HUNTER POWER PROJECT HAZOP REPORT

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Executive Summary

Snowy Hydro Limited (Snowy Hydro) is developing a Gas Turbine Peaking Power Station at Loxford in the Hunter Valley, NSW – the “Project”. Mitsubishi Heavy Industries (MHI) together with its associated company, Mitsubishi Electric Corporation (MELCO) and AECOM Australia Limited are providing the facility design. The Project has been declared Critical State Significant Infrastructure (CSSI) under Section 5.13 of the NSW Environmental Planning and Assessment Act 1979.

The Conditions of Consent (Ref.4), Consent Condition B12(b), for the Project requires preparation and submission of a HAZOP study of the design. This report contains a summary and details of the HAZOP study performed on the Project.

For the purposes of this HAZOP study, the Project was defined by its physical property boundary (the Site) and its terminal points such as the gas connection point at the Gas Receival Station, the diesel unloading point, the water supply, stormwater and sewerage service connection points to the Hunter Water network at the property boundary and the electrical connection within the Switching Station to the Ausgrid 132kV electricity network.

The NSW Government, Department of Planning and Environment (DPE) has a key objective to pursue the orderly development of industry and the protection of community safety. DPE manages risk assessment and land use safety planning processes that account for both the technical and the broader locational safety aspects of potentially hazardous industry. These processes are implemented as part of the environmental impact assessment procedures under the Environmental Planning and Assessment Act 1979 (Ref.3). HAZOP study of the Project design is one of the key procedures in this process and DPE’s requirements for it are described in NSW *Hazardous Industry Advisory Paper 8* (HIPAP-8) (Ref.6). The project completed the hazard and operability study (HAZOP) over the period January to May 2022.

The design being implemented by Snowy Hydro does not involve any unproven, novel technology or methods. The hazards and risks associated with operation of the design are well understood. The Project has been developed to be hydrogen ready meaning that it will be capable of co-firing natural gas with hydrogen in the future. However, this method of operation was not assessed in detail during this HAZOP study. It will be assessed in a future HAZOP as required when the logistics of hydrogen delivery to the Site are established.

Certain Project design interfaces between 3rd parties (i.e., the AECOM balance of plant and MELCO hydrogen seal oil systems, Fire and Gas systems) were mostly but not fully developed at the time of the HAZOP study. Design completion of the 3rd party interfaces will need to be managed carefully. Should the design or system interface change, it would be best practice to HAZOP those sections of plant again. Snowy Hydro has recorded an action to review whether this additional study is required prior to construction, and this is further underpinned by Snowy Hydro’s technical change management process.

Two experienced facilitators were used to complete the HAZOP study, given the size of the project and different design organisations involved.

The HAZOP study teams were selected to achieve a diverse range of relevant organisational roles, technical disciplines and experience representing operations management, production, maintenance, engineering, design and project management. The design teams were comprised of the responsible mechanical engineers, process engineers, electrical, control and instrument engineers.

Snowy Hydro’s selection of operations representatives was drawn primarily from its senior operations personnel at its existing Gas Turbine Generating plants to ensure relevant plant experience was available to the study.

The HAZOP session for the natural gas reticulation system on site considered the impact of disturbances on the Project site from the APA natural gas supply infrastructure, being the Gas Receival Station, which is connected to the Kurri Kurri Gas Lateral and as emphasized in NSW Department of Planning, Industry and Environment letter to SHL, dated 22nd December 2021 (Ref.5). The potential for impacts on the Gas Receival Station were also noted. The Engineering Manager and Lead Process Engineer from APA participated in this session.

The HAZOP study participants were able to review the proposed design in a satisfactory manner under the guidance of the experienced HAZOP study facilitators. Adequate information was available, and the HAZOP study participants had a sound range of relevant design and production experience.

The hazards identified in the Power Island and Closed Cooling Water System were assessed for likelihood and consequence level using Snowy Hydro's risk matrix as shown below.

Likelihood									
	Certain	Low	Medium	High	Extreme	Extreme	Extreme	> 0.9	1 yr /event
	Likely	Low	Medium	High	High	Extreme	Extreme	0.5 - 1	1 - 2 yrs / event
	Possible	Low	Medium	Medium	High	High	Extreme	0.1 - 0.5	2 - 10 yrs /event
	UnLikely	Low	Low	Medium	Medium	High	High	0.02 - 0.1	10 - 50 yrs / event
	Rare	Low	Low	Low	Medium	Medium	High	< 0.02	> 50 yrs /event
		Negligible	Minor	Moderate	Major	Severe	Catastrophic		
	Consquence Level								

Process hazards with the potential to have severe hazardous effects well beyond the immediate area of a *process incident* were identified as:

- High pressure natural gas
- High pressure hydrogen
- Bulk diesel fuel storage

Plant hazards with the potential for localised but severe hazardous effects *resulting from a process incident* are:

- High kinetic energy rotodynamic machinery
- Pressure equipment

A "severe" hazardous effect is defined in Snowy Hydro's Risk Matrix for a safety hazard as:

Single fatality or permanent significant disability, long term impairment or illness significantly affecting the quality of life for an employee, contractor or member of the public.

These systems were given focus for the HAZOP to check that the risks associated with these hazards were suitably managed.

Whilst not within the scope of the HAZOP, the "product" of the facility, being high voltage electricity, is a significant hazard with the potential for localised severe hazardous effects. The risks associated with high voltage electricity are well understood and their management is implemented through application of standards made mandatory though regulation.

The above hazards are highlighted in the context of DPE's stated objective to pursue protection of community safety. There are a range of other process and plant hazards typical of every industrial facility which tend to have hazardous effects local to the source of the hazard e.g., hot surfaces, noise, electrical equipment, equipment at height, etc. Hazards in addition to those highlighted and associated with the process are detailed in the HAZOP study records in the appendices to this report.

The HAZOP study did not reveal any hazards with extreme risk that would compromise the safety or integrity of the Project with respect to the safety of site personnel or the public, which could not be managed. In the opinion of the Facilitators, the Project can proceed, subject to satisfactory resolution of the HAZOP recommendations by the required timeframes.

A summary of the results of the risks assessed are shown below.

Inherent Risk	Low	157
	Medium	68
	High	24
Residual Risk	Low	168
	Medium	79
	High	2

In this HAZOP, there were no hazards identified with a high inherent risk and low residual risk which indicates that there is not an over-reliance on the safety protection layers.

Two hazards were identified as having a high residual risk. Both hazards were for the Generator DC Seal Oil System where the generator uses H_2 as a cooling medium with “Loss of H_2 containment” being the consequence. The residual risk takes into consideration the existing safety protection layers but not the HAZOP recommended action. As part of the closing out of HAZOP recommendations, actions have now been taken to address these two high residual risk items.

The remainder of the high-risk items were assessed as being mitigated to medium risk, as defined the Snowy Hydro’s risk matrix when considering the safety protection layers.

The schedule for completion of HAZOP recommendations is summarised in Appendix E. There were 335 recommendations made in total. Most of the recommendations have been scheduled for completion prior to issuing construction drawings. Of the recommendations to be completed in subsequent project implementation phases, 34 recommendations are scheduled for completion prior to commissioning and 6 recommendations are scheduled for completion prior to handover to operations for beneficial operation. No recommendations are scheduled for completion after beneficial operation commences.

1 Introduction

Snowy Hydro Limited (Snowy Hydro) is developing a new Gas Turbine Peaking Power Station at Loxford in the Hunter Valley, NSW – the Project. The Project will be comprised of 2 x 330MW open cycle gas turbines (OCGT) with natural gas as the primary fuel and diesel as the backup.

The design being implemented by Snowy Hydro does not involve any unproven, novel technology or methods. The Project has been developed to be hydrogen ready meaning that it will be capable of co-firing natural gas with hydrogen in the future. However, this method of operation was not assessed in detail during this HAZOP study. It will be assessed in a future HAZOP as required when the logistics of hydrogen delivery to the Site are established.

The Project has been declared Critical State Significant Infrastructure (CSSI) under Section 5.13 of the NSW Environmental Planning and Assessment Act 1979 (Ref.3). The Conditions of Consent (Ref.4), Consent Condition B12(b), for The Project requires preparation and submission of a HAZOP study of the design. This report contains a summary and details of the HAZOP study performed on the Project.

The HAZOP was conducted over several sessions between 20 January 2022 and 5 May 2022 and attended by experienced representatives from both the Owner and Contractors' teams. Given the COVID-19 health orders in place at the time of conducting the HAZOP, the sessions were all held virtually.

The HAZOP study scope was divided into three parts and conducted by two facilitators, who each prepared separate HAZOP study reports. The scope was split in this way as that was the logical division between the main contracting parties and representatives from each party were present for each part of the study. This document is structured as follows:

- Report Body – summarises the HAZOP study
- Appendix A – contains the credentials of the HAZOP study facilitators.
- Appendix B – contains the detailed HAZOP study report for the Power Island. (MHI & Pantac)
- Appendix C – contains the detailed HAZOP study report for the Closed Cooling Water System. (AECOM & Pantac)
- Appendix D – contains the detailed HAZOP study report for the Balance of Plant. (AECOM & RiskCon)
- Appendix E – contains the HAZOP Recommendations Completion Schedule by Project Phase developed at the time of the HAZOP
- Appendix F – contains the updated status of the recommendations at the time of submitting this report

1.1 Aim of the Report

The aim of this report is to address Consent Condition B12(b) by summarising the findings of the overall HAZOP study and provide sufficient context, information, and cross references to enable the outcomes to be understood and managed to closure.

2 Glossary and Abbreviations

A glossary and list of abbreviations used in the body of this report is shown in Table 1. Each HAZOP study report contained in Appendices B, C and D includes its own glossary and list of abbreviations as there is potential for differences between them because of the different design organisations involved.

Table 1 - Glossary and Abbreviations

Term	Definition
AECOM	AECOM Australia Ltd
AS	Australian Standard
BoP	Balance of Plant – a contractual division of plant design – primarily covers services and utilities
CSSI	Critical State Significant Infrastructure (NSW)
DPE	NSW Department of Planning and Environment
GT	Gas Turbine
GTG	Gas Turbine Generator
HAZOP	Hazard and Operability Study
HIPAP	Hazardous Industry Advisory Paper (NSW)
H&S	Health and Safety
IEC	International Electrotechnical Commission
km	kilometre
kV	kilovolt
MELCO	Mitsubishi Electric Corporation
MHI	Mitsubishi Heavy Industries
MW	megawatt
NSW	New South Wales
OCGT	Open Cycle Gas Turbine
P&ID	Piping and Instrument Diagram
Power Island	A contractual division of plant design – primarily covers the core turbine and generation equipment
RACI	Responsible, accountable, consulted, and informed matrix or chart
Snowy Hydro	Snowy Hydro Ltd
SPL	Safety Protection Layer
WHSA	NSW Work Health and Safety Act 2011 No 10

3 Summary of Main Findings and Recommendations

The HAZOP study participants were able to review the proposed design in a satisfactory manner, including the impact of disturbances from the Kurri Kurri Gas Lateral on the Project, under the guidance of experienced HAZOP study facilitators. Adequate information was available, and the HAZOP study participants had a sound range of relevant design and production experience.

Snowy Hydro has reviewed and accepts the finding of the HAZOP and has actions in place to steward the closure of the recommendations as required under its obligations under the NSW Work Health and Safety Act by applying its H&S policy in a timely manner on the Project and satisfying Consent Condition B12(b) in the Infrastructure Approval.

The HAZOP study did not reveal any hazards with extreme risk that would compromise the safety or integrity of the Project with respect to the safety of site personnel or the public, which could not be managed. In the opinion of the Facilitators, the Project can proceed, subject to satisfactory resolution of the HAZOP recommendations by the required timeframes.

The hazards identified in the Power Island and Closed Cooling Water System were assessed using Snowy Hydro's risk matrix as shown below.

Figure 1 - Snowy Hydro Risk Matrix

Likelihood									
	Certain	Low	Medium	High	Extreme	Extreme	Extreme	> 0.9	1 yr /event
	Likely	Low	Medium	High	High	Extreme	Extreme	0.5 - 1	1 - 2 yrs / event
	Possible	Low	Medium	Medium	High	High	Extreme	0.1 - 0.5	2 - 10 yrs /event
	UnLikely	Low	Low	Medium	Medium	High	High	0.02 - 0.1	10 - 50 yrs / event
	Rare	Low	Low	Low	Medium	Medium	High	< 0.02	> 50 yrs /event
		Negligible	Minor	Moderate	Major	Severe	Catastrophic		
		Consquence Level							

In the initial assessment, the 'Likelihood' and 'Severity' represented the possibility and consequence of a hazard without taken credit for the safety protection layer (SPL). This is summarised below as the Inherent Risk.

'Likelihood with SPL' and 'Severity with SPL' represent the possibility and consequence of a hazard having taken credit for the correct operation of the SPL. The consequence remains the same, only the frequency was modified. This is summarised below as the Residual Risk.

The descriptions of the different types of consequence levels are provided in Appendix B Power Island HAZOP Report in Appendix 3.

A summary of the results of the risks identified are shown below.

Table 2 - Summary of the Risks

Inherent Risk	Low	157
	Medium	68
	High	24
Residual Risk	Low	168
	Medium	79
	High	2

In general, when a hazard is assessed as having a high inherent risk and a low residual risk, this can indicate an over-reliance on the protection measures. In this HAZOP, there were no hazards identified with a high inherent risk and low residual risk.

During the HAZOP, two hazards were identified as having a high residual risk. Both hazards were for the Generator DC Seal Oil System where the generator uses H2 as a cooling medium with "Loss of H2 containment" being the consequence. The residual risk takes into consideration the existing safety protection layers but not the HAZOP recommended action. As part of the closing out of HAZOP recommendations, actions have now been taken to address these two high residual risk items. The items as recorded in the HAZOP are shown below along with the current HAZOP recommendation status.

Figure 2 - High Residual Risk HAZOP Records

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments
NODE No. 53 - Generator - DC seal oil system Dwg A13C870 - Generator seal oil diagram for GT										
Pressure Low	DC Pump fault	Loss of H2 containment	UnLikely	Severe	High		UnLikely	Severe	High	There is no safeguard for DC pump failure. No DC pump discharge pressure sensor. Pump is tested monthly. Proof test procedure with pressure limits and response time to be confirmed on site. No method for automatic H2 venting system.
Pressure Low	Oversized DC pressure relief valve RV-2 passing	Loss of H2 containment	UnLikely	Severe	High		UnLikely	Severe	High	Note monthly testing regime

Recommendations	Owner	Required Completion Phase 1- Prior to design completion 2 - Prior to commissioning 3 - Prior to handov	Type Firm action / recommendation A verification check Further Study For considerati	Does it relate to a SHL OI / procedure to be drafted?	Status
Change DC pressure PI-5 to pressure transmitter for DC pump test run and linking to H2 automatic venting system. MELCO team suggest change is technically possible but may cause delays. MELCO will consider changing DC pressure indicator PI-5 to pressure transmitter.	MELCO	2	Verify	No	The existing pressure indicator will be changed to a pressure transmitter. Snowy Hydro has also instructed the Supplier to develop a suitable venting design to reduce this risk and are currently working with the Supplier to implement this design.
MELCO team to confirm DC pump recirc line size. The large size valve passing may result in very low DC seal oil pressure	MELCO	1	Verify	No	CLOSED

The remainder of the high-risk items were assessed as being mitigated to medium or lower risk when considering the implementation of the mitigating actions.

The schedule for completion of the HAZOP recommendations is summarised in Appendix E. There were 335 recommendations made. Most of the recommendations have been scheduled for completion prior to issuing construction drawings. Of the recommendations to be completed in subsequent project implementation phases, 34 recommendations are scheduled for completion prior to commissioning and 6 recommendations are scheduled for completion prior to handover to operations for beneficial operation. No recommendations are scheduled for completion after beneficial operation commences.

Further discussion and analysis of the results is provided in Section 11 Analysis of Main Findings.

4 Scope and Objectives

The HAZOP for the new 660MW OCGT power station development was undertaken for the following main objectives:

1. Ensure the Company Values, as articulated in the Snowy Hydro Group Health and Safety Policy (H&S Policy) (Ref.1), are applied in a timely manner to the Project
2. Discharge Snowy Hydro's duty under the NSW Work Health and Safety Act 2011 No 10 (WHSA) (Ref.2)
3. Satisfy Consent Condition B12(b) in the Infrastructure Approval document from the NSW Government, Department of Planning, Industry and Environment, dated 17th December 2021 (Ref.4)

Snowy Hydro will own and operate the Hunter Power Station for its operating life. The target of the HAZOP Objectives is a design that is safe to build and operate and does not pose risk to the community.

