13/01/17	MANILDRA - SHOALHAVEN STARCHES PTY LTD JOB TITLE PROP. SPEC. PRODUCTS, PROD. DRYER, BOILERS. DWG TITLE PROPOSED NEW BOILER, GENERATOR SET, LIME SILOS & BOILER RELOCATION, EASTERN ELEVATION. PROJECT No. 6531C DWG No. MN6531-009	SHEET A3 OF P08
	DESIGNED	DATE		
	CHKD	DATE		
	APPD	DATE		
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14 APPENDIX H – ELECTRICAL MODIFICATIONS DRAWINGS

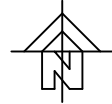
**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**



PROPOSED INDOOR SUB-STATION.

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	DESIGNED	DATE	JOB TITLE PROP.SPEC.PRODUCTS,PROD.DRYER,BOILERS.	SHEET P07
	CHKD	DATE	DWG TITLE PROPOSED NEW HV SUB-STATION.	OF
	APPD	DATE	BUILDING DETAIL	REV.
	SCALE 1 : 200	PROJECT No. 6531	DWG No. MN6531-011	

EXISTING APPROVED PLANT — BLACK.
PROPOSED 2ND STOREY EXTENSION
TO EXISTING MAIN SUB STATION. — RED.



7000

4950

2000

EXISTING SWITCH YARD.

EXISTING PACKAGING BUILDING.

2450

15000

2450

PLAN VIEW.

12.50m

4500

700

2450

4850

EXISTING
SUB-
STATION.

EXISTING
PACKAGING BUILDING.

00.00m

WESTERN ELEVATION.

SOUTHERN ELEVATION.



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DRAWN
DESIGNED
CHKD
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SCALE
1 : 100

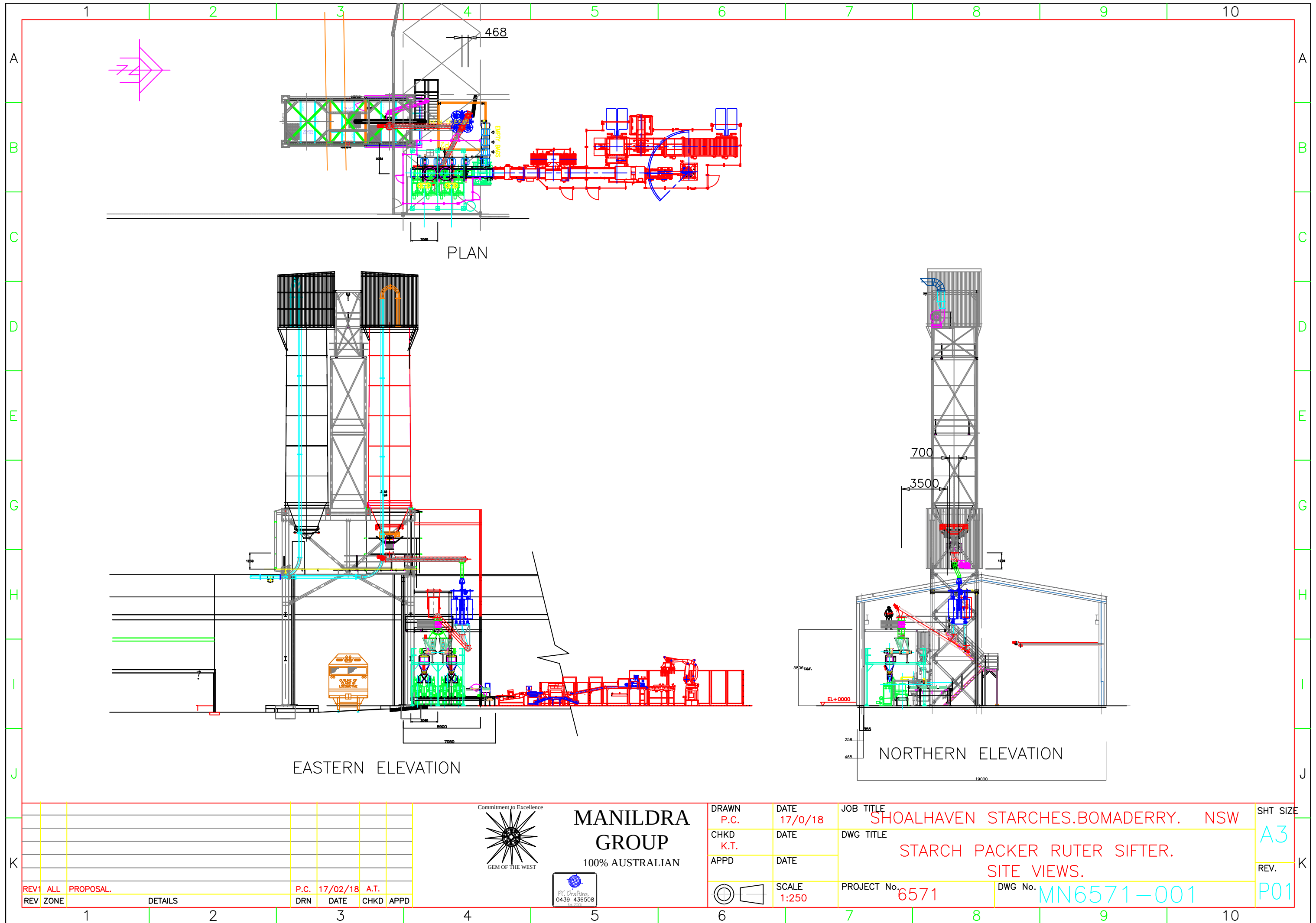
DATE
DATE
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SITE
JOB TITLE
DWG TITLE
PROJECT No.
DWG No.

SHY SIZE
SHEET
OF
REV.

**15 APPENDIX I – SIFTER (PACKING SHED) LAYOUT AND
ELEVATION DRAWING**

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**



REV	ZONE	DETAILS	DRN	DATE	CHKD	APPD
REV1	ALL	PROPOSAL.	P.C.	17/02/18	A.T.	



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DRAWN P.C.	DATE 17/0/18	JOB TITLE SHOALHAVEN STARCHES.BOMADERRY. NSW	SHT SIZE A3
CHKD K.T.	DATE	DWG TITLE STARCH PACKER RUTER SIFTER. SITE VIEWS.	REV. P01
APPD	DATE	PROJECT No. 6571	DWG No. MN6571-001
SCALE 1:250			

16 APPENDIX J – HAZARDOUS MATERIALS PROPERTIES

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**

Appendix J – Hazardous Materials Properties

1. Wheat including Flour

Wheat, like barley, oats and rye, is a cereal grain. Wheat grains are generally oval shaped although different wheats have grains that range from almost spherical to long, narrow and flattened shapes. The grain is usually between 5 and 9 mm in length and weighs between 35 and 50 mg.

There are three main components to the grain:

Bran:

The outer coating or "shell" of the wheat kernel is made up of several layers. These layers protect the main part of the kernel.

Endosperm:

This is the main part of the wheat kernel and represents about 80% of the kernel weight. It is from this part that white flour is milled. The endosperm is rich in energy-yielding carbohydrate and important protein.

Germ or Embryo:

This part grows into a new plant if sown. The germ lies at one end of the grain and represents only 2% of the kernel. It is a rich source of B vitamins, oil, vitamin E and natural plant fat. It needs to be removed during milling because the fat is liable to become rancid during flour storage.

Dust from wheat can be formed by activities such as loading / unloading, filling a silo, milling and pneumatic conveying. It is a potentially explosive dust when critical parameters exist, e.g. particle size less than 500 micron.

Ignition sources include (Ref 15):

- Smouldering, self-heating or burning dust;
- Open flames, e.g. welding, hot work, cutting and matches;
- Hot surfaces, e.g. hot bearings, dryers, incandescent materials and heaters;
- Lightning;
- Heat from mechanical impact or friction; and
- Electrical discharges and arcs.

K_{st} is a measure of a dust's explosibility classification and is a measure of the maximum rate of pressure rise, i.e. the higher the K_{st} value, the greater the explosive energy. For grain dust (i.e. flour, gluten and starch), the K_{st} value is typically between 0 and 200 bar.m/s. These are deemed potentially weak

explosions although it is noted that previous incidents involving grain dust explosions have led to fatalities (Refs 15 and 16).

Whilst grains are combustible when exposed to strong ignition sources, e.g. open flames, they typically burn as a smouldering type of fire and therefore do not pose significant radiant heat hazards. Smouldering grains, however, can be a precursor to dust explosions as the hot grains can provide the ignition energy to cause a dust cloud to deflagrate.

Starch:

Starch or amyllum is a carbohydrate consisting of a large number of glucose units joined together. The chemical formula for starch is $(C_6H_{10}O_5)_n$. It is not defined as a hazardous material or a Dangerous Good.

Starch is produced by most green plants as an energy store. It is the most common carbohydrate in human diets and is contained in large amounts in such staple foods as potatoes, wheat, corn, rice, and cassava.

Papermaking is the largest non-food application for starches globally. In a typical sheet of copy paper, the starch content may be as high as 8%.

Starch is a fine, white, odourless powder. The respiratory TWA (time weighted average) is 5 mg/m³. It is insoluble in water. Starch is not defined as a combustible solid (it will not support combustion) but may form explosive mixtures with air. It is a potentially explosive dust when critical parameters exist, e.g. particle size less than 500 microns.

The K_{st} value for starch is up to 199 bar.m/s. These are deemed potentially weak explosions.

Starch is non-toxic to people and has a low environmental impact potential. It is mildly irritating to eyes and lungs.

Gluten:

Gluten is a composite of storage proteins and is stored together with starch in the endosperm of the wheat grain. It is an odourless, slightly yellow powder. It is not defined as a hazardous material or a Dangerous Good.

Gluten is added to various foods to increase the protein concentration.

The K_{st} value for gluten is approximately 149 bar.m/s although a value of 200 bar.m/s may be used for explosion vent sizing. These are deemed potentially weak explosions.

It is slightly hazardous in case of skin contact (irritant), of eye contact (irritant) and inhalation.

2. Natural Gas

Natural gas is a Class 2.1 Dangerous Good (flammable gas).

Natural gas is a colourless hydrocarbon fluid mainly composed of the following hydrocarbons:

- Methane (typically 88.5% or higher);
- Ethane (typically 8%);
- Propane (typically 0.2%);
- Carbon dioxide (typically 2%); and
- Nitrogen (typically 1.3%).

For a typical natural gas, the TLV (threshold limit value) is approximately 1,000 ppm and the STEL (short term exposure limit) is 30,000 ppm (i.e. approaching 5 vol% which is the lower explosive limit).

The hydrocarbons are not considered to represent a significant environmental threat. Their hazard potential derives solely from the fact that they are flammable materials.

To enable ready leak detection, natural gas is normally odourised with mercaptans (sulphur containing hydrocarbons).

The flammability range is typically 5% to 15% v/v in air. The vapours are lighter than air and will normally disperse safely if not confined and/or ignited.

Natural gas ignition can lead to jet fires, flash fires or vapour cloud explosions.

Products of combustion include carbon monoxide and carbon dioxide.

3. Caustic Soda, Hydrochloric Acid and Cleaning Chemicals Containing hypochlorite

Caustic soda, hydrochloric acid and sodium hypochlorite are all Class 8 corrosive liquids, i.e. there is the potential for burn injuries to personnel on contact. Hydrochloric acid and hypochlorite are also corrosive to many common materials of construction, e.g. carbon steel and concrete.

Caustic Soda:

Caustic soda is a colourless liquid. It is highly alkaline and hence corrosive to human tissue and can cause serious injury to skin and eyes. Inhalation of any mist containing caustic soda can result in respiratory irritation and lung conditions such as pulmonary oedema.

It is typically transported as a 46 – 50 wt% solution although lower strengths are also produced.

Caustic soda is corrosive to aluminium, zinc, lead, brass and tin. A product of reaction with metals is hydrogen (i.e. a highly flammable gas). Care is therefore required when maintaining pipework etc containing caustic soda as hydrogen flash fires can occur, e.g. hot work in cutting through pipes.

It reacts vigorously with acids. When mixed with ammonium salts, ammonia gas will be evolved. Caustic soda will react exothermically with water. It will also attack many glasses and ceramic materials. When mixed with some organic matter (e.g. milk residues), carbon monoxide can be evolved.

Caustic soda will absorb carbon dioxide to form solid deposits, e.g. white solid deposits from small valve leaks.

Depending on the production method, caustic soda may contain trace impurities such as mercury. Mercury bioaccumulates and can cause nervous system damage. Therefore, any sludge should be considered for the presence of mercury.

When spilt, caustic soda is very slippery. At low ambient temperatures, higher strength caustic soda can freeze.

Hydrochloric Acid:

Hydrochloric acid is normally supplied as a 33wt% solution. It is a clear to slightly yellow fuming solution with a pungent odour.

Hydrochloric acid reacts violently with alkalis and sodium hypochlorite (the latter reaction evolves chlorine gas). It is highly corrosive to most metals with evolution of hydrogen gas (i.e. a highly flammable gas).

Exposure to hydrochloric acid can lead to severe burns and irritation. Prolonged exposure can lead to dermatitic effects.

Hydrochloric acid is not classifiable as a human carcinogen.

Hydrogen chloride gas can be released to the atmosphere by evaporation from spills of concentrated hydrochloric acid. It is toxic and acts as a respiratory irritant. It has a readily noticeable odour at low concentrations (around 0.3 ppm) that do not constitute an acute hazard; therefore, the odour acts as a hazard warning. The Time Weighted Average (TWA) exposure limit for hydrogen chloride for an eight-hour day is 5 ppm. The IDLH (immediately dangerous to life and health) value is 50 ppm.

If involved in a fire, toxic fumes can be evolved.

Sodium Hypochlorite:

Sodium hypochlorite is a pale, yellow-green liquid which has a slight odour of chlorine. It is normally supplied as a 10-13% w/v available chlorine solution.

Sodium hypochlorite reacts violently with acids, liberating chlorine gas (a toxic substance with a TWA of 1 ppm).

Sodium hypochlorite has a limited shelf life as it decomposes to oxygen, sodium chlorite and salt. The rate of decomposition is accelerated by exposure to light and heat and the presence of the metal iron, cobalt and nickel. The prevention of exposure of sodium hypochlorite to these elements will minimise but not eliminate the decomposition process.

Sodium hypochlorite is an alkaline oxidising agent and therefore corrosive to human tissue and can cause serious injury to skin and eyes. Inhalation of any mist containing sodium hypochlorite can result in respiratory irritation and lung conditions such as pulmonary oedema.

These materials are used on the Shoalhaven site now and hence the hazards and controls are well-known.

4. Cationic Starch Reagent

The cationic (i.e. positively charged) starch reagent is not deemed to be a Dangerous Good. It is a quaternary ammonium salt (NR_4^+). Prolonged exposure to this material is not likely to cause significant skin irritation or impacts due to absorption.

When this reagent is converted to an epoxide (an organic compound whose molecule contains a three-membered ring involving an oxygen atom and two carbon atoms, e.g. ethylene or propylene oxide), exposure to high concentrations (of the epoxide) has produced tumours in mice. Note that the proposed process does not involve an epoxide being formed.

The reagent is a clear, odourless liquid.

Above 150 C, some components of the reagent can breakdown to materials such as chloroacetone, hydrogen chloride, methyl chloride and trimethylamine, i.e. harmful materials.

The reagent is considered to be non-toxic to aquatic organisms on an acute basis.

5. Hydrated Lime (Ca(OH)_2)

Hydrated lime is a hazardous substance but not deemed to be a Dangerous Good. It is corrosive and an irritant.

Hydrated lime is a white to off-white powder with a bitter taste. It is a non-combustible material that is insoluble in water.

Hydrated lime is also known as slaked lime, calcium hydrate, lime hydrate, calcium hydroxide, builders lime, garden lime and plasterers lime.

All work with hydrated lime should be carried out in a manner that minimises dust generation, exposure to dust and repeated skin contact. The pH is approximately 12. Contact can severely irritate and burn the skin and eyes (eye damage is possible). Breathing calcium hydroxide can irritate the nose, throat and lungs.

When handling hydrated lime, local mechanical ventilation or extraction should be used in areas where dust could escape into the work environment. Work areas should be cleaned regularly by wet sweeping or vacuuming.

In the presence of moisture, hydrated lime may react with some metals to form hydrogen gas.

6. Coal

Anthracite coal is a hard, compact variety of coal that has a submetallic lustre. It has the highest carbon content, the fewest impurities and the highest calorific content of all types of coal except for graphite.

Coal is not a Dangerous Good but is classified as hazardous according to Safe Work Australia criteria. It is a combustible solid and may form explosive dust mixtures with air. When involved in a fire it may evolve toxic gases, e.g. carbon monoxide, nitrogen and sulphur oxides, and hydrocarbons.

Spontaneous combustion may occur under storage conditions of elevated temperatures and a continuous supply of oxygen. Smouldering combustion of coal can also lead to flammable gases such as methane and carbon monoxide. These can cause explosions when confined and ignited, e.g. in silos.

Coal may also evolve toxic coal ash decomposition products such as mercury, arsenic, selenium, cadmium and lead when burnt.

Coal Ash:

Coal ash is the waste that is left after coal is combusted (burned). It includes fly ash (fine powdery particles in the combustion gas stream and captured by pollution control devices such as cyclones and baghouse filters) as well as coarser materials that fall to the bottom of the furnace.

Depending on where the coal was mined, coal ash typically contains heavy metals including arsenic, lead, mercury, cadmium, chromium and selenium, as well as aluminium, antimony, barium, beryllium, boron, chlorine, cobalt, manganese, molybdenum, nickel, thallium, vanadium, and zinc.