These objectives are discussed in the following sections.

4.1 Applying Snowy Hydro's Company Values

Snowy Hydro identifies its values as:

- Safety – Safety is always our number one priority
- Teamwork – We help each other succeed through support and trust
- Ownership – We take pride in our work and own our choices
- Agility – We are adaptable and embrace change
- Decency – We treat others the way we'd like to be treated
- Courage – We speak up and act for what's important

The organisational value of safety is further enumerated in Snowy Hydro' H&S Policy (Ref.1). Key extracts from the Policy include:

> *The fundamental belief of the Snowy Hydro Group is that all injuries can be prevented.*
>
> *The purpose of this Policy is to outline the Group's commitment to managing its operations to provide safe and healthy working conditions for the prevention of injury or ill health to all workers (including contractors), visitors and members of the public.*
>
> *…*
>
> *Our minimum expectation is that we meet or exceed legislative and other requirements;*
>
> *…*
>
> *Managers and supervisors must take steps to provide for the health and safety of workers by: Maintaining work premises and facilities, plant, systems, and working environments where risks to health and safety are understood and actively managed;*

This HAZOP study is one of the processes undertaken during the project development and design phase to review and demonstrate the safety of the new gas turbine power station for its future operation.

4.2 Duty under the NSW Work Health and Safety Act

In ensuring the project team follows the Snowy Hydro H&S Policy (Ref.1) and enabling procedures, Snowy Hydro can ensure it discharges its safety duties under the WHSA (Ref.2) and the Project Conditions of Consent (Ref.4). The objectives of the WHSA (Ref.2) and DPE are highlighted below.

The objective of the WHSA (Ref.2) is stated in Division 2, Clause 3 as:

> *The main object of this Act is to provide for a balanced and nationally consistent framework to secure the health and safety of workers …*

4.3 Satisfy Consent Condition B12(b)

DPE has a key objective to pursue the orderly development of industry and the protection of community safety, which aligns well with Snowy Hydro's H&S Policy (Ref.1). This is described in the Executive Summary of *Hazardous Industry Advisory Paper 8* (HIPAP-8) (Ref.6), maintained by DPE, as follows:

> *The orderly development of industry and the protection of community safety necessitate the assessment of hazards and risks. The Department of Planning has formulated and implemented risk assessment and land use safety planning processes that account for both the technical and the broader locational safety aspects of potentially hazardous industry. These processes are implemented as part of the environmental impact assessment procedures under the Environmental Planning and Assessment Act 1979.*
>
> *The Department has developed an integrated assessment process for safety assurance of development proposals, which are potentially hazardous. The integrated hazards-related assessment process comprises:*
>
> - *a preliminary hazard analysis undertaken to support the development application by demonstrating that risk levels do not preclude approval;*
> - *a hazard and operability study, fire safety study, emergency plan and an updated hazard analysis undertaken during the design phase of the project;*
> - *a construction safety study carried out to ensure facility safety during construction and commissioning, particularly when there is interaction with existing operations;*
> - *implementation of a safety management system to give safety assurance during ongoing operation; and*
> - *regular independent hazard audits to verify the integrity of the safety systems and that the facility is being operated in accordance with its hazards-related conditions of consent.*

Section 1.2 of HIPAP-8, also identifies the following objective for HAZOP study reports submitted to a consent authority:

> *a report should be able to satisfy a consent authority as to the competence of the examining team and that the potential hazards involved in the enterprise have been addressed.*

The Project has completed the hazard and operability study (HAZOP) element of this integrated hazards-related assessment process.

4.4 Scope of the Study

For the purposes of this HAZOP study, the Project was defined by its physical property boundary (the Site) and its terminal points such as the gas connection point at the Gas Receival Station, the diesel unloading point, the water supply, stormwater, and sewerage service connection points to the Hunter Water network at the property boundary and the electrical connection within the Switching Station to the Ausgrid 132kV electricity network.

A summary of the plant systems covered in the HAZOP study is given in Table 3 below.

Table 3 - Plant Systems Covered in HAZOP Study

System	Main Project Division of Design
Fuel Oil (Diesel)	Power Island
Fuel Gas (Natural Gas)	Power Island
Air & Flue Gas	Power Island
GT Lube Oil	Power Island
GT Control Oil	Power Island
Package Enclosure Ventilation	Power Island
Gas Turbine Casing Cooling	Power Island
Gas Turbine Blade Washing	Power Island
Evaporative Cooler (Inlet Air Filter)	Power Island
Purge Air	Power Island

Cooling water	Power Island
Generator CO2	Power Island
Generator H2	Power Island
Generator Lube Oil	Power Island
Generator Seal Oil	Power Island
Diesel Systems	Balance of Plant
Natural Gas Systems	Balance of Plant
Hydrogen Systems, CO2 systems, Nitrogen Systems	Balance of Plant
Instrument Air Systems, Services Air Systems	Balance of Plant
Potable Water Systems, Services Water Systems, Demineralised Water Systems, chemical dosing systems	Balance of Plant
Fire water systems, oily water systems	Balance of Plant
Blade washing systems, trade waste and sewer systems	Balance of Plant

4.5 Excluded Scope and Other Studies

Non-process systems infrastructure (such as telecommunication, electrical transmission connections, etc), tasks and activities are not within the scope of the HAZOP study. Aspects of these relevant to DPE's objective of *orderly development of industry and the protection of community safety* are addressed by other elements in DPE's integrated hazards-related assessment process.

The Project has also completed various other safety and design studies during the development and design phase which include:

- Preliminary Hazard Analysis
- Final Hazard Analysis
- Safety in Design workshops (for both the AECOM balance of plant design and the Mitsubishi Power Island design);
- Layers of Protection Analysis (LOPA) workshops for the Mitsubishi Power Island design;
- Safety integrity level (SIL) assessment;
- Fire Safety Study; and
- Maintainability and Operational study

5 Description of the Facility

A detailed project description is included in Section 2 of the *Hunter Power Project Environmental Impact Statement* (*ref 9*). For convenience, a summary of the main aspects of the Project are described below.

The intent of establishing a peaking power station in the Hunter Valley is to enable Snowy Hydro to increase its dispatchable generating capacity in NSW. The facility will be able to supply electricity to the grid at short notice during periods of high electricity demand including during low supply periods from intermittent renewable sources or during supply outages or shortages at other base load power stations.

The Project Site is located at Hart Road, Loxford, about one kilometre (km) east of the M15 Hunter Expressway and about three km's north of the town of Kurri Kurri as shown in Figure 3. An overview of the power station layout is shown in Figure 4.

Figure 3 - Project Location

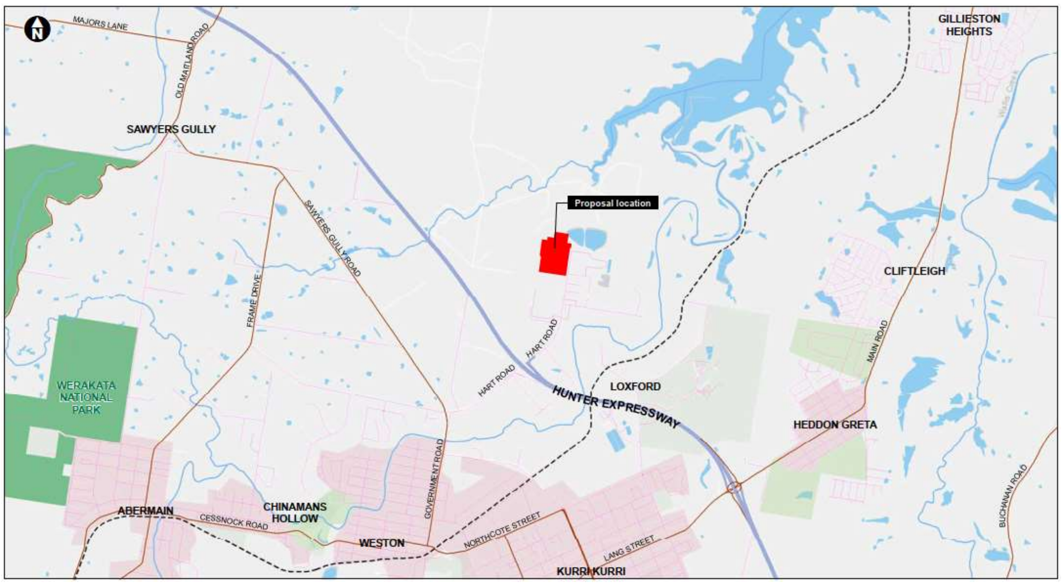
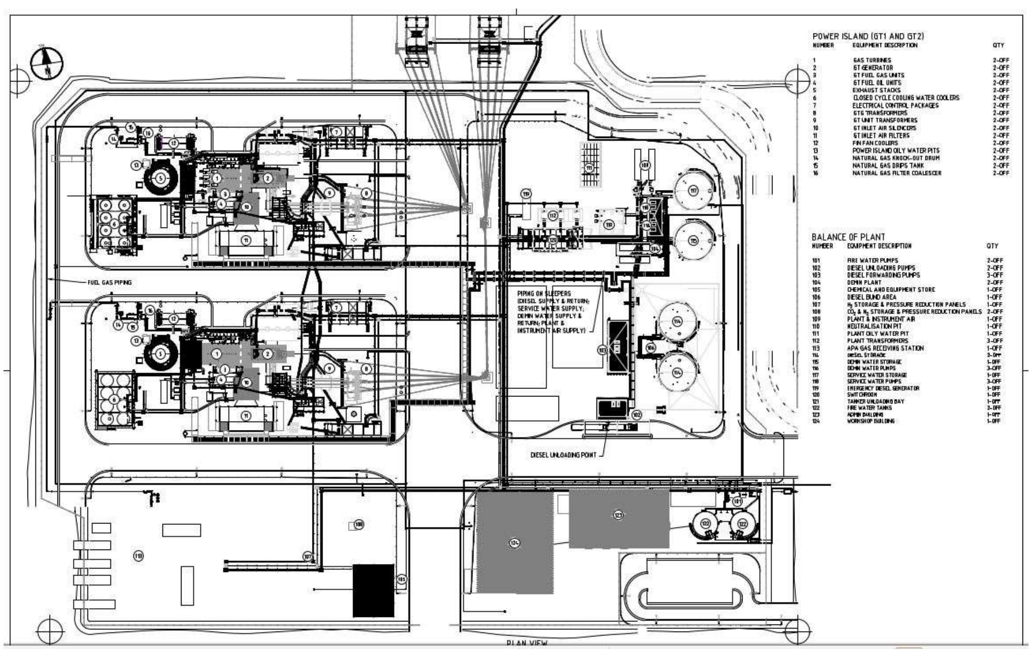


Figure 4 - Plant Layout



The power station will be a dual fuel (gas and diesel), “peak load” generation facility supplying electricity at a capacity of up to approximately 660 MW, which will be generated via two heavy-duty open cycle gas turbines (OCGTs). The gas turbines are model M701F units supplied new by Mitsubishi Heavy Industries (MHI) and manufactured in Japan.

The Project involves the construction and operation of the power station together with other associated infrastructure. The major supporting infrastructure required for the Project is a 132kV electrical Switching Station located adjacent to the main power generation footprint but within the Project Site. The Project will connect into the existing 132kV Ausgrid electricity transmission infrastructure located near the Project Site. A new gas lateral pipeline is being developed by a third party to supply gas to the power station and will terminate at the Gas Receival Station, at which point it will connect to the Project infrastructure.

Snowy Hydro has engaged two main organisations to perform the overall process design for the Project with the following division of design responsibility:

- Power Island - Mitsubishi Heavy Industries (MHI)
- Balance of Plant and Closed Cooling Water System – AECOM Australia Ltd

These systems are described in more detail below.

5.1 Power Island

The power island consists of two dual fuel, MHI M701F series gas turbines (GT) with water injection for fuel oil low NOx control and two hydrogen cooled generators. The GT intakes are equipped with an evaporative cooling system to increase output performance. The power island also includes the following auxiliary plant infrastructure:

- Generator circuit breaker
- power/distribution transformers,
- Static frequency converter and associated equipment
- Excitation transformer and associated equipment
- Electrical equipment and I&C
- Fuel gas control
- Fuel oil control
- Oil systems (control, lubrication, and gas sealing)
- Turbine enclosure air cooling
- Fire detection system
- Gas fire suppression systems
- Firewater deluge systems
- Turbine blade washing facility
- Emergency diesel generator

Refer to the individual HAZOP report for the Power Island in Appendix B for further details on the system.

5.2 Closed Cooling Water System

The Closed Cooling Water System forms part of the Balance of Plant system design and circulates cooling water throughout the power island to cool the various oil, air and process gas systems. It comprises the following main components:

- Fin fan coolers
- Helper cooler and booster pump
- Expansion tank
- Cooling water pumps
- GT HP purge air coolers
- GTG H2 air coolers
- GT control oil coolers
- GT lube oil coolers

Refer to the individual HAZOP report for the Closed Cooling Water System in Appendix C for further details on the system.

5.3 Balance of Plant

The Balance of Plant infrastructure includes:

- Natural Gas Supply – from the main gas supply provider at the power station boundary to the GT enclosure, including metering systems, knock out drums, filter/coalescers, cartridge filters, condensate tank and associated pipework
- Diesel Fuel Supply – including diesel truck fuel unloading and reloading, diesel storage tanks, forwarding pumps and associated delivery pipework from the tanks to the GT enclosure
- Process Gas – Hydrogen gas systems including gas cylinders (trailers) and delivery pipework to the generator for each GT
- Process Gas – Carbon Dioxide (CO_2) gas systems including cylinders and delivery pipework to the generator for each GT
- Process gas - Nitrogen gas systems including cylinders and delivery pipework to the natural gas supply line to the GT
- Compressed Air and Instrument air systems supplying air services to the site and to the GT equipment
- Water Supply – potable water supply to the service water tank and site users, including service water tank, service water pumps and associated pipework to users
- Water Supply – service water systems including pumps to Reverse Osmosis (RO) plant, RO plant, demineralised (demin.) water tanks, pumps, filters and chemical dosing systems
- Water Supply – fire water and fire services systems, including fire water tanks, pumps and pipework
- Waste-Water Systems – Oily water collection and treatment systems, Demin plant and blade washing wastewater systems, chemical dosing systems for the trade waste system and sewer systems.
- Fire-fighting system including water storage, pumps, hydrants and deluge systems
- Emergency diesel generator with associated internal fuel storage
- Electrical Switch Rooms and associated power distribution cabling
- Stormwater drainage system
- Administration Building incorporating a Local Control Room and amenities
- Integrated Workshop and Warehouse
- Chemical Store
- Yards for outdoor laydown
- Roads, car parks and security fencing

Refer to the individual HAZOP report for the Balance of Plant in the Appendix D for further details on the balance of plant equipment including process descriptions, pressures and flows and the P&IDs.

6 HAZOP Team Members

The HAZOP study teams were selected to achieve a diverse range of relevant organisational roles, technical disciplines and experience representing operations management, production, maintenance, engineering, design and project management. The design teams were comprised of the responsible mechanical engineers, process engineers, electrical, control and instrument engineers.

Snowy Hydro's selection of operations representatives was drawn primarily from its senior operations personnel at its existing Gas Turbine Generating plants to ensure relevant plant experience was available to the study.

The MHI design team representatives had extensive experience in design of OCGT plant having delivered many other projects across the world.

The AECOM design team representatives have extensive experience in auxiliary plant designs of the type required for the OCGT plant, having delivered many projects.

The study team participants also had prior HAZOP experience.

Snowy Hydro believes the combination of participants with relevant operations and design experience and prior HAZOP method experience managed by experienced facilitators achieves the objective of deploying a competent examination team.

Full details of the study teams are included in the individual HAZOP reports contained in Appendices B, C and D.

6.1 Facilitator Selection

To cover the entire process, Snowy Hydro engaged two HAZOP facilitators which were approved by the Department of Planning, Industry and Environment:

- Power Island – Paul van Dyk of Pantac Control, who has 30 years of professional experience and 10 years of HAZOP experience
- Balance of Plant – David Lockley of AECOM, who will be assisted by Steve Sylvester, who has over 45 years of professional experience and over 25 years of HAZOP experience

The facilitators were selected for their:

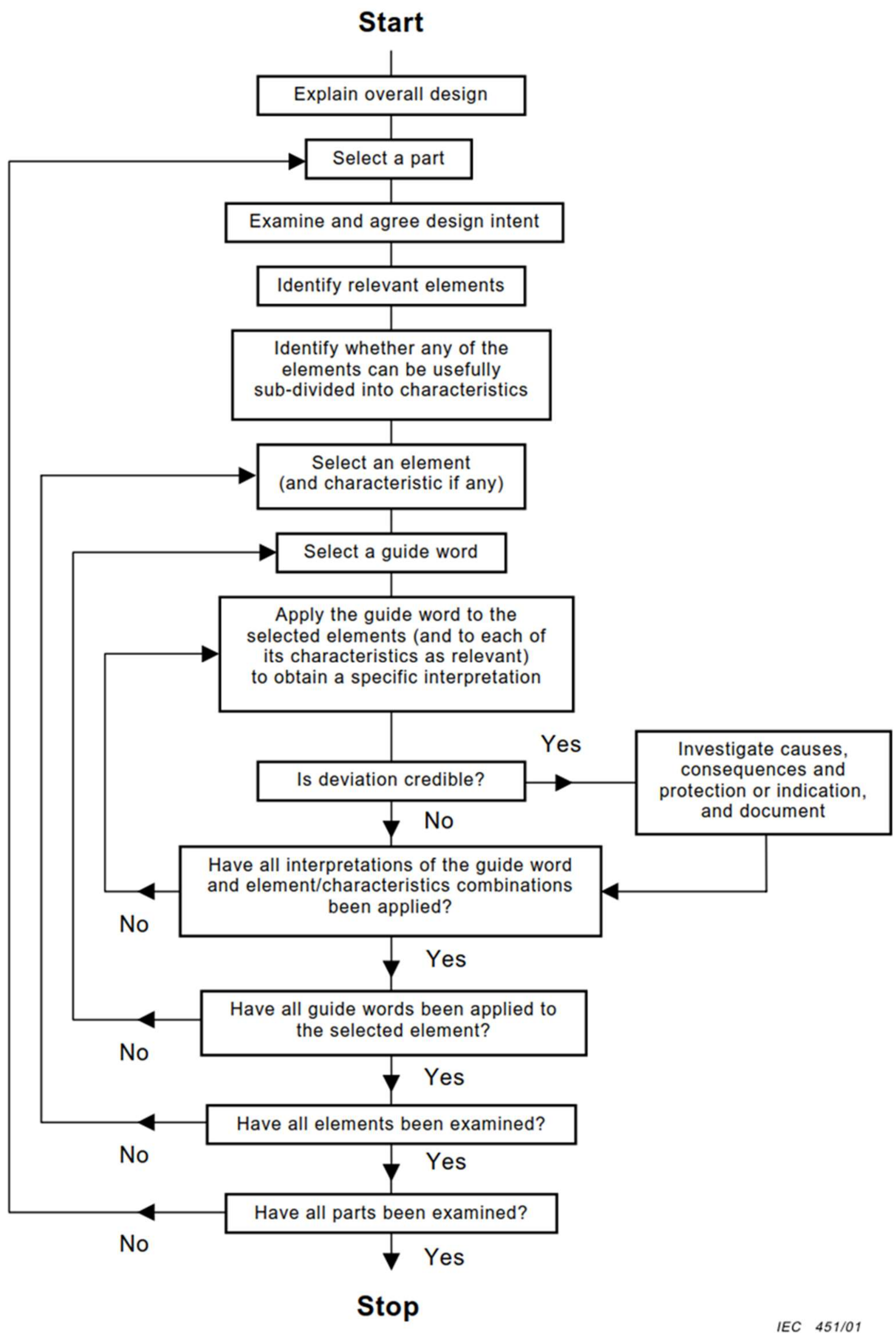
- depth of engineering experience and experience in facilitating HAZOP studies
- knowledge of the technologies being deployed in the Project
- independence of the design teams on the Project

Refer to Appendix A for the Department of Planning, Industry and Environment's approval of the HAZOP Chairpersons as listed above.

7 HAZOP Methodology

The basic approach used for the Hunter Power Project HAZOP complies with and was that as described in HIPAP-8 (Ref.6). This process is further standardised in Australian Standard, AS/IEC 61882:2017 (Ref.7), which depicts it as shown in **Figure 5**.

Figure 5 - Flow Chart of the Workshop Examination Procedure, as per AS IEC 61882:2017



During the HAZOP study, the study team identified hazardous conditions or operational issues in the design by considering how the design responds to process deviations, synthesized through application of the guidewords to the process. The study team also played out the hazardous condition or operational issue to further understand the potential consequences thus identifying a complete risk scenario. Planned safeguards for the risk scenario were identified and evaluated for effectiveness in treating the risk and a decision then taken as to whether additional risk treatment measures were required. As the HAZOP study team is not collectively responsible for the design, it makes “recommendations” to the responsible designers for follow-up risk treatment action.

A specific form of additional risk treatment was immediately recorded as a study team recommendation when it:

- was obvious
- would not introduce other risks
- was strongly endorsed by the study team, which includes the responsible designers.

Further investigation and analysis by the responsible designers were recorded as a study team recommendation when:

- the form of additional risk treatment was not obvious
- multiple alternatives were available
- identified risk treatments had the potential to introduce other risks or operational difficulties.

In this latter case, where possible options for risk treatment were identified they were recorded “for consideration” as part of the follow-up investigation and analysis by the responsible designer.

The detail of the risk scenarios, planned safeguards, study team recommendations and organisational assignment for recommendations are documented in the HAZOP study worksheets appended to the individual HAZOP reports contained in Appendices B, C and D. The study team recommendations and required project completion phase are also summarised in Appendix E.

8 Study Details

8.1 General

Due to the size of the plant and different design teams associated with the overall design, the HAZOP study was conducted in separate sessions over the period from January to May 2022. Details regarding the individual HAZOP studies are included in the HAZOP reports contained in Appendices B, C and D which cover:

- Meeting location, timing and participants
- Guidewords selection
- Drawings and node selection
- Description of the plant systems
- Relevant supporting design documents
- HAZOP study results.

8.2 HAZOP Study Management

The key management steps in implementing a HAZOP study are enumerated in the following RACI matrix. The RACI matrix identifies the division of accountability (“A”) and responsibility (“R”) for performance of the work. In this context, responsibility is distinguished from accountability by meaning the party performing a task. Additionally, the RACI matrix identifies when related parties need to be consulted (“C”) during performance of a task in order to properly complete the task and when related parties only need to be informed (“I”) of the outcome of a task. Separate RACI matrices are given for the division of design responsibility introduced in Section 3.

The HAZOP study participants were able to review the proposed design in a satisfactory manner, including the impact of disturbances from the Kurri Kurri Gas Lateral on the Project, under the guidance of experienced HAZOP study facilitators. Adequate information was available, and the HAZOP study participants had a sound range of relevant design and production experience.

Snowy Hydro has reviewed and accepts the finding of the HAZOP and has actions in place to steward the closure of the recommendations as required under its obligations under the NSW Work Health and Safety Act by applying its H&S policy in a timely manner on the Project and satisfying Consent Condition B12(b) in the Infrastructure Approval.

The HAZOP study did not reveal any hazards with extreme risk that would compromise the safety or integrity of the Project with respect to the safety of site personnel or the public, which could not be managed. In the opinion of the Facilitators, the Project can proceed, subject to satisfactory resolution of the HAZOP recommendations by the required timeframes.

The hazards identified in the Power Island and Closed Cooling Water System were assessed using Snowy Hydro’s risk matrix as shown below in Figure 6.

Figure 6 - Snowy Hydro Risk Matrix

Likelihood								
Certain	Low	Medium	High	Extreme	Extreme	Extreme	> 0.9	1 yr /event
Likely	Low	Medium	High	High	Extreme	Extreme	0.5 - 1	1 - 2 yrs / event
Possible	Low	Medium	Medium	High	High	Extreme	0.1 - 0.5	2 - 10 yrs /event
UnLikely	Low	Low	Medium	Medium	High	High	0.02 - 0.1	10 - 50 yrs / event
Rare	Low	Low	Low	Medium	Medium	High	< 0.02	> 50 yrs /event
	Negligible	Minor	Moderate	Major	Severe	Catastrophic		
	Consquence Level							

In the initial assessment, the ‘Likelihood’ and ‘Severity’ represented the possibility and consequence of a hazard without taken credit for the safety protection layer (SPL). This is summarised below as the Inherent Risk.

‘Likelihood with SPL’ and ‘Severity with SPL’ represent the possibility and consequence of a hazard having taken credit for the correct operation of the SPL. The consequence remains the same, only the frequency was modified. This is summarised below as the Residual Risk.

The descriptions of the different types of consequence levels are provided in Appendix B Power Island HAZOP Report in Appendix 3.

A summary of the results of the risks identified are shown below in Table 4.

Table 4 - Summary of the Risks

Inherent Risk	Low	157
	Medium	68
	High	24
Residual Risk	Low	168
	Medium	79
	High	2

and repeated below:

- Power Island – Mitsubishi Heavy Industries (MHI) (as per **Table 5**)
- Balance of Plant – AECOM Australia Ltd (as per **Table 6**)

The HAZOP study for the Power Island was co-ordinated by Evan Bayliss and Sara Roder, Snowy Hydro Limited and the HAZOP study for the Balance of Plant was co-ordinated by David Lockley, AECOM.

Table 5 - Power Island HAZOP Study RACI Matrix

Activity	SHL Project Manager	Power Island HAZOP Coordinator	BoP HAZOP Coordinator	Facilitator Paul van Dyk	Power Island Lead Plant Engineer
Review Power Island Plant Systems for HAZOP	A	C		R	
Establish a preliminary Power Island Plant HAZOP session schedule	A	C		R	
Prepare template HAZOP Terms of Reference	A	C		R	
Prepare template HAZOP Report	A		R		
Review Power Island Plant design drawings and intent with Lead Process Engineer and select nodes	A			R	C
Review and refine Power Island Plant HAZOP session schedule	A	C		R	C
Detail and publish Power Island Plant HAZOP Terms of Reference to participants	A	C		R	C
Facilitate Study sessions	A			R	
Detail Formal Power Island Plant HAZOP Report	A			R	
Review Formal Power Island Plant HAZOP Report	A	R	C		C
Finalise Formal Power Island Plant HAZOP Report	A	C	I	R	I
Issue Formal Power Island Plant HAZOP Report	A	R	I	I	I

Table 6 - Balance of Plant HAZOP Study RACI Matrix

Activity	SHL Project Manager	BoP HAZOP Coordinator	Facilitator Steve Sylvester	Lead BoP Process Engineer
Review Balance of Plant (BoP) Systems for HAZOP	A	R		C
Establish a preliminary BoP HAZOP session schedule	A	R		C
Prepare template HAZOP Terms of Reference	A	R		I
Prepare template HAZOP Report	A	R		I
Review BoP design drawings and intent with Lead Process Engineer and select nodes	A		R	C
Review and refine BoP HAZOP session schedule	A	I	R	C
Detail and publish BoP HAZOP Terms of Reference to participants	A	I	R	C
Facilitate Study sessions	A		R	
Detail Formal BoP HAZOP Report	A		R	
Review Formal BoP HAZOP Report	A	R		C
Finalise Formal BoP HAZOP Report	A	C	R	I
Issue Formal BoP HAZOP Report	A	R	I	I

8.3 Study Language

As the Power Island design is being performed by MHI in Japan, the HAZOP sessions were bilingual i.e., English and Japanese. A translator was selected, who is experienced in the technical language used for this type of project.

8.4 Study Preparation

Preliminary work by the facilitators included review of the P&IDs and supporting explanatory design documents followed by clarification of the design intent with the design teams to enable preliminary identification of study nodes and guidewords. The facilitators' preliminary study nodes and guidewords were discussed with Snowy Hydro and the respective design team to confirm that they appropriately reflected the proposed design and operations. Refinements were made as appropriate.

Prior to the study commencement, the P&IDs were provided in electronic format to the study participants to allow them an opportunity for private study of the design.

8.5 Study Environment

Owing to the diverse geographic location of the HAZOP study participants (reaching across Australia, New Zealand and Japan) and complications associated with COVID-19 rules all study sessions were conducted as a hybrid of small in-person groups connected via video conference.

It was recognized that this hybrid approach and bilingual language is demanding on the study participants. To manage fatigue, the sessions were scheduled to limit consecutive study days to provide adequate rest days. Within each session, rest breaks were implemented.

This is discussed in more detail by the facilitators in the individual HAZOP reports contained in Appendices B, C and D.

8.6 Power Island and Balance of Plant Interface

As indicated previously, Snowy Hydro has entered into two main contracts covering the design of the power station, which created a major design interface. To ensure scenarios were properly examined irrespective of the physical location of the contractual interface for design, design representatives from each of the two major design contract teams i.e., MHI and AECOM, participated in each other's HAZOP sessions.

8.7 Kurri Kurri Gas Lateral Interface

The HAZOP session for the natural gas reticulation system on the Site considered the impact of disturbances on the Project from the APA supply infrastructure, being the Gas Receival Station, which is connected to the Kurri Kurri Gas Lateral; this is good HAZOP practice and was also emphasized in the NSW Department of Planning, Industry and Environment letter to SHL, dated 22nd December 2021 (Ref.5). The potential for impacts on the Gas Receival Station were also noted. The Engineering Manager and Lead Process Engineer from APA participated in this session. The full Kurri Kurri Gas Lateral and Gas Receival Station HAZOP is to be undertaken by the separate project developing that infrastructure.

From the HAZOP study there were 8 recommendations regarding the emergency shut down and safe venting of the fuel gas system including to perform a dynamic study of the system based on closure times of the valves considering all system shutdown (trip) scenarios.

The detail pertaining to this interface is in the individual HAZOP report contained in Appendix D in Table 11 (Node 2.1).

9 Guide Words

The guide words for each portion of the HAZOP scope were selected to be the most appropriate given the nature of the systems being studied.

The guide words are located as described below:

- Power Island portion are in Appendix B, Section 6.1
- Closed Cooling Water System portion are in Appendix C, Section 6.1
- Balance of Plant portion are in Appendix D, Section 2.2 – Table 2

10 Plant Overview

In addition to the line-by-line guideword analysis conducted during the HAZOP study, the following general conditions and situations likely to result in a hazardous outcome, were also considered for the various HAZOP sections.

Power Island:

- Start up
- Shut down
- Utility failure
- Fire

Closed Cooling Water System:

- Start up
- Shut down
- Utility failure
- Fire
- Maintenance

Balance of Plant:

- Toxicity
- Physical Damage
- Fire/Explosion
- Environmental Impact
- Material of Construction
- Access
- Utilities and Services
- Commissioning
- Start Up
- Shut down
- Safety Equipment
- Natural Hazards
- Inspection and Testing
- Procedures – e.g. maintenance, emergency
- Quality Control

Any issues or recommended actions from the plant overview portion of the HAZOP studies were recorded in the HAZOP reports contained in Appendices B, C and D.

11 Analysis of Main Findings

The results of the HAZOP, giving deviations, consequences and actions required are recorded in the detailed individual HAZOP reports in Appendices B, C and D.

Actions were taken based on consensus of the HAZOP participants on whether the hazard was adequately addressed in the design. Where the recommended inclusion or change to the design was clear, the specific change was recorded. Where further investigation was required, the action was recorded for the action owner to "review" or "confirm" the design with the context of the hazard provided.

For those events on which the decision of no action was made, these are also listed in the HAZOP results, along with the events for which consequence or risk analysis was considered necessary.

A summary and discussion of the main findings of the HAZOP is given in the following section.

11.1 Summary and Discussion of the HAZOP Results

Process hazards for the Project with the potential to have severe hazardous effects well beyond the immediate area of a *process incident* were identified as:

- High pressure natural gas
- High pressure hydrogen
- Bulk diesel fuel storage

Plant hazards for the Project with the potential for localised but severe hazardous effects *resulting from a process incident* are:

- High kinetic energy rotodynamic machinery
- Pressure equipment

A "severe" hazardous effect is defined in Snowy Hydro's Risk Matrix for a safety hazard as:

Single fatality or permanent significant disability, long term impairment or illness significantly affecting the quality of life for an employee, contractor or member of the public.

These systems were given focus for the HAZOP to check that the risks associated with these hazards were suitably managed.

Whilst not within the scope of the HAZOP study, the "product" of the facility, being high voltage electricity, is a significant hazard with the potential for localised severe hazardous effects. The risks associated with high voltage electricity are well understood and their management is implemented through application of standards made mandatory though regulation.