The US Environmental Protection Agency has found that living next to a coal ash disposal site can increase the risk of cancer or other diseases. If eaten, drunk or inhaled, these toxic materials can cause cancer and nervous system impacts such as cognitive deficits, developmental delays and behavioural problems.

Boiler Feedwater Chemicals:

Note: The site's boiler feedwater dosing chemicals will not change as a result of this project.

17 APPENDIX K – HAZARDOUS EVENT WORD DIAGRAMS

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**

Appendix K – Hazardous Event Word Diagrams

Table 10 – Rail Intake Pit Hazardous Event Word Diagram

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
1.	Ignition of the wheat grains	Strong ignition source, e.g. hot work. Self-heating	Smouldering local fire leading to equipment damage. Potential for the smouldering wheat to propagate to a dust explosion, e.g. within the bucket elevator or receiving silo	Control of ignition sources, e.g. hot work permit. Equipment designed to ATEX including hazardous area assessment. The design will avoid low points / dead-legs where wheat can accumulate and self-heat. Fire water available from the existing fire hydrant system
2.	Ignition of confined wheat dust with the bucket elevator	Foreign object, belt slip, poor belt tracking, friction. Failure of the drive end clutch resulting in high temperatures	Potential for an internal dust explosion, e.g. within the bucket elevator or receiving silo	Bearings are external. Belt drift / mis-alignment sensors. Aspiration system (with interlocks). Equipment designed to ATEX including hazardous area assessment

Table 11 – Mill C Hazardous Event Word Diagram

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
3.	Bucket elevators and drag chain conveyors	Ignition of confined wheat dust	Foreign object, belt slip, poor belt tracking, baghouse fire / explosion propagating back to the elevators. Failure of the drive end clutch resulting in high temperatures. Flame will propagate to screw - chain conveyor and spread throughout the mill	Product and equipment fire, potential for internal dust explosion	Bearings are external. Belt drift / mis-alignment sensors. Aspiration system (with interlocks). Equipment designed to IECEx including hazardous area assessment. Foreign objects removed via screen and separators. Belts are self-extinguishing, anti-static, flame retardant, oil resistant, very low elongation
4.	Hazardous Zoning	Explosion	Static electrical explosions	Explosion - fire, loss of life, equipment damage, production downtime	Earthing of equipment, static bonding, preventative maintenance in hazardous areas
5.	Whole Mill	Dust explosion	Loss of containment of dust within the building, e.g. failure of product lift pipe	Dust explosion within the building, loss of life, equipment damage, production downtime	Sealed process systems lowering the likelihood of leaks, aspirated system, instrument and electrics to hazardous zones, housekeeping. Permit to work system requiring adequate cleaning and control of ignition sources. Positive pressure ventilation within the building

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
6.	Magnetic separators	Fire	Failure of magnets	Metal particles through the process - ignition source due to impact or friction	Daily checks, cleaned every morning. Fire sprinkler system, fire hose reels, hydrants and fire extinguishers installed
7.	Aspiration system	Propagating explosion	Charged particles on the conveyor	Fire / explosion could propagate to other equipment, e.g. dust collectors	Design of process includes explosion vents on the dust collectors. Removal of ferromagnetic materials via magnets
8.	LAAB Cleaning Separator	Static explosion	Static electricity from product flowing over the flour trays (vibrators and motors)	Static fire, causing explosion	All equipment is bonded and earthed
9.	Mill A or B	Fire or Explosion	Fire or explosion event in Mill A or B	Loss of life, equipment damage, production downtime. These events can also propagate to Mill C	Process is designed for containment with foreign object removal, e.g. magnetic separators. Equipment designed to ATEX standards. Interlocks on loss of air flow through the dust collectors and blowlines. Positive pressure ventilation within the building. Mills A and B&C are separated by the building walls

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
10.	Rollers	Dust explosion	Broken roller, failed roller mechanism, failure of equipment	Dumping of product in front of inspection flap, i.e. flour pushed up the inlet chute and a loss of containment from choking of the system. Dust in the area that can settle on motors causing heat build-up. This can result in ignition of product from hot motor. Build-up of product on the roller that continues to roll. Overfill the inlet chute as above, heating of the flour due to the rollers and hence a possible smouldering fire	Covers over motor, high level switch, programmed maintenance every three months, housekeeping, testing of sensors to ensure sensitivity is suitable
11.	Rollers / Impact Detacher (machines)	Hot surfaces – burn hazard to personnel	Rollers running hot, e.g. unable to segregate wheat products, relifts pipes choke and leading to friction causing heat. Internal ignition within the rollers	Potential for burn injury to worker. Also, there is the potential for a fire within the building	Preventative maintenance on all rotating equipment. High level alarm will detect choking, inspections every hour during staffed times, housekeeping within the building, hazardous area zones. Fire sprinkler system, fire hose reels, hydrants and fire extinguishers installed

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
12.	Rollers	Dust explosion	Foreign object within the rollers, e.g. failure of the magnets, or static	Dust explosion that can propagate to other equipment, injury and production downtime	Maintenance, inspections and housekeeping on the magnets. Procedures for checking the source of particular items (e.g. ball bearings) when they appear on the magnets. Regular walkthroughs during staffed hours would pick up noises in the rollers. Designed to IECEx standards
13.	Detachers	Dust explosion	Foreign object (e.g. detacher pin release), plate contact within the detacher, static	Fire within the detacher which has the potential to propagate to the dust collector via the cyclone	Explosion vent on the dust collector, detacher earthed, magnet prior to the rollers, preventative maintenance on the detacher
14.	Detachers	Fire	Hand hold leak – gravity feed product (vacuum) product will settle on motor and hence will heat up (source of ignition)	Heat from motor causing fire hazard	Operators trained to replace inspection hatch covers, walkthroughs to detect abnormal conditions, housekeeping, hazardous area zones. Fire sprinkler system, fire hose reels, hydrants and fire extinguishers installed. Positive pressure ventilation within the building

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
15.	Distributors – Cyclones	Dust explosion	High velocity impact / object	Propagate to dust collectors. Dust collector fills up with dust and product	High level switch stops the mill (dust collectors and filtered flour hopper). Magnetic separators before the rollers, explosion vents on dust collectors, earthing and bonding
16.	Sifters	Fire / Explosion	Mechanical / electrical problems, counter weight within sifter coming loose (1 te each), choke underneath one of the sifters leading to too much flour on one side of a sifter	Sifters out of alignment, structural damage to building, worn electrical cables due to excessive vibration which could lead to ignition	When the sifter motors stop, it will be alarmed and the Mill will trip, safety cables (16mm stainless cable) on the sifters, canes (nylon or timber) on each corner of sifter, rotation sensor on top of each of the sifters. Fire sprinkler system, fire hose reels, hydrants and fire extinguishers installed
17.	Sifters	Explosion	Failure of connecting socks	Loss of containment of flour dust with potential of ignition – explosion in the building	Sensors on each of the bottom socks – if they disconnect – break the beam and stop the mill (bottom socks only – not the top socks). Walkthrough observations
18.	Rotary Valves	Explosion	Surface ignition, e.g. from a foreign object	Potential for a fire / explosion	Magnets and screens

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
19.	Transfer to Flour Bins	Loss of containment of product – enclosed area	High level switch failure on a bin	Overfill bins and the flour is blown into the aspiration lines to the dust collector which fills up and then escapes to the atmosphere via the air inlet line	High pressure trip on the blowers. Level sensor calibration
20.	Dust Collectors	Explosion	Static, carryover spark. Propagation of fire event from elsewhere in the process, e.g. burning embers	Explosion resulting in equipment damage (the dust collectors are located on the roof of the building)	Earthing / bonding of all equipment. Hazardous area zones. The switches on the explosion vents stop the mill including the rotary seals to stop the explosion propagating. Induced draft which keeps the concentration kept below the LEL. All filters are pulsed with air for cleaning, pressure is measured and checked every day. If issues arise the socks are changed. The socks are also changed every 6 months. Anti-static socks. Explosion propagation prevention as per Mill B, e.g. one-way valves
21.	Dust Collector	Release of product	Failed sock	Product release impacting the environment	Visual detection, reporting from outside sources, sock replacement every 6 months – as above. LEL levels not reached, i.e. not considered to be an ignition risk

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
22.	Silos and bins	Dust explosions and fires	Static, foreign object, hot work	Confined dust explosion with damage to the silos and bins, potential for injury to people	All equipment containing dust are to be designed to IECEX standards. The mill is to be rated for hazardous zones including electrics and instruments are to be suitably rated and all equipment is to be bonded and earthed. Fire sprinkler system, fire hose reels, hydrants and fire extinguishers installed. Permits to work
23.	Mill feed blowline	Internal dust explosion within the blowline	Low likelihood event, e.g. static	As the blowline is to be designed for containment then the flame front will travel to the downstream bin	Bonding and earthing of the entire blowline, no other sources of ignition present during normal operation, control of ignition sources during maintenance, high pressure trip on the blower