The above hazards are highlighted in the context of DPE's stated objective to pursue protection of community safety. There are a range of other process and plant hazards typical of every industrial facility which tend to have hazardous effects local to the source of the hazard e.g., hot surfaces, noise, electrical equipment, equipment at height, etc. Hazards in addition to those highlighted and associated with the process are detailed in the HAZOP study records in the appendices to this report.

The types of hazards commonly identified, and noteworthy observations for each section are discussed below to provide a summary and context to the HAZOP study.

11.1.1 Power Island

One of the main design observations that was uncovered during the HAZOP study was that the original generator hydrogen seal oil system design relied heavily on administrative controls (Operator response to alarms), which is the second lowest category in the Hierarchy of Controls.

There were several action items related to the hydrogen generator system design with respect to single points of failure and remote operational requirements.

The workshop identified that the proposed MHI M701F class gas turbine generator plant design was more typically installed in fully attended plants. As the Hunter Power Station is planned to operate remotely and can be unattended, there were some aspects identified that were not consistent with the attended operation design philosophy. This is particularly relevant to the hydrogen generator plant and the general higher reliance on operator alarm and response measures. 20 alarm response instances were recorded in the study records. So, this was one part of the design that resulted in several recommendations for change.

Certain Project design interfaces between 3rd parties (i.e., the AECOM balance of plant design and the MELCO hydrogen seal oil systems, Fire and Gas systems) were mostly but not fully developed at the time of the HAZOP study. Design completion of the 3rd party interfaces will need to be managed carefully. Should the design or system interface change it would be best practice to HAZOP those sections of plant again. Snowy Hydro has recorded an action to review whether this additional study is required prior to construction, and this is further underpinned by Snowy Hydro's technical change management process

Although the turbine control and protection systems appeared to be robust, generally SIL rated and well documented, the Snowy Hydro project team will need to ensure that AS3814 compliance is demonstrated and a suitable AS3814 Type B compliance dossier is created. The technical regulator approval approach is not unique to gas / combustion safety and the approval process effort should be consistent with the generator protection, governor and voltage control modelling, fire and gas detection and suppression compliance requirements. This was another area of the HAZOP study that resulted in some recommendations.

11.1.2 Closed Cooling Water System

One of the main considerations uncovered was that the closed cooling water system design relies on a cooling water system discharge pressure that is greater than the generator hydrogen pressure to prevent any hydrogen leakage or accumulation in the water system in the event of an exchanger leak. There is an action to review the cooling water system discharge pressure control in light of this requirement.

It was also uncovered that the high-pressure air compressors interlocks and protection was not well understood at the time of the HAZOP study and thus an action item was assigned to MHI to confirm with their 3rd party supplier. It was identified that this section of the plant will need to be reviewed again on completion of design and when suitable interlock and protection information becomes available. An action has been recorded to check that this review has been completed.

11.1.3 Balance of Plant

There are no novel technologies being used as part of the overall Balance of Plant design. The hazards and recommendations are considered typical for each of these systems. The types of hazards and recommendations generally identified in the HAZOP study for each system are provided below:

System	Main Findings
Diesel Systems	Nothing unusual identified, to be dealt with through normal design processes
Natural Gas Systems	The main recommendations are regarding the review of the emergency shut down and venting requirements around the terminal point with the gas supply from the Gas Receival Station.
Hydrogen Systems, CO2 systems, Nitrogen Systems	Nothing unusual identified, to be dealt with through normal design processes
Instrument Air Systems, Services Air Systems	Nothing unusual identified, to be dealt with through normal design processes
Potable Water Systems, Services Water Systems, chemical dosing systems	Nothing unusual identified, to be dealt with through normal design processes
Demineralised Water Systems	Demineralised water is mildly hazardous as it is slightly acidic and must be neutralised prior to release to the environment. It can also cause corrosion of the metals it comes in contact with. The demineralised water system is used infrequently with the possible consequence of it not working when required. There is also the possibility of damage to RO plant caused by biocide added to the service water used to feed the system. There are also 6 recommendations regarding the integration of the demineralised water control system into the overall plant PLC.
Fire water systems, oily water systems	Nothing unusual identified, to be dealt with through normal design processes
Blade washing systems, trade waste and sewer systems	Nothing unusual identified, to be dealt with through normal design processes

12 Action Arising from the HAZOP

Snowy Hydro will manage the close out of the HAZOP recommendations according to the plan outlined in the following section.

12.1 Plan to Manage HAZOP Recommendations

The HAZOP study recommendations and required project completion phase timelines are listed in Appendix E.

Where a recommendation has been made, the project sequence for its resolution is indicated in the HAZOP study record according to the following project implementation phases in order of priority:

1. Phase 1 - Prior to Design Completion and Construction
2. Phase 2 - Prior to Commissioning
3. Phase 3 - Prior to Handover for Beneficial Operation
4. Phase 4 - Within 12 months of Beneficial Operation

Indicative dates that Snowy Hydro are targeting (at the date of initially preparing this report) for the four HAZOP action close out phases as described above are as follows:

- Phase 1 – February 2023
- Phase 2 – October 2023
- Phase 3 – December 2023
- Phase 4 – December 2024

The responsibility for processing a given recommendation during the HAZOP study was assigned at responsible organization level either by company name or company project manager name (or delegate) in the HAZOP study record.

The HAZOP recommendations will be transferred from each HAZOP study record to a master project issues and actions management register, where the recommendations will be assigned to specific individuals with specific target dates for completion commensurate with the remaining project schedule. HAZOP recommendations for the major project implementation participants beyond design will be transferred to the respective entity for incorporation into its management and operational readiness plans. Snowy Hydro retains overall accountability for ensuring that all HAZOP recommendations are resolved in accordance with the required project phase.

Snowy Hydro will continue to provide the co-ordination between the project parties as required to ensure the HAZOP recommendations are resolved. The Snowy Hydro Project Technical Director will provide the project governance by periodically reviewing the status of the HAZOP recommendations and checking that they are suitably addressed prior to progressing to the next phase of the Project.

13 References

1. Snowy Hydro Ltd. 2020, *Policy Number 002: Snowy Hydro Group Health and Safety Policy - 16 December 2020*
2. NSW Government 2011, *Work Health and Safety Act No 10*
3. NSW Government 1979, *Environmental Planning and Assessment Act*
4. NSW Government, Department of Planning, Industry and Environment 2021, *Infrastructure Approval - 17th December 2021*
5. NSW Government, Department of Planning, Industry and Environment 2021, *HAZOP Chairperson Approval – 22nd December 2021*
6. NSW Government, Department of Planning 2011, *Hazardous Industry Advisory Paper 8 (HAZOP Guidelines)*
7. Standards Australia 2017, *AS IEC 61882:2017 – Hazard and Operability Studies (HAZOP studies) – Application Guide*
8. Jacobs Group (Australia) Pty Ltd 2021, *Hunter Power Project Environmental Impact Statement*

Appendix A

DPE Letters of Facilitator Acceptance and Facilitator Credentials

Ian Smith
Approvals Manager – Hunter Project
Snowy Hydro Limited
PO Box 332
Cooma, NSW, 2630

22/12/2021

Dear Mr. Smith

Hunter Power Project (SSI-12590060)
HAZOP Chairperson Approval

I refer to your request (SSI-12590060-PA-15) for the Secretary's approval of suitably qualified persons to undertake the role of HAZOP Chairperson for the Hunter Power Project (SSI-12590060).

The Department has reviewed the nominations and information you have provided and is satisfied that these experts are suitably qualified and independent. Consequently, I can advise that the Secretary approves the appointment of David Lockley of AECOM to undertake the role of the HAZOP Chairperson, assisted by Steven Sylvester of Riskcon Engineering.

Please note, the HAZOP study should consider the operating conditions arising from the Kurri Kurri Lateral Pipeline (SSI-22338205) and provide recommendations as necessary.

If you wish to discuss the matter further, please contact Wayne Jones on (02) 6575 3406.

Yours sincerely

Stephen O'Donoghue
Director Resource Assessments

As nominee of the Secretary

Department of Planning and Environment

Our ref: SSI-12590060-PA-44

Ian Smith
Approvals Manager – Hunter Power Project
Snowy Hydro Limited
PO Box 332
Cooma, NSW 2630

27/09/2022

Dear Mr Smith

Hunter Power Project (SSI-12590060)
HAZOP Chairperson Approval

I refer to your request (SSI-12590060-PA-44) for the Secretary's approval of a suitably qualified person to undertake the role of HAZOP Chairperson for the Hunter Power Project (SSI-1259006).

The Department has reviewed the nomination and information you provided and is satisfied the expert is suitably qualified and independent. Consequently, I can advise that the Secretary approves the appointment of Paul van Dyk of Pantac Control to undertake the role of HAZOP Chairperson.

Please note, the HAZOP study should consider the operating conditions arising from the Kurri Kurri Lateral Pipeline (SSI-22338205) and provide recommendations as necessary.

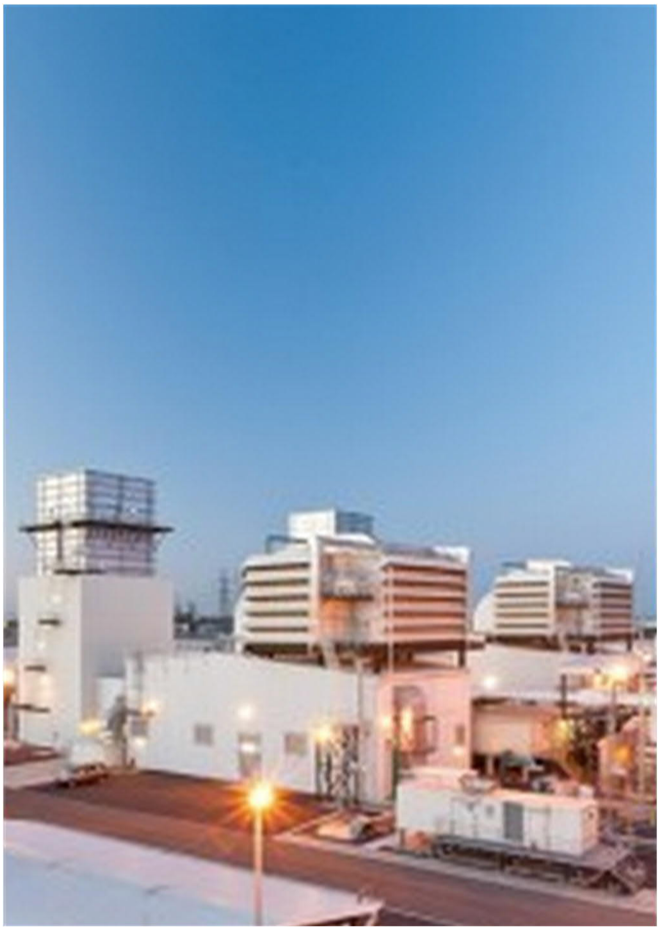
If you wish to discuss the matter further, please contact Jack Turner on 9995 5387.

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments
As nominee of the Planning Secretary

Appendix B

Power Island HAZOP Study Report



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HAZOP STUDY

SnowyHydro – Hunter Power Station
Mitsubishi Heavy Industries
M701G Gas turbine generators
SHL Purchase Work Order No. 314502

PANTAC
SYSTEM CONTROL

ABSTRACT

Hazard and Operability (HAZOP) Study of the Hunter Power Station gas turbine generator process design

Pantac System Control

Risk Assessment Doc No 21081700-001-R0

Contents

Revision History

Date	Rev	Description
20 Apr. 2022	0	Draft – Issued for comments

Revision	Prepared By	Reviewed by	Approved By
0	Paul van Dyk	Reinier van Dyk	Paul van Dyk

1. Executive Summary

This report covers the findings of the HAZOP study workshop for the SnowyHydro Hunter Power Station gas turbine generator process design. Due to COVID travel restrictions, the workshop was performed remotely via google meet with client, vendor, translation services and specialist representation. The scope and focus of the study are limited to the gas turbine generator Process and Instrumentation Design (P&IDs) systems.

The workshop was performed according to the agreed scope as outlined in Section 4, using the methodology described in Section 6. It is considered that the stated objectives listed in Section 5 were satisfactorily met, subject to implementation of the recommendations generated.

The workshop generated:

83 recommendations tabled in appendix 4 and identified

50 Safeguards tabled in appendix 5

It is worth noting the following:

- The generator hydrogen seal oil system design relies heavily on administrative controls (Operator response to alarms), which is the second lowest category in the Hierarchy of Controls. Refer Hierarchy of Controls note 1 below.

  There are several action items related to the hydrogen system design with respect to single points of failure and remote operational requirements.

  Note 1 - There are five levels in the Hierarchy of Controls:

  1. Elimination
  2. Substitution
  3. Engineering controls
  4. Administrative controls
  5. Personal protective equipment.

  The hierarchy is arranged beginning with the most effective controls and proceeds to the least effective.

- The workshop identified that the MHI M701F class gas turbine generator plant is typically installed in fully attended combined cycle plants. Hunter Power Station is planned to operate remotely and unattended, which is not consistent with the attended operation design.

  This is particularly relevant to the hydrogen plant and the generally high reliance on Operator alarm response. 20 alarm response instances were recorded in the study records, refer appendix 5 Safeguards instances

- Due to the complexity of the systems, the English Japanese language barrier and the number of people required to attend the web-based sessions, this HAZOP study ran for eleven days spread out over seven weeks. Design interfaces between 3rd parties (AECOM balance of plant, MELCO hydrogen seal oil systems, Fire and Gas systems, were mostly but not fully developed.

3rd party interfaces will need to be managed carefully to define scope and deliverables. Should the design or system interface change it would be best practice to HAZOP those sections of plant again.

- MHI is not familiar with the Australian gas fired appliance standard AS3814 approval process. Although the turbine control and protection systems appear to be robust, SIL rated and well documented, the SnowyHydro project team will need to ensure that AS3814 compliance can be demonstrated and a suitable AS3814 Type B compliance dossier is created. Technical regulator approval approach is not unique to gas / combustion safety and the approval process effort should be consistent with the generator protection, governor and voltage control modelling, fire and gas detection and suppression compliance requirements.

2. Background

This new gas turbine peaking plant will be commissioned on liquid fuel in 2023 to provide power to the New South Wales electricity spot market. Natural gas firing will follow 6 to 12 months after that.

The plant will be owned and operated by SnowyHydro Ltd.

Hydrogen blending with natural gas for combustion is not included at the time of this study.

3. Process description

Hunter Power Station will be a dual fuel (high speed diesel and natural gas fired), Open Cycle Gas Turbine Power Station with a rated output of approximately 2 x 330 MW. The plant consists of two dual fuel, MHI M701G series gas turbines with water injection for fuel oil low NOx control, two hydrogen cooled generators, associated lube and seal oil and gas systems, electrical equipment and I&C, emergency diesel generator, power/distribution transformers, closed circuit cooling system, firefighting and detection systems and HVAC. The GT intakes are equipped with an evaporative cooling system to increase output performance.

The station is designed for peak load operation with fast start-up and loading (approximately 5 minutes to synchronising and 15 MW/min normal load rate {TBC}) but has a predicted operating regime of only 48 fired hours per year {TBC} with 25 starts {TBC}.

The plant may be dispatched and operated remotely for much of the time. Site staffing will be minimal.

4. Scope

The scope of the HAZOP workshop was limited to the gas turbine generator Process and Instrumentation Design systems and any associated control requirements to maintain machine protection and minimise environmental excursions in accordance with the targets defined in the SnowyHydro corporate Risk Matrix, refer appendix 3.

5. Objectives

The objective of the HAZOP workshop is to

- Review the proposed design
- Generate action items for any areas of concern brought to the meeting
- Identify potential hazards and operability problems, to examine safeguards and to make recommendations to address identified problems
- Ensure that all applicable recommendations related to the hierarchical controls are recorded

6. Methodology

The HAZOP examination procedure systematically questions every part of a process or operation to discover qualitatively how deviations from normal operation can occur and whether further protective measures, altered operating procedures or design changes are required.

The examination procedure uses a full description of the process which will, almost invariably, include a P&ID or equivalent, and systematically questions every part of it to discover how deviations from the intention of the design can occur and determine whether these deviations can give rise to hazards.

The questioning is sequentially focused on guide words which are derived from method study techniques. The guide words ensure that the questions posed to test the integrity of each part of the design will explore ways in which operation could deviate from the design intention.