Table 12 – Gluten Dryer 8 and product Dryer 9 Hazardous Event Word Diagram

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation
24.	Dust explosions within the new equipment, e.g. the grinder, disintegrator, screw conveyers, rotary seal valves and hoppers. This event applies to Product Dryer 9 as well	Ignition of combustible dust, e.g. due to smouldering, open flames, hot surfaces, lightning, heat from mechanical impact or friction, and electrical discharges and arcs	Damage to the processing equipment and injury to personnel. Potential propagation to the combustible material processed and stored in the building. Products of combustion emitted with the potential to impact people and the environment. The explosion can also travel throughout equipment with the potential for pressure piling and hence more significant explosive energy. Projectiles are possible with the risk of injury to people and damage to equipment	All equipment containing dust is to be designed to ATEX standards including explosion vents and airlocks to separate transfer systems. Housekeeping to keep the area dust-free. The building is to be rated for hazardous zones including electrics and instruments are to be suitably rated and all equipment is to be bonded and earthed. Permit to work system requiring adequate cleaning and control of ignition sources. Condition monitoring of equipment and preventative maintenance to limit the probability of hot surfaces from friction occurring. Underspeed detection on the screw conveyors, high level detection in the baghouse filters. Use of fire hoses and steam to quench smouldering fires. As the minimum ignition temperature for gluten is approximately 470 C and higher, maintenance of equipment and possibly

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation
				detection by operators may prevent hot surfaces initiating a dust explosion. Spark arrester installed upstream of the hot air box to mitigate flames being emitted from the air intake. Magnetic separator before the grinder
25.	Explosion in a dust collector. This event applies to Product Dryer 9 as well	Propagation of fire event from elsewhere in the process, e.g. burning embers drawn into the dust collector	Explosion with the potential for injury and equipment damage	Inducted draft which keeps the concentration below the LEL (lower explosive limit). All filters are to be pulsed with air for cleaning. All filters are to be checked routinely by maintenance for high differential pressure (DP). If issues arise then the socks are changed. Explosion vents installed
26.	Explosion in the dryer. This event applies to Product Dryer 9 as well	Build-up of solids within the dryer piping, carryover from the hot box	The deposits can self-heat and auto-ignite resulting in a fire / explosion. The flames can be emitted from the air intake, i.e. fire hazard to personnel	Routine cleaning of equipment to prevent material build-up, spark arrester
27.	Fire in the grinder. This event applies to Product Dryer 9 as well	Blocked dust collector on the grinder	Material heating due it being trapped in the grinder and therefore continuous grinding	High dust collector DP (differential pressure) trip on the grinder. High level probe on hopper below the grinder. Grinder amps monitored

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation
28.	Dust explosion. This event applies to Product Dryer 9 as well	Loss of containment of dust within the dryer building, e.g. failure of product lift pipe	Dust explosion within the building, loss of life, equipment damage, production downtime, potential for both a primary and secondary explosion	Sealed system lowering the likelihood of leaks, aspirated system, instruments and electrics rated to hazardous zones, housekeeping. No purlins on the inside of the building where dust can accumulate
29.	Fire / explosion in the disintegrators. This event applies to Product Dryer 9 as well	Foreign objects in the disintegrator causing ignition which can propagate to other equipment	Injury to workers, production downtime due to equipment damage and product loss. Secondary explosion possible. Foreign objects can also block the disintegrator feed chute	Temperature sensor, vibration transmitter on the disintegrator. Magnetic separator prior to the grinder. Equipment designed to ATEX standards
30.	Loss of the dust collectors fans. This event applies to Product Dryer 9 as well	Potential for the combustible dust concentration to increase and enter the explosive range	The plant will be tripped on loss of the dust collectors fans	Hoerbiger valves installed for explosion protection of the grinder, the equipment is to be rated for hazardous zones including electrics and instruments are to be suitably rated and all equipment is to be bonded and earthed
31.	Blockage of the blowline from the grinder. This event applies to Product Dryer 9 as well	Material buildup, blower failure, baghouse exhaust fan failure	Material build up in the grinder with potential for heating and hence fire and explosion	Dryer tripped on loss of a blower and other essential drives. Pressure monitoring on the blowline. High level trips, e.g. in the baghouse filter

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation
32.	Overfilling a silo or bin. This event applies to Product Dryer 9 as well	Failure of the level instrument monitoring the gluten level within the silos or bins	The gluten level can overflow the silo or bin via the aspiration system. This can lead to dust explosions	Independent high level trip on the silos and bins to stop the filling system, the building is to be rated for hazardous zones including electrics and instruments are to be suitably rated and all equipment is to be bonded and earthed
33.	Release of gluten from the blowline. This event applies to Product Dryer 9 as well	Erosion, explosion vent opening, gasket failure	Loss of containment of gluten to atmosphere potential for environmental impact and possible ignition	Schedule 40 pipe for extra thickness, long radius elbows used to minimise the risk of erosion
34.	Natural gas explosion within the dryer. This event applies to Product Dryer 9 as well (if natural gas is used)	Natural gas flow when the burners are offline	Buildup of natural gas in the ducting. If ignited, there is the potential for an internal explosion	Burner management system will be certified to Australian Standards which will include the need for adequate natural gas isolation and air purging prior to startup. The explosion vents for dust explosions will also limit the developed overpressures for an internal gas explosion

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation
35.	Loss of containment of natural gas from the supply pipe. This event applies to Product Dryer 9 as well (if natural gas is used)	Pipe failure, e.g. corrosion or weld defect, gasket failure, valve leak, impact	If ignited, potential for a jet fire, flash fire or explosion which can impact personnel and equipment	The natural gas supply pipe is to be tied into the existing natural gas supply pipe system that runs through the site at present. This is an existing site risk. The pipe is to be protected from impact by locating it in a piperack. Minimum flanges used. Pipe to be included in the hazardous zone study. Remote isolation of the natural gas is possible at the gas metering station. The natural gas supply pipe is to be pressure tested following construction and protected against corrosion by painting. The natural gas piping and equipment items are to be compliant with the Australian Standards

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation
36.	Overheating of the gluten in the dryer. This event applies to Product Dryer 9 as well (if natural gas is used)	Loss of temperature control	Potential for autoignition of the gluten	High temperature trip on the dryer outlet (hard wired to the burner). Gluten has a relatively high autoignition temperature of 470oC. Spark arrestor on the discharge of the air heater
37.	Release of gluten. This event applies to Product Dryer 9 as well (if natural gas is used)	Failed sock in a dust collector	Gluten release and environmental impact	Visual detection of an emission and response, reporting from outside sources, LEL levels not reached, i.e. not considered to be an ignition risk. Maintenance of the socks to check the integrity

Table 13 – Modified Starches Plant Hazardous Event Word Diagram

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation	Actions
38.	Dust explosion. Smouldering fire	Foreign objects in the feed entering the screw conveyors with other causal events, e.g. magnets failure. Bearing failure. The above causes can initiate fires and dust explosions	Starch ignition and fire through process, loss of production. Potential for an internal explosion	Starch is conveyed from SD5 which has screens, magnetic separators and sieves. Blocked chute detection. Regular preventative maintenance (PMs) on the screw conveyors (typically once every eight weeks)	No further action required
39.	Loss of containment of caustic	Level control failure leading to tank overflow. Pipe leak. Pump leak	Potential for corrosive impact to personnel	High tank level alarm and trip. Pipes to be stainless steel with minimum joints. Tank to be bunded. Site practice is to use mono pumps / positive displacement for caustic. Safety showers and eyewash units	No further action required
40.	Loss of containment of reagent	IBC leak including being dropped from a fork lift truck (FLT) or damaged from the FLT tynes. Pipe or hose leak. Pump leak. Reagent dripping from a pump spear when removed from the IBC	Potential for irritation impact to personnel	All FLT drivers trained. FLT speed limited to 10 kmh. Stainless steel piping with minimum joints. IBCs to be in a bunded area	No further action required
41.	Burn injury	Person contacts hot equipment (the starch mixture is approximately 70 C)	Burn injury	All equipment and piping to be insulated where the temperature is above 60 C	No further action required

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation	Actions
42.	Loss of containment of HCL	Level control failure leading to tank overflow. Pipe leak. Pump leak	Potential for corrosive impact to personnel. Corrosive impact to equipment	High level alarm and trip. Pipes to be poly (HCl compatible) with minimum joints. Tank to be banded. Site practice is to use diaphragm pumps for HCl with pulsation dampeners. Safety showers and eyewash units	Review the source for the HCl supply. Provide Perspex splash guards for the HCl and caustic pumps, i.e. to prevent a sprayed leak contacting personnel
43.	Dust explosion	High velocity impact of an object (e.g. metal) causing a spark and hence ignition	Dust explosion which can propagate to the dust collectors. Impact to people, equipment and the business	Explosion vents on dust collectors, earthing and bonding, yearly inspections and maintenance, sieves in the starch supply plant	No further action required
44.	Explosion	Surface ignition, e.g. from a foreign object	Potential for a fire / explosion which can propagate to connected equipment	Magnets and screens in SD5. Slow speed (15 to 20 rpm) for the rotary valves. Overload trips on the rotary valves	No further action required
45.	Dust explosion	Loss of containment of dust within the building, e.g. failure of containment	Dust explosion within the building, loss of life, equipment damage, production downtime	Sealed system lowering the likelihood of leaks, aspirated system, daily housekeeping. Minimum ledges on the inside of the buildings. Hazardous area assessment. Control of ignition sources (permits)	No further action required
46.	Exposure to rotting product	Buildup of product in non-conveying areas	Illness, e.g. due to biological growth	Maintenance / cleaning. Aspiration to be designed to remove humid air and hence blockages	No further action required
47.	Explosion	Dust collector explosion due to static, hot ember (e.g. from screw conveyors), air lock (rotary valve) failure and hot work	Dust explosion leading to a fire, loss of life, equipment damage and production downtime. The explosion can also propagate throughout the process	Explosion vents on all dust collectors. Interlock between the operation of the dust collector and the modified starches equipment	No further action required

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation	Actions
48.	Dust explosion within other equipment	Propagation of event from elsewhere in the process, e.g. burning embers or flame front travels to the dust collectors	Explosion that can result in damage to the dust collector and propagation to connected equipment items. Injury to personnel	Induced draft which keeps the concentration below the lower explosion limit (LEL). All dust collectors are pulsed with air for cleaning the socks. If issues arise the socks are changed (differential pressure gauge across the socks). The socks are also changed as needed as determined by the differential pressure monitoring. Explosion vents on all dust collectors that vent outside the building or will be flameless vents	No further action required
49.	Release of product	Failed sock	Product release, i.e. impact to the environment and people	Visual detection, sock replacement as required - as above. LEL levels not reached, i.e. not considered to be an ignition risk	No further action required
50.	Fire / explosion	Mechanical / electrical problems, choke underneath the sifter leading to too much starch on one side of the sifter	Sifter out of alignment, structural damage to building, worn electrical cables due to excessive vibration which could lead to ignition if a sock fails	Sifter motors trip the plant, safety cables on the sifter, canes (nylon or timber) on each corner of sifter, out-of-balance sensor on top of each of the sifter will trip the sifter, spill detectors (i.e. dust detection monitors), flexible electrical cables, overload trips, PMs for the sifters bearings	No further action required

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation	Actions
51.	Explosion	Failure of connecting socks	Loss of containment of dust with potential of ignition and hence an explosion in the building. This is more likely for a top sock failure with the dust falling on to the moving sifter. Impact to people, equipment and the business	Walkthrough observations by the operators, operators respond to a loss in plant yield, spill detectors	No further action required
52.	Hit by moving object	Human factors, e.g. person concentrating on a task beside a sifter	Operator injury if struck by a sifter	Procedures for attaching socks. Vigilance in that area to remain away from the sifter when in operation. Signage to state that machine starts automatically	No further action required
53.	Dust explosion	Ignition of combustible dust cloud, e.g. tramp metal, hot work, foreign object and hot ember	Dust explosion within the bin resulting in equipment damage and harm to people	Low likelihood of ignition due to removal of foreign objects via the sifter, hot work permits, regular bin turn-over, moisture content is approximately 18%, all bins are aspirated	No further action required
54.	Release of starch	Overfilling the bins	Product loss impacting the environment	High level alarms and trips. Blocked chute detection (trips) installed on screw conveyors. Conveyors have trips on the motors	No further action required
55.	Deadhead the blower	Material hold-up, discharge valves in the closed position	Maximum pressure within the pipe and hence the potential for a loss of containment. Fire or explosion if ignited. Impact to people, equipment and the business	Pressure safety valve on the blower which will only release air, not starch. High pressure trips the process. Steel pipe. Belt driven blower	No further action required

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation	Actions
56.	Air pollution	Loss of containment of starch from a failed blowline (erosion) outside the building	Pollution - starch could be blown off site and hence environmental impact	Blowline made from stainless steel (i.e. hard wearing). Not a confined area, open to elements, no explosion risks. Historically, the holes start small and hence allow corrective action. Long radius elbows with routine inspection	No further action required
57.	Explosion	Low likelihood event, e.g. static or friction	As the blowline is designed for containment then the flame front will travel to the downstream bin	Bonding and earthing of the entire blowline. The blower is a rotary lobe machine and hence mitigate reverse flow out through the air inlet. Dust concentration normally below the approximate lower explosion limit (LEL). NRVs on the rotary lobe blower ##	No further action required
58.	Ignition of starch	Foreign object, contact between the paddles and the mixer shell, i.e. these can cause sparks	Potential for ignition of the starch leading to a fire and explosion	Clearance gap for mixer design with PMs	Include a magnetic separator on the starch feed as the starch is sourced from the SD5 final product hopper, i.e. before the SD5 magnetic separator
59.	External fire / explosion involving natural gas	Leak of natural gas, e.g. piping failure	Jet, flash fire or explosion if the natural gas is ignited, i.e. injury to people and damage to equipment	Australian Standard compliant piping system, routine piping inspections, large building with ventilation to avoid confinement	No further action required

Event Number	Hazardous Event	Causes	Possible Consequences	Safeguards - Prevention Detection Mitigation	Actions
60.	Internal explosion	Natural gas passing into the dryer when it is off-line	If ignited (e.g. at startup), there is the potential for an internal explosion leading to equipment damage and missiles. Potential for injury to personnel	Burner to be designed and certified to the relevant Australian Standards (e.g. AS3814). Note that a steam heater may be used in place of the burner	No further action required
61.	Internal explosion	Broken pin, shaft out-of-alignment, bearing failure, too much feed / choking, foreign object	If ignited, there is the potential for an internal explosion leading to equipment damage and missiles. Potential for injury to personnel	Casing temperature and vibration monitored via the PLC, regular PMs including balance checks, motor overload trip, high level switch within the casing, casing rated for 10 barg (i.e. designed for an internal dust explosion)	Include a speed sensor with a low alarm for the case when the belt fails and hence material will choke inside the pin mill and hence cause friction (an ignition hazard)
62.	Chlorine formation	Mixing HCl and the cleaning liquid which contains hypochlorite	HCl and hypochlorite react to form chlorine gas which is a toxic gas, i.e. impact to people	Spill response procedures when a leak occurs, i.e. the spill is to be immediately handled and hence avoid another (later) spill mixing with it	No further action required

Table 14 – Starch Dryer 5 Modifications Hazardous Event Word Diagram

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
63.	Explosion	Dust collector explosion due to static, hot ember (e.g. from screw conveyors), air lock (rotary valve) failure and hot work	Dust explosion leading to a fire, loss of life, equipment damage and production downtime. The explosion can also propagate throughout the process	Explosion vents on the dust collector. Interlock between the operation of the dust collector and the dryer
64.	Dust explosion within other equipment	Propagation of event from elsewhere in the process, e.g. burning embers or flame front travels to the dust collector from the dryer	Explosion that can result in damage to the dust collector and propagation to connected equipment items. Injury to personnel	Induced draft which keeps the concentration below the lower explosion limit (LEL). All dust collectors are pulsed with air for cleaning the socks. If issues arise the socks are changed (differential pressure gauge across the socks). The socks are also changed as needed as determined by the differential pressure monitoring. Explosion vents on the dust collector that vent outside the building or will be flameless vents
65.	Release of product	Failed sock	Product release, i.e. impact to the environment and people	Visual detection, routine sock replacement. LEL levels not reached, i.e. not considered to be an ignition risk

Table 15 – Boiler 8 and the Co-Generation Plant Hazardous Event Word Diagram

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
66.	Coal dust explosion (this is an existing hazard for Boilers 5 and 6 and also for Boilers 2 and 4 when they were previously operated on coal)	Attrition of coal particles and ignition of the fine particulates e.g. static in the denseveyor, hopper, hot work adjacent to the denseveyor seals where losses of containment of particles can occur	Equipment damage, injury (engulfment) from dust fire / explosion	Unlikely event given the limited quantities of coal dust expected as per the history of operation for Boilers 2, 4, 5 and 6 and hence operating below the lower explosion limit. Earthing of equipment. Sprinklers will be installed over the denseveyor so product is moist (not dusty). Control of ignition sources (hot work permit).
67.	Coal stockpile fire (this is an existing hazard for Boilers 5 and 6 and also for Boilers 2 and 4 when they were previously operated on coal)	Source of ignition such as hot work, lightning strike and self-heating	Local coal fire resulting in equipment damage and products of combustion (i.e. environmental impact) which could include methane and carbon monoxide	Control of ignition sources (hot work permit). Direct water injection to the coal bunkers and isolations on the chutes. Hydrant system and hoses for fire attack response. Emergency Response Team on site. Operator response to the initial combustion, i.e. by smell and/or sight. Water sprinklers on coal stockpile (adjacent to the boilerhouse)