Some of the causes may be so unlikely or trivial, that they need not be considered further, however there may be some deviations with causes that are conceivable and consequences that are potentially serious. The potential problems are then noted for remedial action.

The immediate solution to a problem may not be obvious and could need further consideration either by a team member or perhaps a specialist. All decisions taken are recorded.

The main advantage of this technique is its systematic thoroughness in failure case identification. The method may be used at the design stage, when plant alterations or extensions are to be made, or applied to an existing facility.

6.1 Guide words and Deviations

The following deviations were applied to each study node

No	Deviation	Notes
1	Pressure High	
2	Pressure Low	
3	Pressure No or not	
4	Pressure Vacuum	
5	Temperature High	Include Fire
6	Temperature Low	
7	Temperature – No or not	
8	Flow / Level – High	
9	Flow / Level – Low	
10	Flow / Level – No or not	
11	Flow / Level – Reverse	
12	Vibration – High Low or not	
13	As well as - concentration / two phase	
14	Other then - impurities / contamination	
15	Timing / Sequence - Early / Late	Start up, shutdown, Auto / manual valves
16	Timing / Sequence - Fast / Slow	
17	Utility failure - instr. air / oil / power	Fail safe?
18	Volts / Amps High	
19	Volts / Amps Low	
20	Volts / Amps - No or Not	

7. Participants

Study attendance is normally recorded and listed here in the body of the document but due to large number of attendees over the 11 day period, the participants are listed in Appendix 6

Appendix 1: HAZOP Nodes and drawings

The nodes and drawings should be read in conjunction with the system descriptions listed below

Turbine and generator interlocks – 6327H78_6000_D3-H0250_000_Interlocks.pdf
Governor control model – 6327H78_6000_D3-H0251_000_Governor diagram.pdf
Turbine control – 6327H78_6000_D4-H4790_000_Control descriptions.pdf
Hydrogen and seal oil – ABH-Y1379_TURBINE GENERATOR H2 & CO2 GAS SYSTEM DESCRITION.pdf
Seal oil systems – ABH-Y2273_TURBINE GENERATOR SEAL OIL SYSTEM DESCRIPTION.pdf

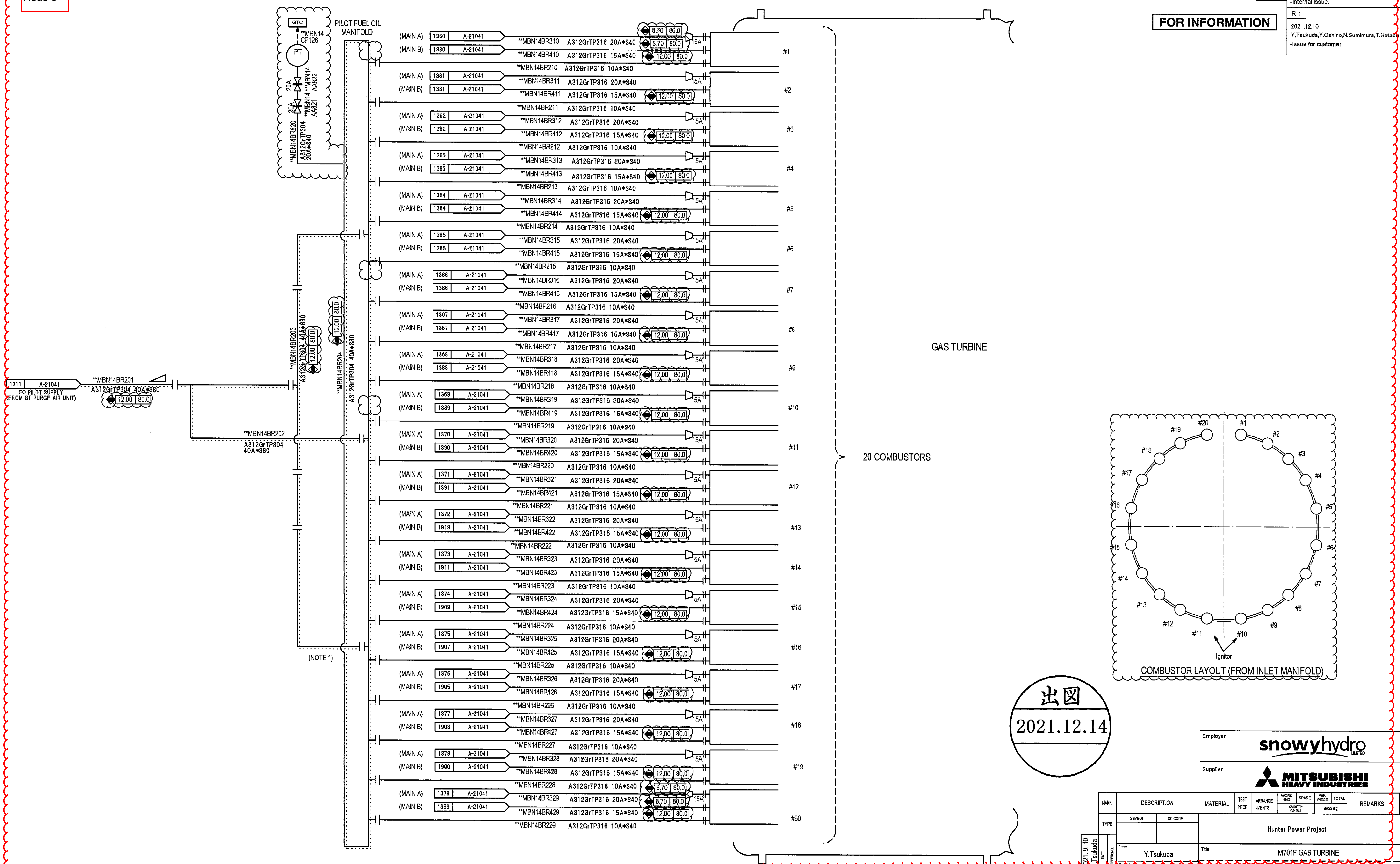
	Node	Dwg	Dwg Title
1	Fuel Oil - High pressure Pump	A-21045	Fuel oil system 5 of 5
2	Fuel Oil - Manifold pressure control	A-21042	Fuel oil system 2 of 5
3	Fuel Oil - Pilot flow control	A-21042	Fuel oil system 2 of 5
4	Fuel Oil - Main flow control	A-21042	Fuel oil system 2 of 5
5	Fuel Oil - Flow divider	A-21043	Fuel oil system 3 of 5
6	Fuel Oil - Burners	A-21044	Fuel oil system 4 of 5
7	Fuel Oil - Drain tank	A-21045	Fuel oil system 5 of 5
8	Fuel Oil - Water injection	A-21043	Fuel oil system 3 of 5
9	Fuel Oil - Purge credit block valves	A-21046	Fuel oil purge credit system
10	Fuel Gas - Supply	A-21061	Fuel gas system 1 of 7
11	Fuel Gas - Supply pressure control	A-21062	Fuel gas system 2 of 7
12	Fuel Gas - Flow control	A-21063	Fuel gas system 3 of 7
13	Fuel Gas - Pilot and Main B burners	A-21064	Fuel gas system 4 of 7
14	Fuel Gas - Top Hat and Main A burners	A-21065	Fuel gas system 5 of 7
15	Fuel Gas - Combustor drain valves	A-21066	Fuel gas system 6 of 7
16	Fuel Gas - Burners	A-21066	Fuel gas system 6 of 7
17	Fuel Gas - GT sweep (purge air)	A-21067	Fuel gas system 7 of 7
18	Fuel Gas - Flow meter	A-21068	Fuel gas flow meter
19	Fuel Gas - Filter and purge credit	A-21069	Fuel gas filter and purge credit system
20	Fuel Gas - Calorie meter	A-21070 & MYP127-DWG-002	Fuell gas Calorie meter package
21	Air & Flue Gas - Seal air	A-21081	Air & Flue gas 1 of 5
22	Air & Flue Gas - GT LP Bleed valve	A-21081	Air & Flue gas 1 of 5
23	Air & Flue Gas - GT MP Bleed valve	A-21082	Air & Flue gas 2 of 5
24	Air & Flue Gas - GT HP Bleed valve	A-21083	Air & Flue gas 3 of 5
25	Air & Flue Gas - Inlet duct flow	A-21084	Air & Flue gas 4 of 5
26	Air & Flue Gas - Air compressor	A-21084	Air & Flue gas 4 of 5
27	Air & Flue Gas - Combustor and Exhaust	A-21084	Air & Flue gas 4 of 5
28	Air & Flue Gas - GT Cooling air supply	A-21085	Air & Flue gas 5 of 5
29	Lube Oil - Tank, pumps, prv	A-21021	Lube oil system 1 of 4
30	Lube Oil - GT bearings	A-21022	Lube oil system 2 of 4
31	Lube Oil - Temp control	A-21023	Lube oil system 3 of 4
32	Lube Oil - Mist extraction fans	A-21024	Lube oil system 4 of 4

	Node	Dwg	Dwg Title
33	Lube Oil - Generator bearing seal oil	A-13C870	Refer nodes 50 - 54
34	Control Oil - Tank, pumps, temp control	A-21031	Control oil system 1 of 3
35	Control Oil - Fuel valve position control	A-21032	Control oil system 2 of 3
36	Control Oil - Fuel valve trip solenoids & Inlet Guide Vanes	A-21033	Control oil system 3 of 3
37	Package Enclosure Ventilation	A-21088	Protection system P&ID
38	Air & Flue Gas - Inlet filter	A-21084	Protection system P&ID
39	Gas Turbine - Casing cooling	A-21090	GT Casing cooling system
40	Gas Turbine - Blade washing device	A-21086	GTW Washing and drain system 1 of 2
41	Gas Turbine - Blade washing and drain system	A-21087	GTW Washing and drain system 2 of 2
42	Evaporative Cooler - pump and tank unit	C-50011	Evaporative cooler system
43	Burner nozzle purge air supply and control	A-21100 & A-21042B	Purge air system
44	Generator cooling water	A13C868	Cooling water P&ID
45	Generator CO2 gas supply	AS29623	Generator H2 & CO2 gas supply diagram for GT
46	Generator H2 gas supply	AS29623	Generator H2 & CO2 gas supply diagram for GT
47	Generator CO2	A13C869	H2 and CO2 for P&ID for GT
48	Generator H2	A13C869	H2 and CO2 for P&ID for GT
49	Generator H2 drying system	A13C869	H2 and CO2 for P&ID for GT
50	Generator - Lube oil system	A13C870	Generator seal oil diagram for GT
51	Generator - Seal oil vacuum pump and tank	A13C870	Generator seal oil diagram for GT
52	Generator - AC seal oil system	A13C870	Generator seal oil diagram for GT
53	Generator - DC seal oil system	A13C870	Generator seal oil diagram for GT
54	Generator - Gland seal oil system	A13C870	Generator seal oil diagram for GT

Node 6

FOR INFORMATION

CAD (PI)	PLAN RECORD
R-0	-Internal issue.
R-1	2021.12.10 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



出図
2021.12.14

NOTE
1. HEAT TRACING WILL BE PROVIDED BY EPC CONTRACTOR.

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Employer: snowyhydro LIMITED
Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

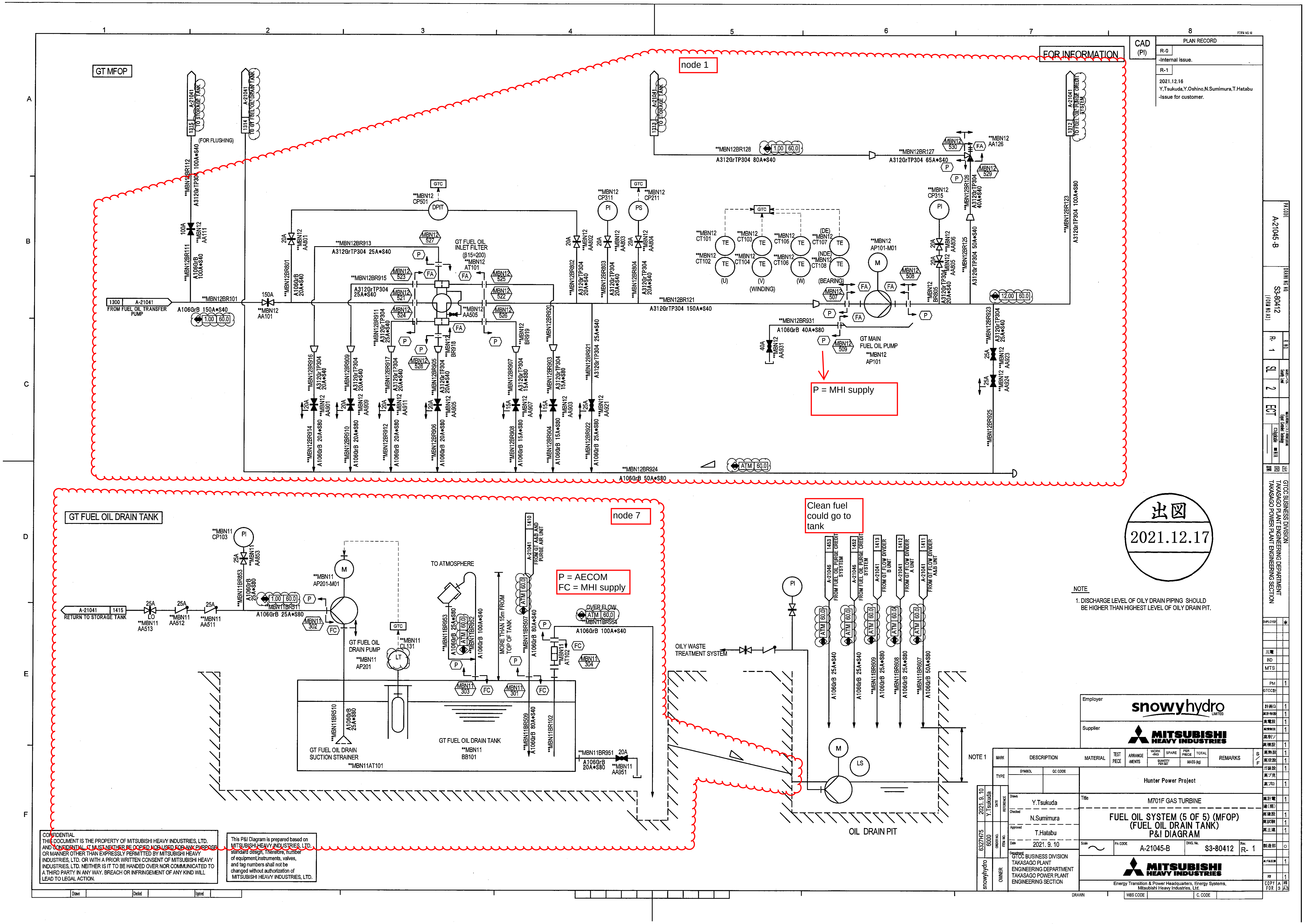
Title: M701F GAS TURBINE
FUEL OIL SYSTEM (4 OF 5) (GT PACKAGE) P&I DIAGRAM

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 10

PA CODE: A-21044-B
DWG. No.: S3-80411
Rev.: R- 1

Department: GTCC BUSINESS DIVISION, TAKASAGO PLANT ENGINEERING DEPARTMENT, TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.