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
68.	Fugitive coal dust emissions	Dust build-up on pipes and structures within the coal fired boiler houses	Destruction of boiler house due to a coal dust explosion and significant injury to workers	Regular housekeeping / cleaning of coal dust build-up
69.	Fire propagation back through the coal feed system	Fire from grate burns upward to the coal bunker, in particular, when the feed system is shutdown	Equipment damage, injury coal fire	Steam sparge system that will extinguish a fire, controlled automatically via thermocouples. Guillotine door closes when feed system stops
70.	Natural gas explosion within the boiler	Natural gas flow when the burners are offline	Buildup of natural gas in the furnace. If ignited, there is the potential for an internal explosion	Burner management system will be certified to Australian Standards which will include the need for adequate natural gas isolation and air purging prior to startup

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
71.	Loss of containment of natural gas from the supply pipe	Pipe failure, e.g. corrosion or weld defect, gasket failure, valve leak, impact	If ignited, potential for a jet fire, flash fire or explosion which can impact personnel and equipment	The natural gas supply pipe is to be tied into the existing natural gas supply pipe system that runs through the site at present. This is an existing site risk. The pipe is to be protected from impact by locating it in a piperack. Minimum flanges used. Pipe to be included in the hazardous zone study. Remote isolation of the natural gas is possible at the gas metering station. The natural gas supply pipe is to be pressure tested following construction and protected against corrosion by painting. The natural gas piping and equipment items are to be compliant with the Australian Standards
72.	Boiler rupture	Low level, loss of boiler feed water pumps, high and low factory demand for steam, failure of level control, control valve stuck closed, low level in deaerator	Catastrophic failure of the boiler, i.e. equipment damage and injury to personnel. Potential for missiles	Australian Standard compliant low level protection, standby boiler feed water pumps, low and low-low level alarms, boiler trip on low-low level, maintenance on the valves and instruments), low level alarm and trip on the deaerator, operator checks on the boiler and deaerator sight glasses

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
73.	High pressure within the furnace	Tube failure within the furnace, loss of the induced draught fan	Potential for flames to be emitted from the furnace openings and hence injure personnel and damage equipment	PMs on the tubes (annual inspection), furnace trip logic to prevent high pressure (trips the forced draught fan as well as the furnace air fan), common alarm sounds on high pressure (control room roof), fan maintenance
74.	Boiler rupture	Corrosion, e.g. poor boiler feed water chemistry. Erosion, e.g. from two phase flow	Catastrophic failure of the boiler, i.e. equipment damage and injury to personnel	Water softeners on all boiler feedwater circuits, dosing of corrosion inhibitor and oxygen scavenger, daily sampling, pH and TDS (total dissolved solids) checks, routine equipment inspections (weekly, monthly and yearly)
75.	Failure of the steam drum or high pressure piping	Corrosion (e.g. under lagging corrosion), weld defect, safety relief valves stuck closed, failure of letdown valves, on low level when the tubes are heated and water is added then the water can flash to develop high pressure	Catastrophic failure of the steam drum or piping, i.e. equipment damage and injury to personnel (potential fatality as steam can fill the building very quickly). Note that superheated steam has a near-invisible jet close to the leak, i.e. difficult to detect	Routine inspections (piping and equipment), operator inspections, operator training (boiler emergency procedure to delay the re-introduction of water following a low-low water level event), redundant safety valves, certifications on equipment, high pressure alarm for operator response
76.	Corrosive burns from caustic dosing to the boiler feed water	Losses of caustic containment e.g. gasket failure	Corrosive burn to personnel	System designed for containment, PPE (personal protective equipment), safety shower / eye wash station, bunded area
77.	Environmental impact from loss of containment of dosing chemicals	Leaks from IBCs, e.g. forklift tynes impact, hose / joint failures	Environmental impact from loss of containment of dosing chemicals	Bunded area, maintenance procedures, operator inspections, losses pumped to the WWTP

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
78.	Steam turbine overspeed	Coupling failure, high steam flow, load rejection	Potential for the turbine blades to be ejected from the casing and hence cause injury and equipment damage. Catastrophic turbine failure	Mechanical (eccentric bolt) and SIL rated electronic overspeed protection. Overspeed trip testing. Maintenance on the steam flow control valve
79.	Release of fly ash	Failed sock within a baghouse filter, e.g. due to sock blockage and high differential pressure, and wear and tear of socks	Potential impact to people due to inhaled dust, e.g. silicosis, as well as exposure to heavy, toxic metals, e.g. may cause cancer or nervous system damage for long term exposure. Potential to impact the environment, i.e. increase in background dust levels	Maintenance (e.g. regular sock replacement and filter inspections at major shutdowns). Replacement socks to meet the original equipment manufacturers specifications. Air pulsing used to reduce high differential pressure across the socks. Visual detection of a fail sock and hence maintenance. Reporting from observations. Pressure differential measured across the baghouse filters and hence operator inspections. Obscuration meter and impact detectors on top of the stack. Regular operator check to confirm warm screw conveyor temperature

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
80.	Release of fly ash when it is deposited on the roads at the Shoalhaven Starches farm	Fly ash drying and moved by the wind or vehicles	Potential impact to people due to inhaled dust, e.g. silicosis, as well as exposure to heavy, toxic metals, e.g. may cause cancer or nervous system damage for long term exposure. Potential to impact the environment, i.e. increase in background dust levels	Water, syrup and calcium chloride are used to manage road dust levels associated with the ash (fly and bottom). The farm roads are also sealed with coal wash. This disposal method is EPA approved
81.	Fire in a baghouse	Ignition of carryover fly ash and socks smouldering	Damage to equipment, environmental impact, loss of production	Obscuration meter in the stacks. Alarm on high temperature in the baghouses. Hydrant system and hoses for fire attack response. Emergency Response Team on site
82.	Failure of the lime addition desulphurisation process	Blockage, air blower failure, no lime in the silos	Breach of SOx emissions targets	Two silos with level monitoring. Lime dosing system monitoring with alarms. Analysis of flue gas composition

Event Number	Hazardous Event	Causes	Consequences	Safeguards - Prevention Detection Mitigation
83.	Loss of containment of lime	Silo filter bag failure, eroded hose or pipe, pipe or joint failure	Corrosive impact to people and the environment	Lime storage and handling system to be designed to industry good practice, e.g. long-radius bends in piping. Emergency response will include sweeping and/or vacuuming of any spills to avoid impact to people and the environment. Silo's filters to be air pulsed with routine inspection and replacement of the bags

Table 16 – Additional Sifting Equipment for the Packing Plant Hazardous Event Word Diagram

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
84.	Magnetic separators	Fire	Failure of magnets	Metal particles through the process to the product, i.e. business reputation and customer impact	Daily checks, cleaned every morning
85.	Sifters	Fire / Explosion	Mechanical / electrical problems, counter weight within sifter coming loose, choke underneath one of the sifters leading to too much flour on one side of a sifter	Sifters out of alignment, structural damage to building, worn electrical cables due to excessive vibration which could lead to ignition	When the sifter motors stop, it will be alarmed and the process will trip, safety cables (16mm stainless cable) on the sifters, canes (nylon or timber) on each corner of sifter, rotation sensor on top of each of the sifters. Fire sprinkler system, fire hose reels, hydrants and fire extinguishers installed
86.	Sifters	Explosion	Failure of connecting socks	Loss of containment of flour dust with potential of ignition – explosion in the building	Sensors on each of the bottom socks – if they disconnect – break the beam and stop the process. The packing shed is occupied when operational and hence any releases will be immediately observed

18 APPENDIX L – DUST HAZARD ANALYSIS DESCRIPTION

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**

Appendix L – Dust Hazard Analysis Description

For each identified cause-consequence combination of interest for an identified hazardous event, the risk, i.e. consequence times likelihood, is assessed using the CCPS dust hazard analysis methodology and Pinnacle Risk Management's risk matrix.

The Pinnacle Risk Management risk matrix is shown in Figure 10.