GT MFOP
FOR INFORMATION
CAD (PI)
PLAN RECORD
R-0
-Internal issue.
R-1
2021.12.16
Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu
-Issue for customer.
node 1
P = MHI supply
GT FUEL OIL DRAIN TANK
node 7
P = AECOM
FC = MHI supply
Clean fuel could go to tank
TO ATMOSPHERE
MORE THAN 15m FROM TOP OF TANK
OVER FLOW
OILY WASTE TREATMENT SYSTEM
OIL DRAIN PIT
GT FUEL OIL INLET FILTER
GT MAIN FUEL OIL PUMP
GT FUEL OIL DRAIN PUMP
GT FUEL OIL DRAIN SUCTION STRAINER
GT FUEL OIL DRAIN TANK
FROM FUEL OIL TRANSFER PUMP
RETURN TO STORAGE TANK
TO STORAGE TANK
TO GT FUEL OIL DRAIN TANK
TO FUEL OIL PURGE CREDIT SYSTEM
FROM FUEL OIL PURGE CREDIT SYSTEM
FROM GT FLOW DIVIDER
FROM GT A&B AND PURGE AIR UNIT
(FOR FLUSHING)
NOTE
1. DISCHARGE LEVEL OF OILY DRAIN PIPING SHOULD BE HIGHER THAN HIGHEST LEVEL OF OILY DRAIN PIT.
出図
2021.12.17
GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT ENGINEERING SECTION
Employer
snowyhydro
Supplier
MITSUBISHI HEAVY INDUSTRIES
Hunter Power Project
M701F GAS TURBINE
FUEL OIL SYSTEM (5 OF 5) (MFOP)
(FUEL OIL DRAIN TANK)
P&I DIAGRAM
Drawn Y.Tsukuda
Checked N.Sumimura
Approved T.Hatabu
2021. 9. 10
A-21045-B
S3-80412
R- 1
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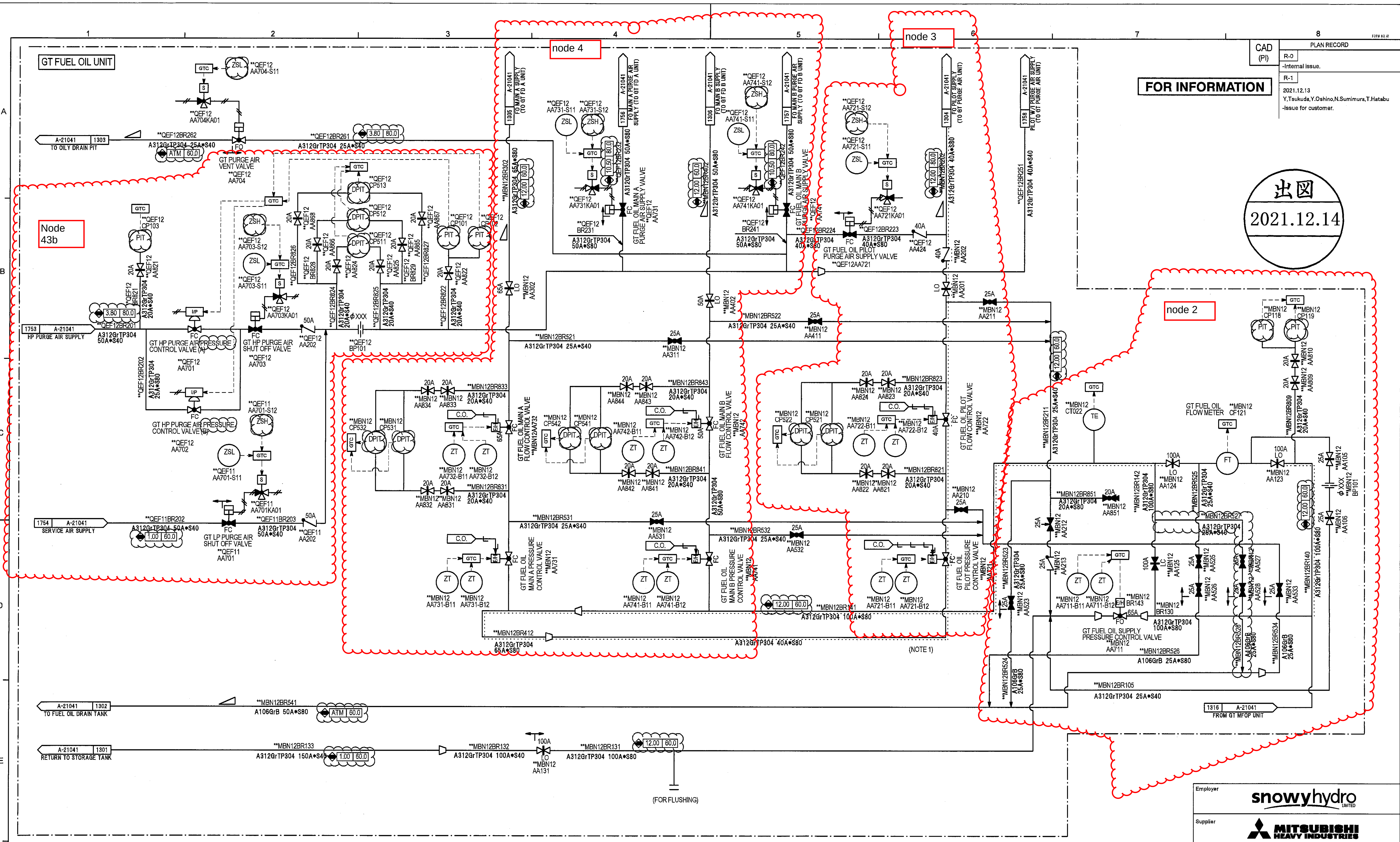

FOR INFORMATION

CAD (PI)	PLAN RECORD
R-0	-Internal issue.
R-1	2021.12.13 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.

出図
2021.12.14

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NOTE
1. HEAT TRACING WILL BE PROVIDED BY EPC CONTRACTOR.

Employer: snowyhydro
Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project
Title: M701F GAS TURBINE
FUEL OIL SYSTEM (2 OF 5)
(FUEL OIL UNIT) P&I DIAGRAM

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 10
PA CODE: A-21042-B
DWG. No.: S3-80409
Rev.: R- 1

Department: GTCC BUSINESS DIVISION, TAKASAGO PLANT ENGINEERING DEPARTMENT, TAKASAGO POWER PLANT ENGINEERING SECTION

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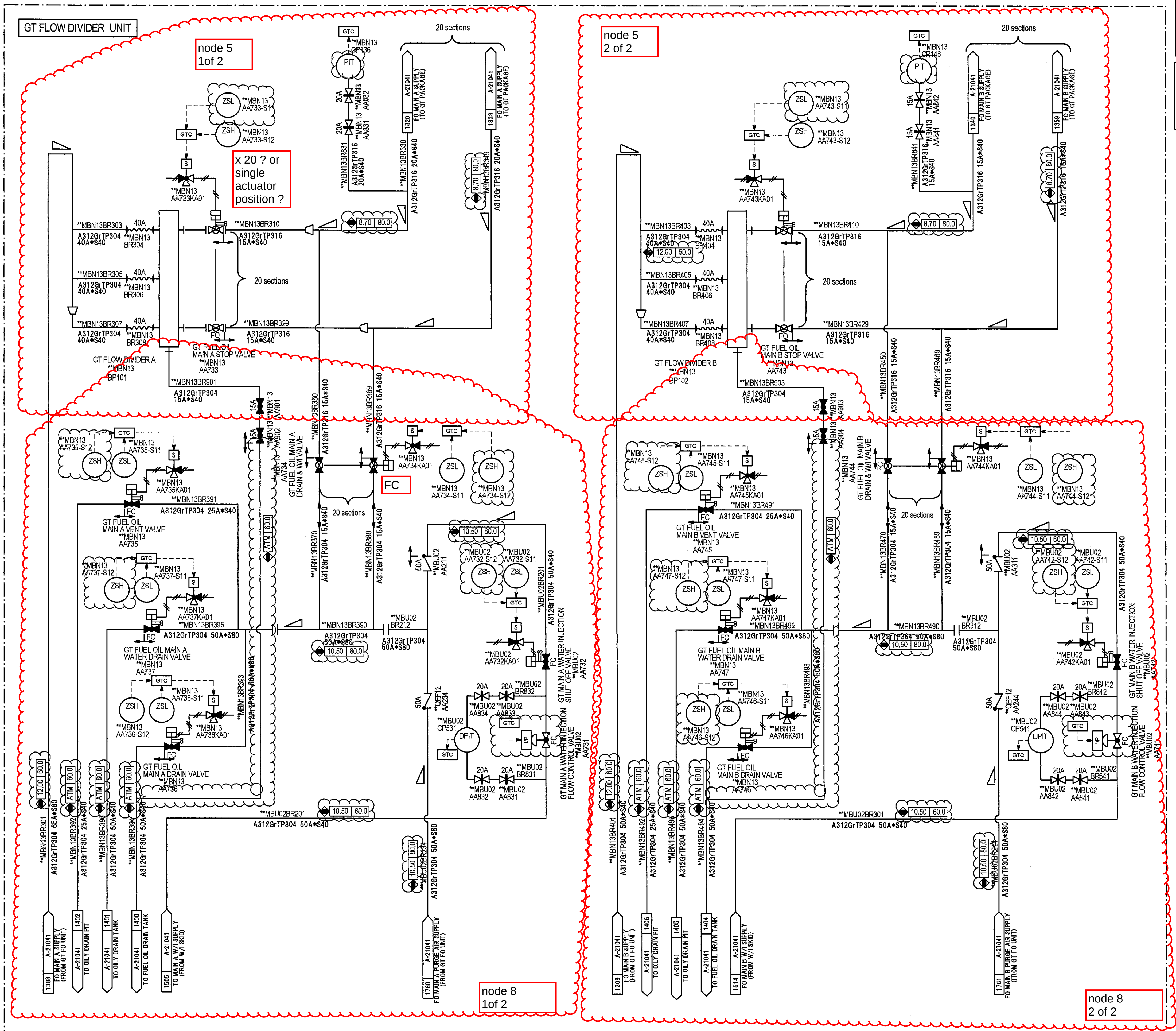

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CAD (PI)

PLAN RECORD

R-0	-Internal issue.
R-1	2021.12.10 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.

FOR INFORMATION

出図 2021.12.14

Employer: snowyhydro

Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

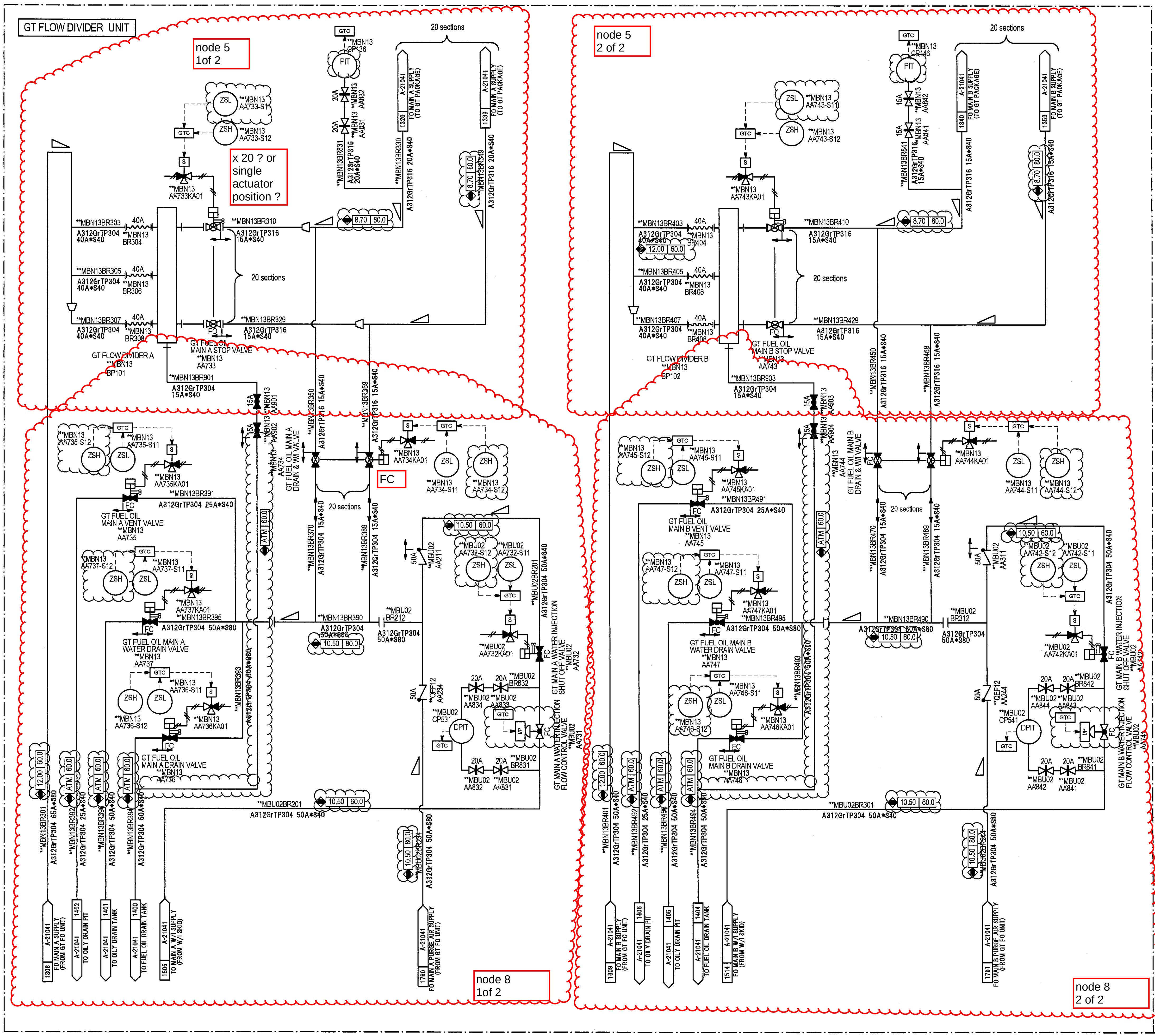
Title: M701F GAS TURBINE

FUEL OIL SYSTEM (3 OF 5) (FLOW DIVIDER UNIT)

Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 10
PA CODE	A-21043-B
DWG. No.	S3-80410
Rev.	R- 1

Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.



CAD (PI)

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FOR INFORMATION

PLAN RECORD

R-0	-Internal issue.
R-1	2021.12.10 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.

出図
2021.12.14

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

Title: M701F GAS TURBINE

FUEL OIL SYSTEM (3 OF 5)
(FLOW DIVIDER UNIT)

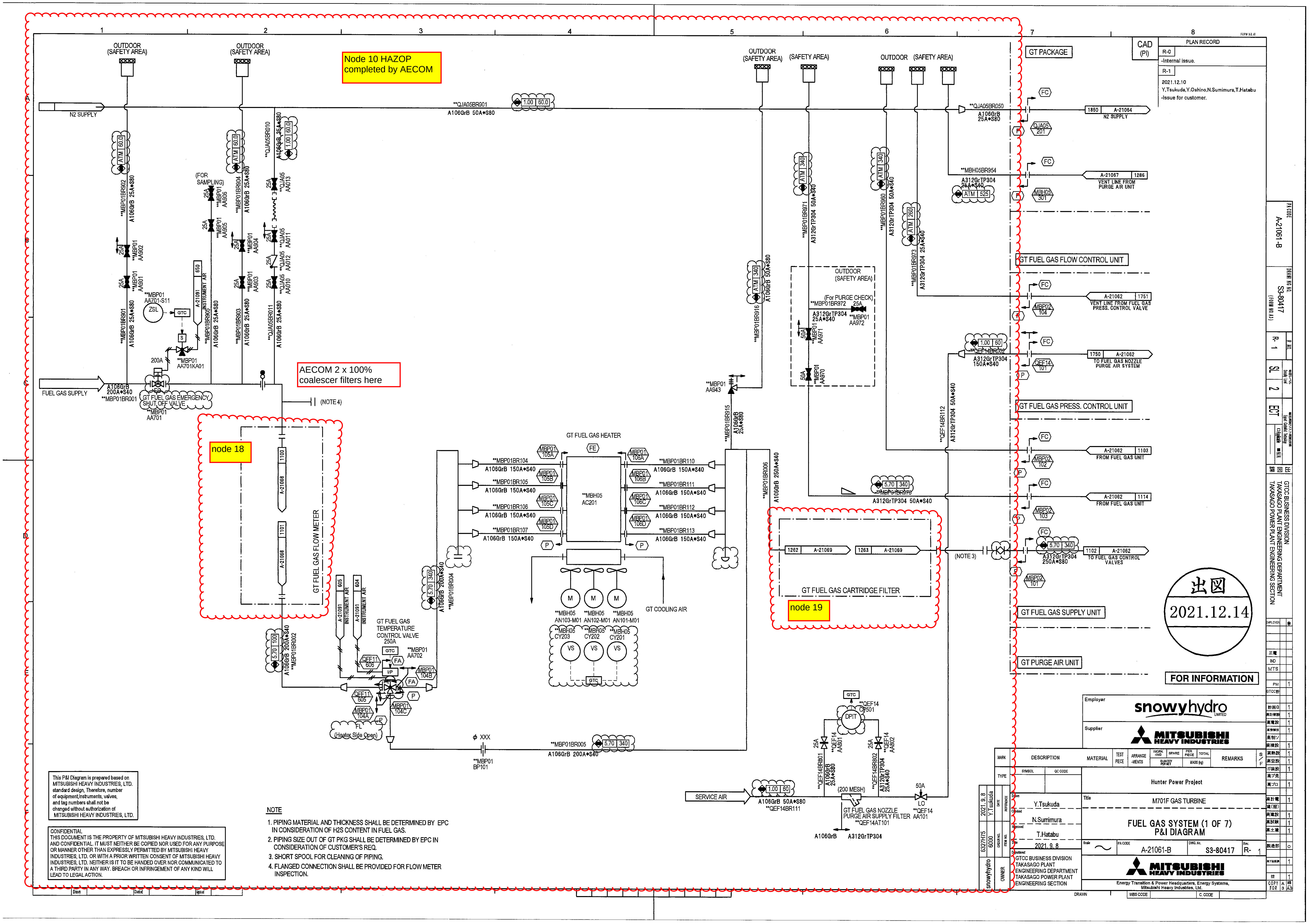
Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 10
PA CODE	A-21043-B
DWG. No.	S3-80410
Rev.	R- 1

Department: GTCC BUSINESS DIVISION, TAKASAGO PLANT ENGINEERING DEPARTMENT, TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

snowyhydro 6327H75 6000 2021. 9. 10 Y.Tsukuda

PA CODE A-21043-B
DRAWING NO. S3-80410
R- 1


Node 10 HAZOP
completed by AECOM
AECOM 2 x 100%
coalescer filters here
node 18
node 19
OUTDOOR (SAFETY AREA)
N2 SUPPLY
FUEL GAS SUPPLY
GT FUEL GAS EMERGENCY SHUT OFF VALVE
**QJA05BR901
A106GrB 50A*S80
(FOR SAMPLING)
INSTRUMENT AIR
(NOTE 4)
GT FUEL GAS FLOW METER
GT FUEL GAS HEATER
**MBH05 AC201
GT COOLING AIR
GT FUEL GAS TEMPERATURE CONTROL VALVE 250A
(Heater Side Open)
GT FUEL GAS CARTRIDGE FILTER
(NOTE 3)
OUTDOOR (SAFETY AREA)
(For PURGE CHECK)
SERVICE AIR
GT FUEL GAS NOZZLE PURGE AIR SUPPLY FILTER
(200 MESH)
GT PACKAGE
N2 SUPPLY
VENT LINE FROM PURGE AIR UNIT
GT FUEL GAS FLOW CONTROL UNIT
VENT LINE FROM FUEL GAS PRESS. CONTROL VALVE
TO FUEL GAS NOZZLE PURGE AIR SYSTEM
GT FUEL GAS PRESS. CONTROL UNIT
FROM FUEL GAS UNIT
TO FUEL GAS CONTROL VALVES
GT FUEL GAS SUPPLY UNIT
GT PURGE AIR UNIT
出図
2021.12.14
FOR INFORMATION
CAD (PI)
PLAN RECORD
R-0 -Internal issue.
R-1 2021.12.10 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.
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NOTE
1. PIPING MATERIAL AND THICKNESS SHALL BE DETERMINED BY EPC IN CONSIDERATION OF H2S CONTENT IN FUEL GAS.
2. PIPING SIZE OUT OF GT PKG SHALL BE DETERMINED BY EPC IN CONSIDERATION OF CUSTOMER'S REQ.
3. SHORT SPOOL FOR CLEANING OF PIPING.
4. FLANGED CONNECTION SHALL BE PROVIDED FOR FLOW METER INSPECTION.
Employer snowyhydro LIMITED
Supplier MITSUBISHI HEAVY INDUSTRIES
Hunter Power Project
M701F GAS TURBINE
FUEL GAS SYSTEM (1 OF 7) P&I DIAGRAM
Y.Tsukuda
N.Sumimura
T.Hatabu
2021. 9. 8
A-21061-B
S3-80417
GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

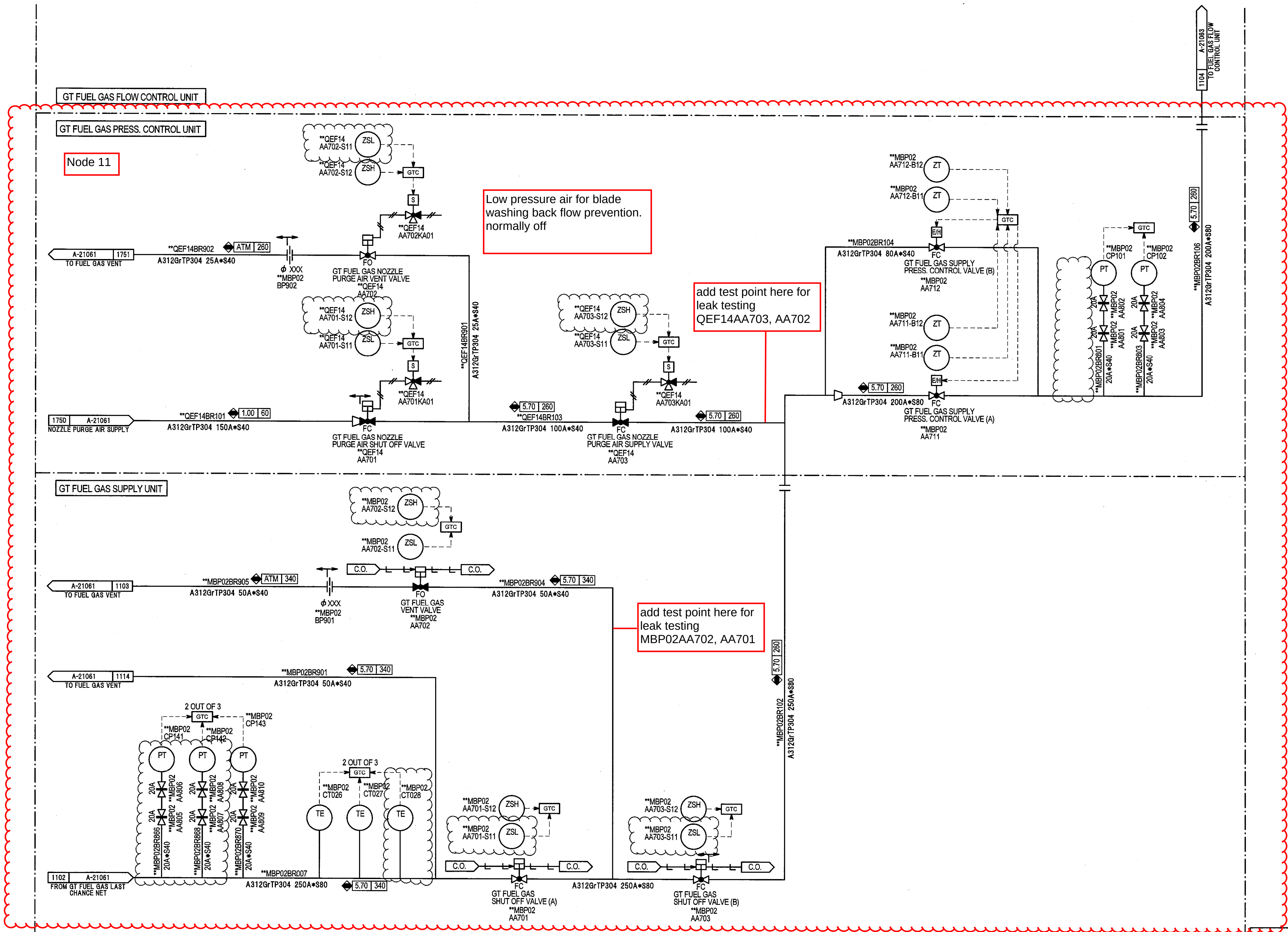
FOR INFORMATION

CAD (PI)

PLAN RECORD

R-0 -Internal issue.

R-1 2021.12.8 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



出図 2021.12.13

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

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Hunter Power Project

Title: M701F GAS TURBINE

FUEL GAS SYSTEM (2 OF 7) (SUPPLY UNIT) P&I DIAGRAM

Drawn: Y.Tsukuda

Checked: N.Sumimura

Approved: T.Hatabu

Date: 2021. 9. 8

PA CODE: A-21062-B

DWG. No.: S3-80418

Rev.: R- 1

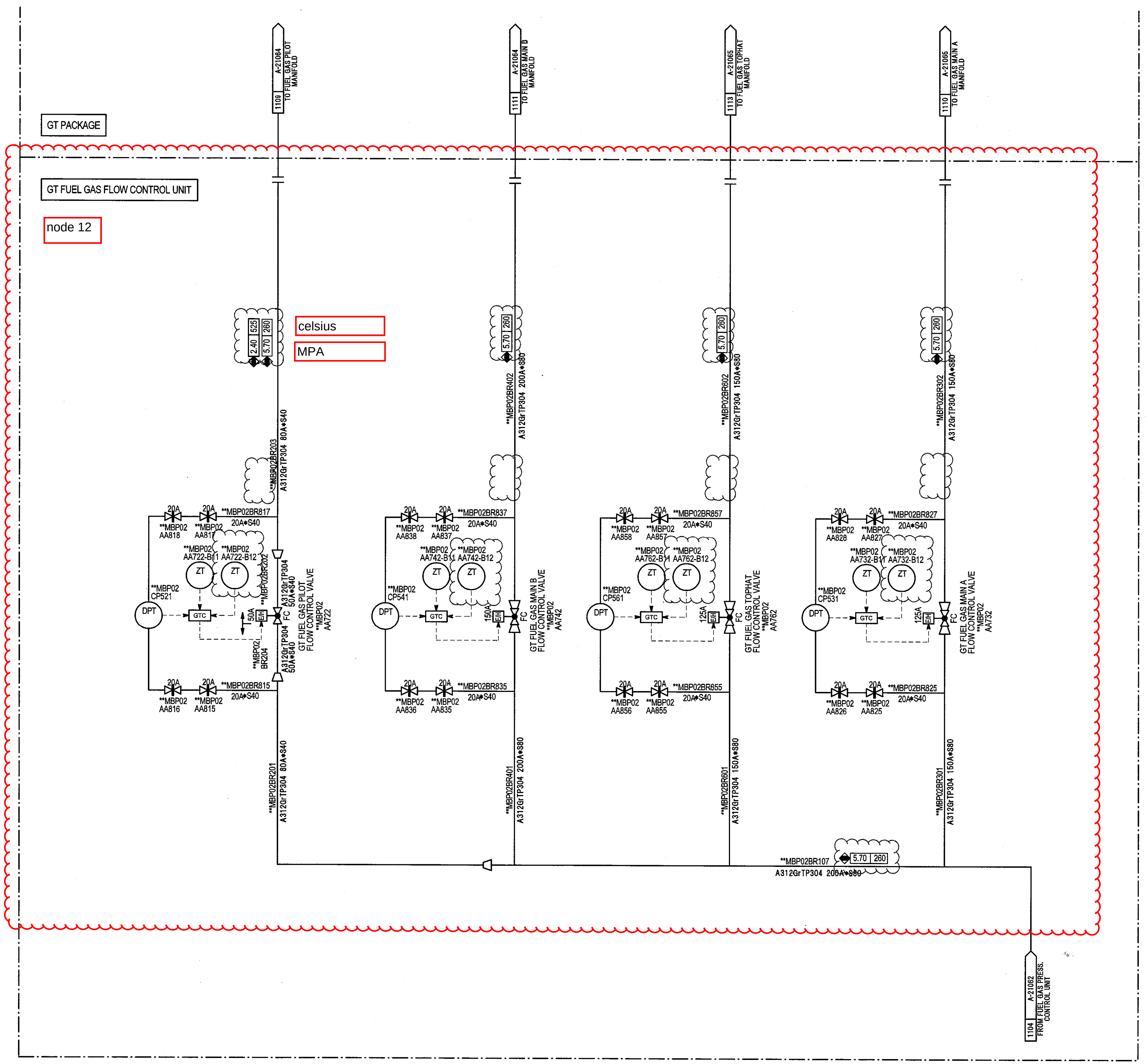
Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES

Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

FOR INFORMATION

CAD (PI)	PLAN RECORD
	R-0 -Internal issue.
	R-1 2021.12.8 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



出図 2021.12.13

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Employer: snowyhydro LIMITED
Supplier: MITSUBISHI HEAVY INDUSTRIES

MARK	DESCRIPTION	MATERIAL	TEST PIECE	ARRANGE-MENTS	WORK-ING / SPARE (QUANTITY PER SET)	PER PIECE / TOTAL (MASS (kg))	REMARKS	S/F

Hunter Power Project

Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 8
Department	GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

Title: M701F GAS TURBINE

FUEL GAS SYSTEM (3 OF 7) (CONTROL UNIT) P&I DIAGRAM

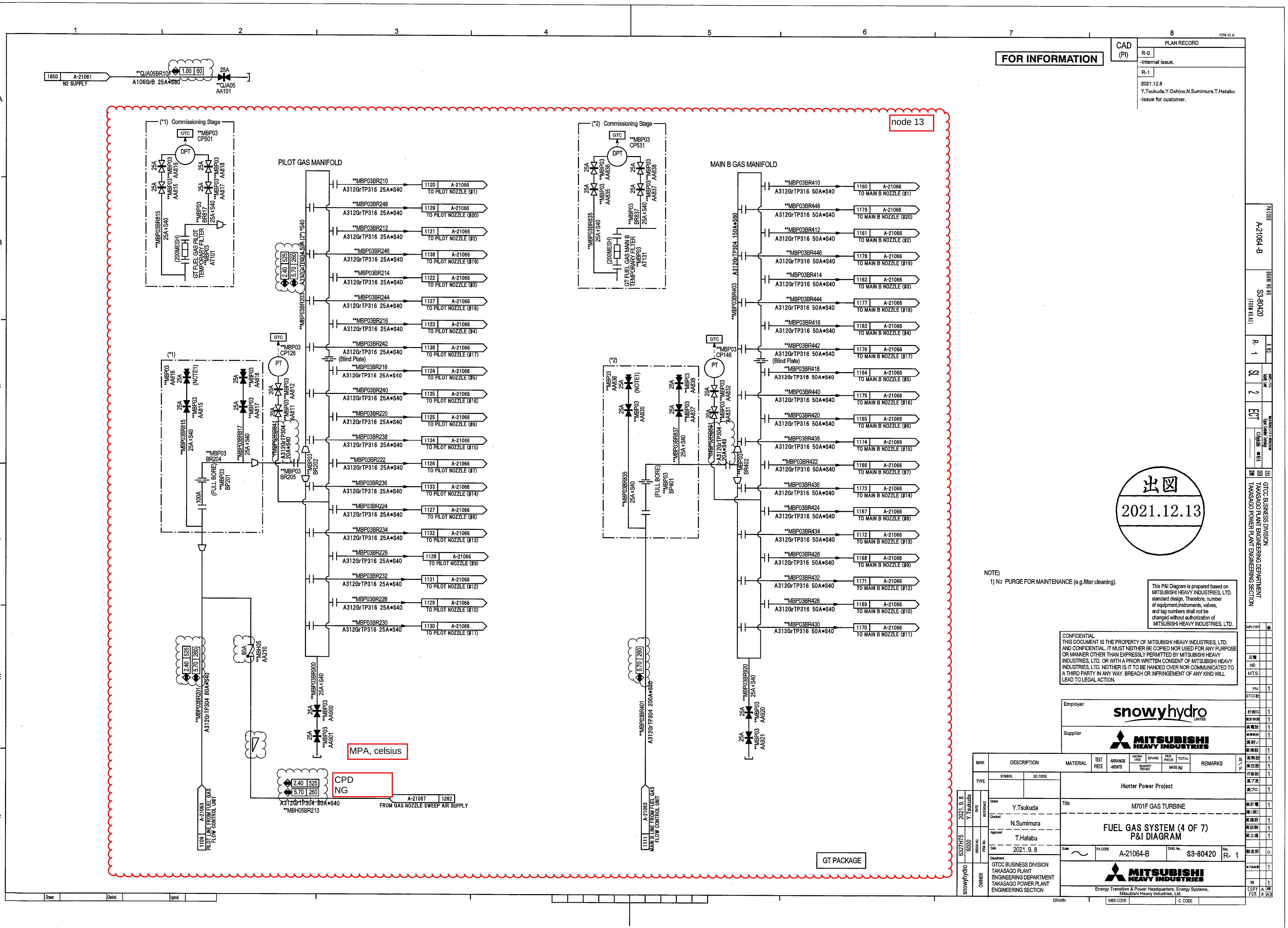
Scale: ~ | PA CODE: A-21063-B | DWG. No. S3-80419 | Rev. R- 1

Owner: snowyhydro | Order No. 6327H75 | Item No. 6000 | Date 2021. 9. 8 | Y.Tsukuda