Figure 10 – Risk Matrix

	Severity of Consequences					
Likelihood	Minor 1	Significant 2	Severe 3	Serious 4	Extremely Serious 5	Catastrophic 6
Frequent > 1/yr	II	II	I	I	I	I
Probable >10 ⁻¹ to 1/yr	III	II	II	I	I	I
Possible >10 ⁻² to 10 ⁻¹ /yr	III	III	II	II	I	I
Unlikely >10 ⁻⁴ to 10 ⁻² /yr	III	III	III	III	II	I
Very Unlikely >10 ⁻⁶ to 10 ⁻⁴ /yr	III	III	III	III	III	II
Extremely Unlikely <=10 ⁻⁶ /yr	III	III	III	III	III	III

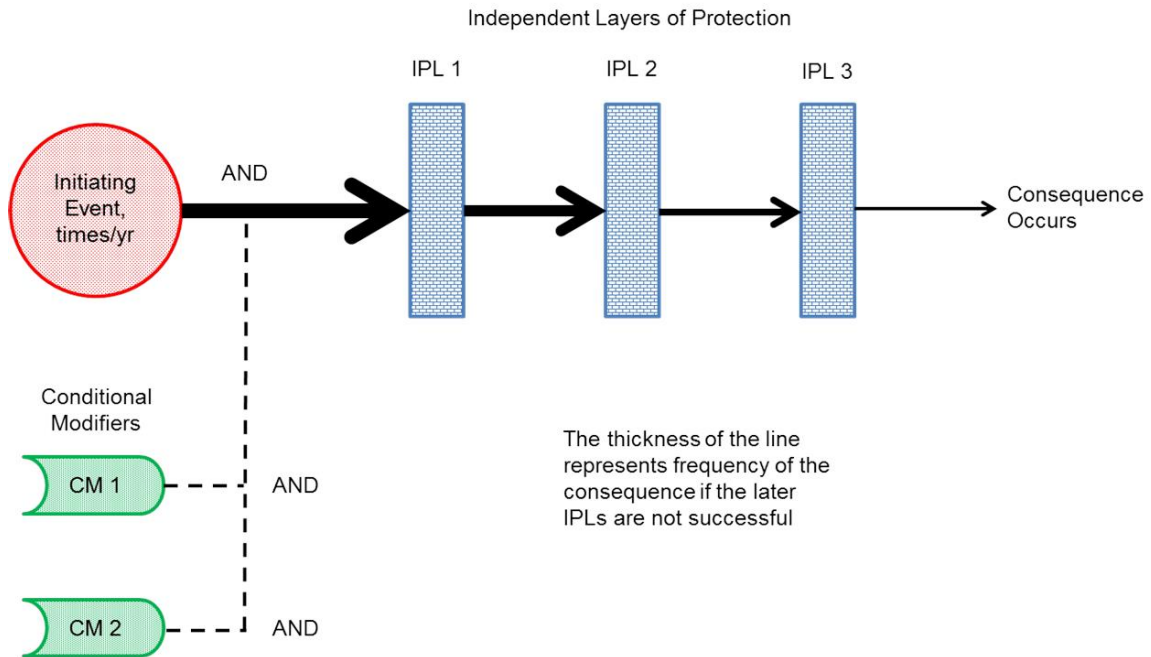
The consequences are determined qualitatively using the guidelines in Figure 11.

Figure 11 – Consequence Ratings

	Consequence Ratings					
	Minor 1	Significant 2	Severe 3	Serious 4	Extremely Serious 5	Catastrophic 6
Safety and Health	One minor injury, First Aid	Recordable or single MTI	Multiple MTI or one LTI	Permanent disability casualty or multiple LTI	Multiple permanent disabilities or one fatality	Multiple fatalities
Environment	Very minor pollution. No offsite escape of material (contained within the operational areas). Onsite nuisance value only	Minor local pollution. Nuisance offsite effect, typically of short duration, e.g. noise, odours, dust and/or visible plumes for less than one hour	Evident pollution, local concern. Minimal duration offsite effects (e.g. waterway slightly discoloured, turbid etc around the point of release with no or very few fish killed)	Significant local pollution. For example, waterways discoloured 10s of metres, fire or smoke affecting people near to the site	Major local pollution. Observable offsite effect (e.g. waterways discoloured 10s to 100s of metres for a few weeks with a significant number of aquatic life adversely affected)	Extremely severe pollution. Ecosystems at high risk of destruction. Only resolved via long term solutions (potentially taking years)
Public Relations	Minor issue, one complaint	Local issue, 10 complaints	Local media, 100 complaints	Regional or state media	Wide media national coverage	Headlines, corporate damage
Financial Impact	< \$25,000	\$25,000 to \$100,000	> \$100,000 to \$1 million	> \$1 million to \$20 million	> \$20 million to \$100 million	> \$100 million

The estimated likelihood of the cause of each potential hazardous event, i.e. the initiating event, is multiplied by the probabilities for the conditional modifiers (if any, e.g. the probability of 2 or more people being present) and the probabilities of failure on demand (PFD) for the IPLs. This is summarised in Figure 12.

Figure 12 – Event Likelihood



The resulting likelihood for each potential hazardous event is compared to the acceptable risk levels on the risk matrix. The risk should preferably be below the line between risks levels II and III for each consequence rating.

The target and upper likelihoods for each consequence category are shown in the Table 17.

Table 17 – Likelihood Limits

Consequence Category	Target Likelihood for Tolerable Risk, times/year	Acceptable Likelihood Range if ALARP, times/year
Minor	1	1 to 10
Significant	0.1	0.1 to 10
Severe	0.01	0.01 to 1
Serious	0.01	0.01 to 0.1
Extremely Serious	0.0001 (or 10^{-4})	10^{-4} to 0.01
Catastrophic	0.000001 (or 10^{-6})	10^{-6} to 10^{-4}

The data presented in the CCPS methodology is used to determine the likelihood of the hazardous events. The data in the following tables summarise the allowable initiating events and IPLs for dust hazard analyses.

Table 18 – Dust Hazard Analysis Initiating Events

Item	Description	Frequency
BPCS Control Loop	The process parameter controlled by the BPCS (Basic Process Control System) control loop deviates without the ability to recover on its own, resulting in a consequence of concern	0.1/yr
Safety Controls, Alarms and Interlocks	The spurious operation of any safety control, alarm or interlock may lead to an upset or other consequences of concern	0.1 - 1/yr
Human Error (routine task performed once or more per week)	A human error occurs on a task that is performed at a frequency of once per week or more often. The consequences are dependent on the task being performed by the person	1/yr
Human Error (task performed 1/week to 1/month)	A human error occurs on a task that is performed at a frequency of once per week to once per month. The consequences are dependent on the task being performed by the person	0.1/yr
Human Error (task performed less than once per month)	A human error occurs on a task that is performed at a frequency of less than once per month. The consequences are dependent on the task being performed by the person	0.01/yr
Screw Conveyor Failure	The failure of the screw conveyor stops the process flow, resulting in an upstream and/or downstream upset or other consequence of concern	1 to 10/yr
Screw Conveyor Overheating of Materials	Overheating of the conveyed material potentially resulting in ignition or decomposition of material within the conveyor. This value can be used for other mechanical failures resulting in ignition (Table 8.19 in Ref 14)	0.1/yr
Fan or Blower Failure	This loss of operation could result in a process upset with a number of possible consequences as a result of the process deviation	0.1/yr
Mill	Explosion within a mill that has safeguards (Table 8.23 in Ref 14). This is within processing equipment	0.1/yr
Baghouse Filter Bags	Failure of the filters bags resulting in combustible dust entering the downstream blower (Table 8.25 in Ref 14)	0.1/yr
Packaging Unit	Existence of a combustible atmosphere at a bagging station	0.01/yr

Table 19 – Dust Hazard Analysis IPLs 1

Item	Description	Probability of Failure on Demand
Safety interlock or trip	Safety interlocks prevent progression of a scenario to the consequence of concern following an initiating event. This is in the BPCS (basic process control system). For example, a dryer high temperature or high carbon monoxide trip	0.1
SIS loop	A SIS loop prevents progression of a scenario following an initiating event, e.g. a high temperature or vibration trips on a hammer mill	SIL 1 - 0.1 SIL 2 - 0.01 SIL 3 - 0.001
Explosion isolation valve	An explosion isolation valve protects against the propagation of flame between interconnected equipment. This includes rotary valves PRM Comment: The PFD may be lower, e.g. 0.01, if the suppression system is well-designed (SIL rated)	0.1
Explosion panels on process equipment	Proper operation of explosion panels during an internal dust/vapour/gas explosion can protect a vessel or duct from excessive overpressure	0.01
Vent panels on enclosures	Vent panels prevent damage to an enclosure or room. However, activation of the panel does result in a pressure wave and loss of containment of dust/vapour/gas. If the vent panel relieves into an occupied area, a vent panel may not be an effective IPL against impact to nearby workers	0.01
Automatic fire suppression system	Within process equipment: An automated fire suppression system prevents propagation of a fire outside of the process equipment PRM Comment: The PFD may be lower, e.g. 0.01, if the suppression system is well-designed (SIL rated)	0.1
Automatic fire suppression system	For local applications: Fire suppression systems for local applications mitigate fires in small areas PRM Comment: The PFD may be lower, e.g. 0.01, if the suppression system is well-designed (SIL rated)	0.1
Automatic fire suppression system	For a room: Fire suppression systems mitigate fire in a room or small enclosure PRM Comment: The PFD may be lower, e.g. 0.01, if the suppression system is well-designed (SIL rated)	0.1
Human response to an abnormal condition	Human response to an abnormal condition can prevent a variety of possible consequences of concern. PRM Comment: It is also possible to use data that takes into account stress and time of response, e.g. the HEART methodology	0.1

Item	Description	Probability of Failure on Demand
Automated explosion suppression system for process equipment	An explosion suppression system protects against explosions that could cause equipment damage including rupture. More quantitative analysis may support a lower PFD value for a specific system than the generic PFD provided PRM Comment: The PFD may be lower, e.g. 0.01, if the suppression system is well-designed (SIL rated)	0.1
Inerting	Inert a vessel or bin, e.g. with nitrogen, and install an oxygen detector with an interlock if the oxygen concentration exceeds a defined value (e.g. 2 vol% below the LEL). That is, a SIL 1 function	0.01
Personal Protective Equipment (PPE)	PPE prevents consequences associated with exposure of people within the area of potential impact to a hazard of concern. PRM Comment: This is not normally taken as an IPL in LOPAs but this approach for dust fires and explosions appears to allow such risk reductions	0.1
Bonding and earthing	Failure of the bonding and earthing (NFPA 654 - 9.3.2)	0.1

The following safeguards are used by the CCPS in their dust hazard analysis LOPA methodology even though they are not traditionally considered IPLs. This could be due to the definition of the methodology, i.e. a risk-based dust hazard analysis where safeguards (not IPLs) are taken into consideration. That is, the CCPS use the LOPA technique in a less formal way to allow safeguards to be included in the dust risk assessment. Independence rules for the Basic Process Control System (BPCS) and (Safety Instrumented System) SIS functions still apply though.

Table 20 - Dust Hazard Analysis IPLs 2

Item	Description	Probability of Failure on Demand
Bulk bag	Use of a standard design bulk bag (NFPA 654 - 9.3.4.3) reduces the probability of a release if dropped	0.1
PMs and training	PMs and training on a specific task (NFPA 654 - Sections 11 and 12)	0.1
Area classification	Proper area classification, e.g. to prevent hot surfaces on electrical equipment	0.1
PM for bonding	PM to maintain bonding and grounding of the equipment (NFPA - 12.1.2). PRM Comment: This is taken into account as well as an IPL for having bonding and earthing in the CCPS methodology, i.e. effectively a PFD of 0.01 (0.1×0.1)	0.1
Procedures	Dedicated, specific procedures with supervisory controls, e.g. emptying and cleaning a tank during a shutdown	0.1
Housekeeping	Written checklist for cleaning and ignition control procedures are in-place	0.1
Fugitive dust collection system	Installation of a fugitive dust collection system, e.g. extraction hood, ducting and fan (NFPA 654 - 8.1.1)	0.1
Fugitive dust collection system	Probability of a dust concentration above the MEC (minimum explosive concentration) within a fugitive dust collector only occurs during pulsing. Therefore, take a PFD = 0.1 (this is not applicable to a baghouse filter given the high dust concentrations in the feed streams)	0.1
Occupancy	Restrict the area around a hazardous equipment item, e.g. hammer mill, when it is running. Need a formal procedure	0.1
Occupancy	Restrict the area around a hazardous equipment item, e.g. hammer mill, when it is running. Need a formal procedure. Install a means to alert personnel that the equipment is running, e.g. flashing light	0.01
Hot sealing system for bag sealing	Ensure the temperature is below the auto-ignition temperature of the product. Note that a lower PFD can be used (e.g. 0.01) if the maximum temperature is physically limited (e.g. low power supply)	0.1

The following data (Ref 17) can be used to estimate the ignition probabilities.

Note: This data is used for LOPA studies and assumes there are no safeguards in-place, i.e. further risk reduction can be taken for the safeguards that do exist, e.g. area classification.

Table 21 – Ignition Probabilities

MIE	Probability of Ignition
$0 < \text{MIE} < 10 \text{ mJ}$	1
$10 < \text{MIE} < 100 \text{ mJ}$	0.1
$\text{MIE} > 100 \text{ mJ}$	0.01
Hot work, failed bearing, dust entering a fan etc (unless other data exists)	1

MIE = Minimum Ignition Energy

The following table shows typical MIEs for dusts (Refs 18, 19, 20 and 21). As dust explosibility values will vary, e.g. different particle size distributions, the probability of ignition for the main agricultural dusts should be taken as 0.1.

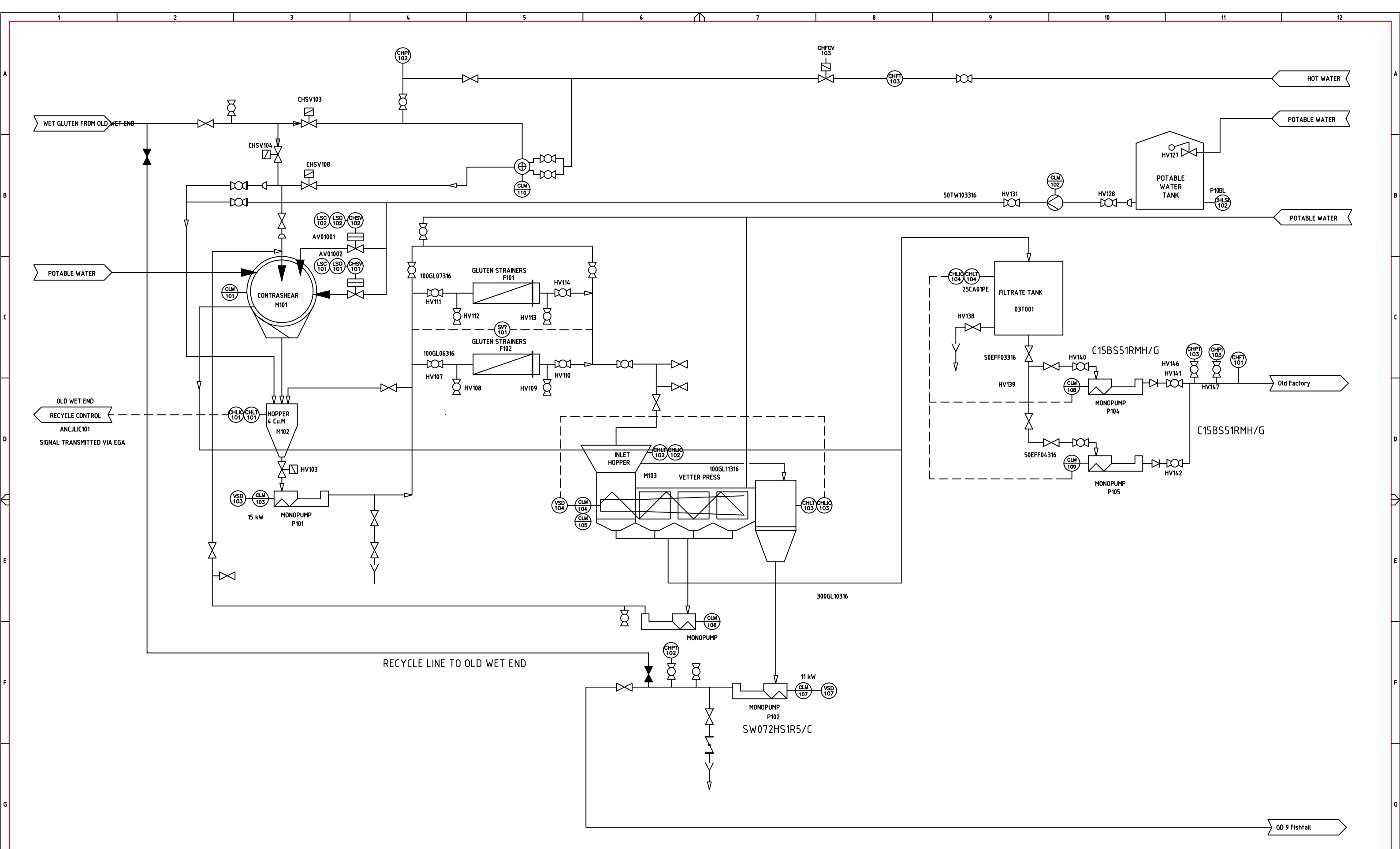
Table 22 – Typical Minimum Ignition Energies

Material	MIE (mJ)
Wheat Dust	> 20
Flour	> 50
Starch	> 20
Gluten	30 - 100
Glucose	> 30

To calculate the risk, the likelihood is estimated by multiplying the initiating event likelihood by the probabilities for any conditional modifiers and IPLs failing. This value is then combined with the qualitatively determined consequence on the risk matrix to determine the acceptability of risk and hence whether any further controls are required.

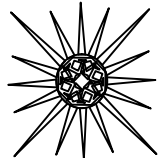
19 APPENDIX M – PRODUCT DRYER 9 P&IDs

**Preliminary Hazard Analysis, Shoalhaven Starches,
Modification to MP06_0228 MOD 16 and 17**



REV	REVISION DETAILS	DRN	DATE	CHKD	APPD
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NOTES :



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RD9 WET GLUTEN FEED			
PROCESS AND INSTRUMENT DIAGRAM			
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CHK BY	AT & KT		
A1		DRG No.	CH-X-X-00X
SCALE	NTS	SHEET	1 OF 1
REV.	1		

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