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

DRAWN | WBS CODE | C. CODE

COPY FOR A3


FOR INFORMATION
CAD (PI)
PLAN RECORD
R-0 -Internal issue.
R-1 2021.12.8 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.
node 13
N2 SUPPLY
(*1) Commissioning Stage
GT FUEL GAS PILOT TEMPORARY FILTER
PILOT GAS MANIFOLD
(*2) Commissioning Stage
GT FUEL GAS MAIN B TEMPORARY FILTER
MAIN B GAS MANIFOLD
TO PILOT NOZZLE (#1)
TO MAIN B NOZZLE (#1)
(Blind Plate)
(FULL BORE)
MPA, celsius
CPD
NG
FROM GAS NOZZLE SWEEP AIR SUPPLY
PILOT LINE FROM FUEL GAS FLOW CONTROL UNIT
MAIN B LINE FROM FUEL GAS FLOW CONTROL UNIT
GT PACKAGE
NOTE)
1) N2 PURGE FOR MAINTENANCE (e.g.filter cleaning).
出図
2021.12.13
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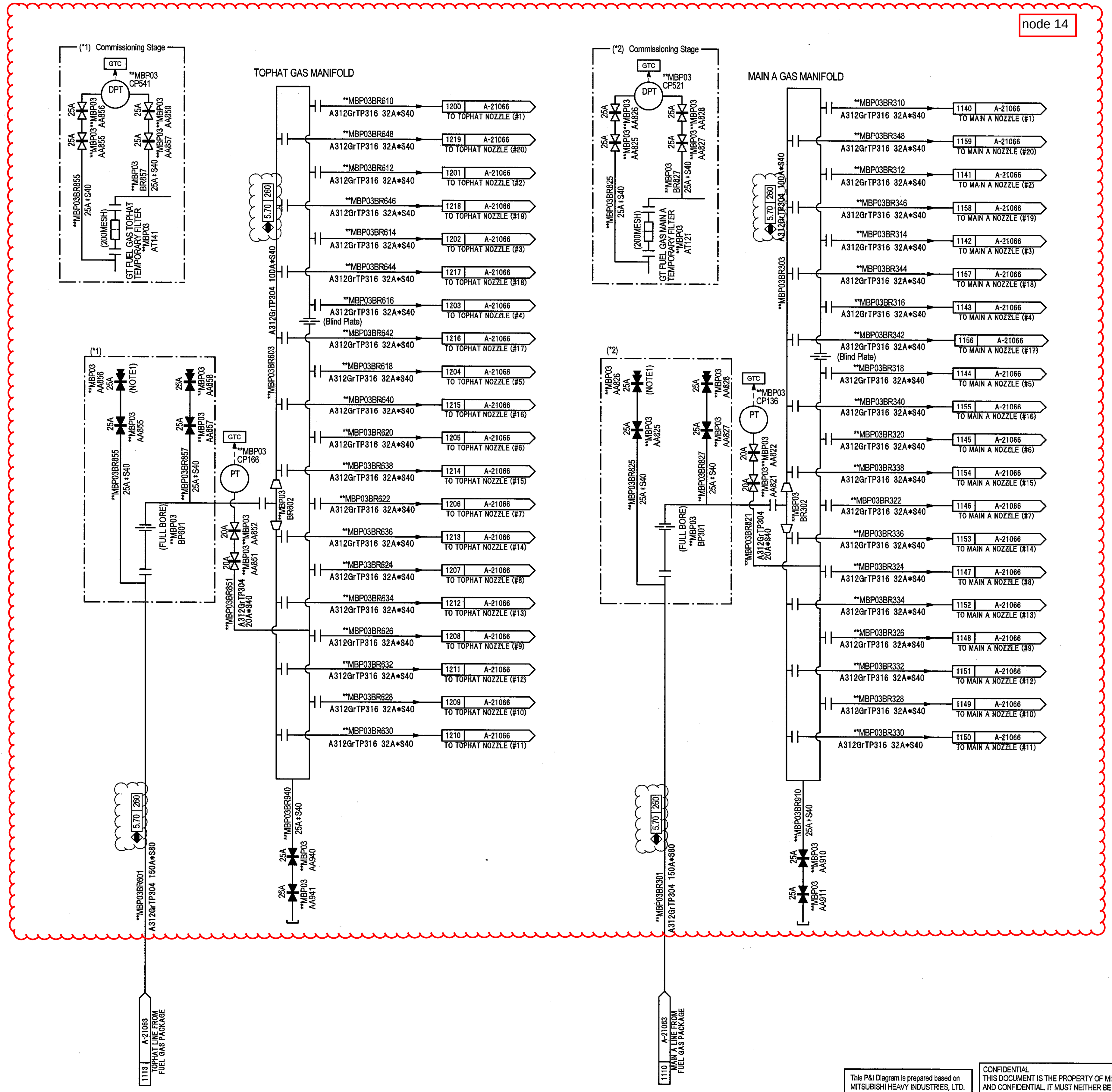
Employer snowyhydro
Supplier MITSUBISHI HEAVY INDUSTRIES
Hunter Power Project
Y.Tsukuda
N.Sumimura
T.Hatabu
2021.9.8
M701F GAS TURBINE
FUEL GAS SYSTEM (4 OF 7)
P&I DIAGRAM
A-21064-B
S3-80420
R- 1
GTCC BUSINESS DIVISION
TAKASAGO PLANT
ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT
ENGINEERING SECTION
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

FOR INFORMATION

CAD (PI)	PLAN RECORD
R-0	-Internal issue.
R-1	2021.12.8 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



NOTE)
1) N_2 PURGE FOR MAINTENANCE (e.g.filter cleaning).

出図
2021.12.13

GT PACKAGE

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Employer: snowyhydro LIMITED
Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

Title: M701F GAS TURBINE
FUEL GAS SYSTEM (5 OF 7)
P&I DIAGRAM

Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 8

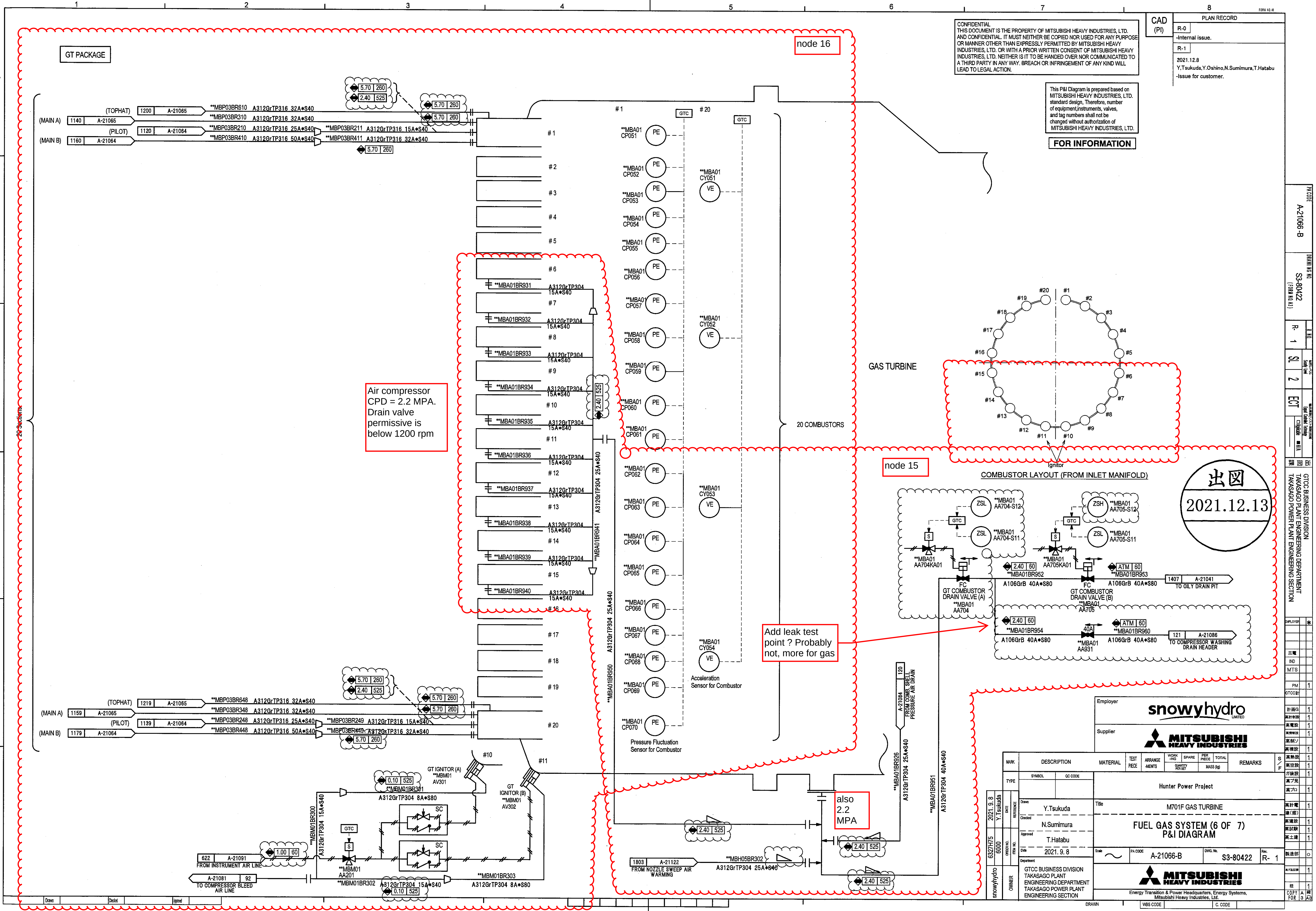
Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

PA CODE A-21065-B
DWG. No. S3-80421
Rev. R- 1

2021.9.8 Y.Tsukuda
6327H75 6000
snowyhydro

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

A-21065-B
S3-80421
R- 1
GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION



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CAD (PI)
PLAN RECORD
R-0 -Internal issue.
R-1 2021.12.8 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.
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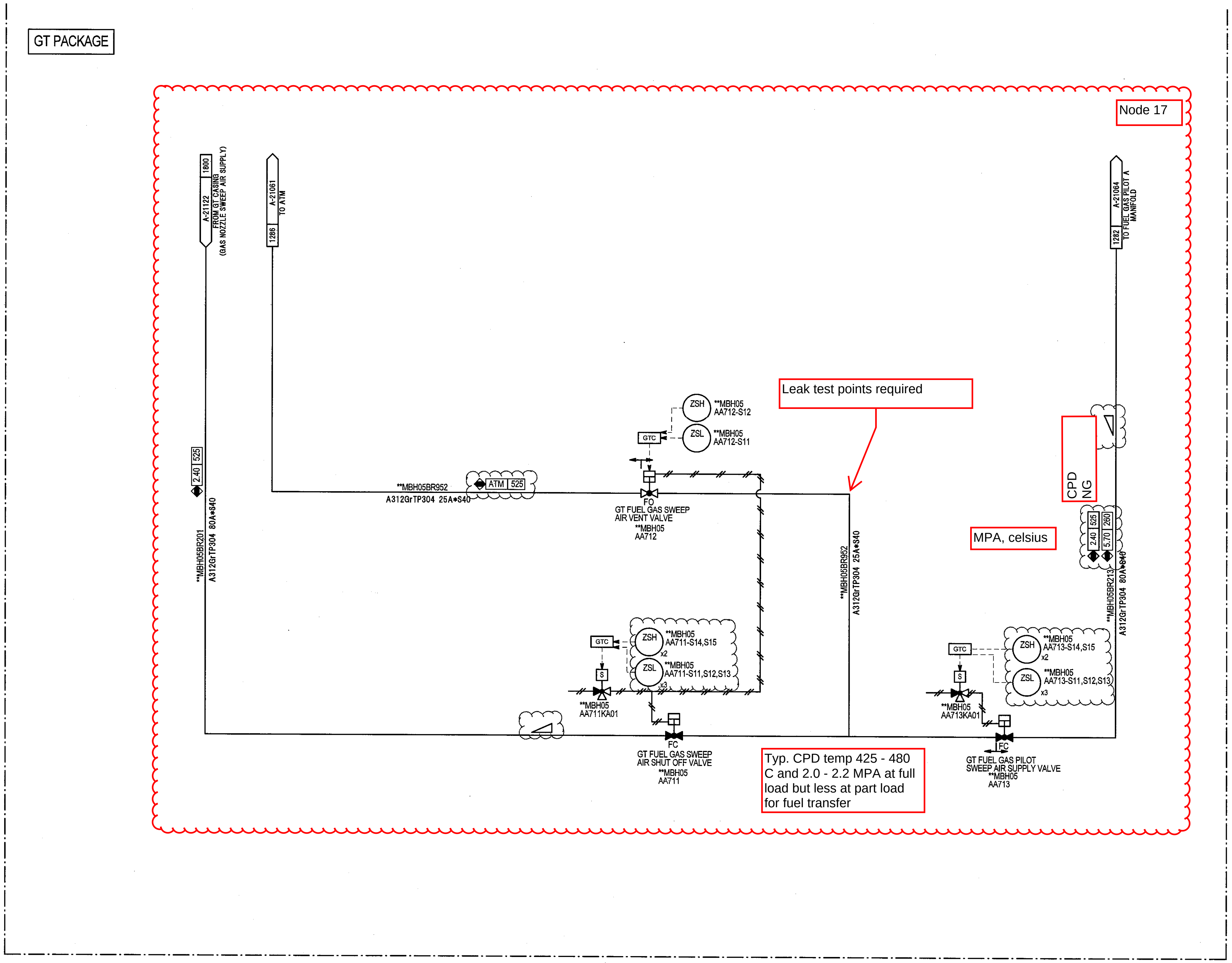
FOR INFORMATION
GT PACKAGE
node 16
node 15
Air compressor CPD = 2.2 MPA. Drain valve permissive is below 1200 rpm
Add leak test point ? Probably not, more for gas
also 2.2 MPA
(TOPHAT) 1200 A-21065
(MAIN A) 1140 A-21065
(PILOT) 1120 A-21064
(MAIN B) 1160 A-21064
(TOPHAT) 1219 A-21065
(MAIN A) 1159 A-21065
(PILOT) 1139 A-21064
(MAIN B) 1179 A-21064
20 Sections
20 COMBUSTORS
GAS TURBINE
Pressure Fluctuation Sensor for Combustor
Acceleration Sensor for Combustor
COMBUSTOR LAYOUT (FROM INLET MANIFOLD)
Ignitor
GT IGNITOR (A) **MBM01 AV301
GT IGNITOR (B) **MBM01 AV302
622 A-21091 FROM INSTRUMENT AIR LINE
A-21081 92 TO COMPRESSOR BLEED AIR LINE
1803 A-21122 FROM NOZZLE SWEEP AIR WARMING
A-21084 120 FROM COMB. SHELL PRESSURE AIR DRAIN
FC GT COMBUSTOR DRAIN VALVE (A) **MBA01 AA704
FC GT COMBUSTOR DRAIN VALVE (B) **MBA01 AA705
1407 A-21041 TO OILY DRAIN PIT
121 A-21086 TO COMPRESSOR WASHING DRAIN HEADER
出図 2021.12.13
Employer snowyhydro
Supplier MITSUBISHI HEAVY INDUSTRIES
Hunter Power Project
M701F GAS TURBINE
FUEL GAS SYSTEM (6 OF 7) P&I DIAGRAM
Drawn Y.Tsukuda
Checked N.Sumimura
Approved T.Hatabu
Date 2021. 9. 8
A-21066-B
S3-80422
R- 1
GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

FOR INFORMATION

CAD (PI)

PLAN RECORD
R-0 -Internal issue.
R-1 2021.12.8 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



出図 2021.12.13

This P&I Diagram is prepared based on MITSUBISHI HEAVY INDUSTRIES, LTD. standard design, Therefore, number of equipment,instruments, valves, and tag numbers shall not be changed without authorization of MITSUBISHI HEAVY INDUSTRIES, LTD.

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

MARK	DESCRIPTION	MATERIAL	TEST PIECE	ARRANGE-MENTS	WORK-ING	SPARE	PER PIECE	TOTAL	REMARKS

Hunter Power Project

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 8

Title: M701F GAS TURBINE
FUEL GAS SYSTEM (7 OF 7) (PURGE AIR UNIT) P&I DIAGRAM

PA CODE A-21067-B
DWG. No. S3-80423
Rev. R- 1

Order No. 6327H75 6000
2021. 9. 8 Y.Tsukuda
OWNER snowyhydro

Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

A-21067-B
S3-80423

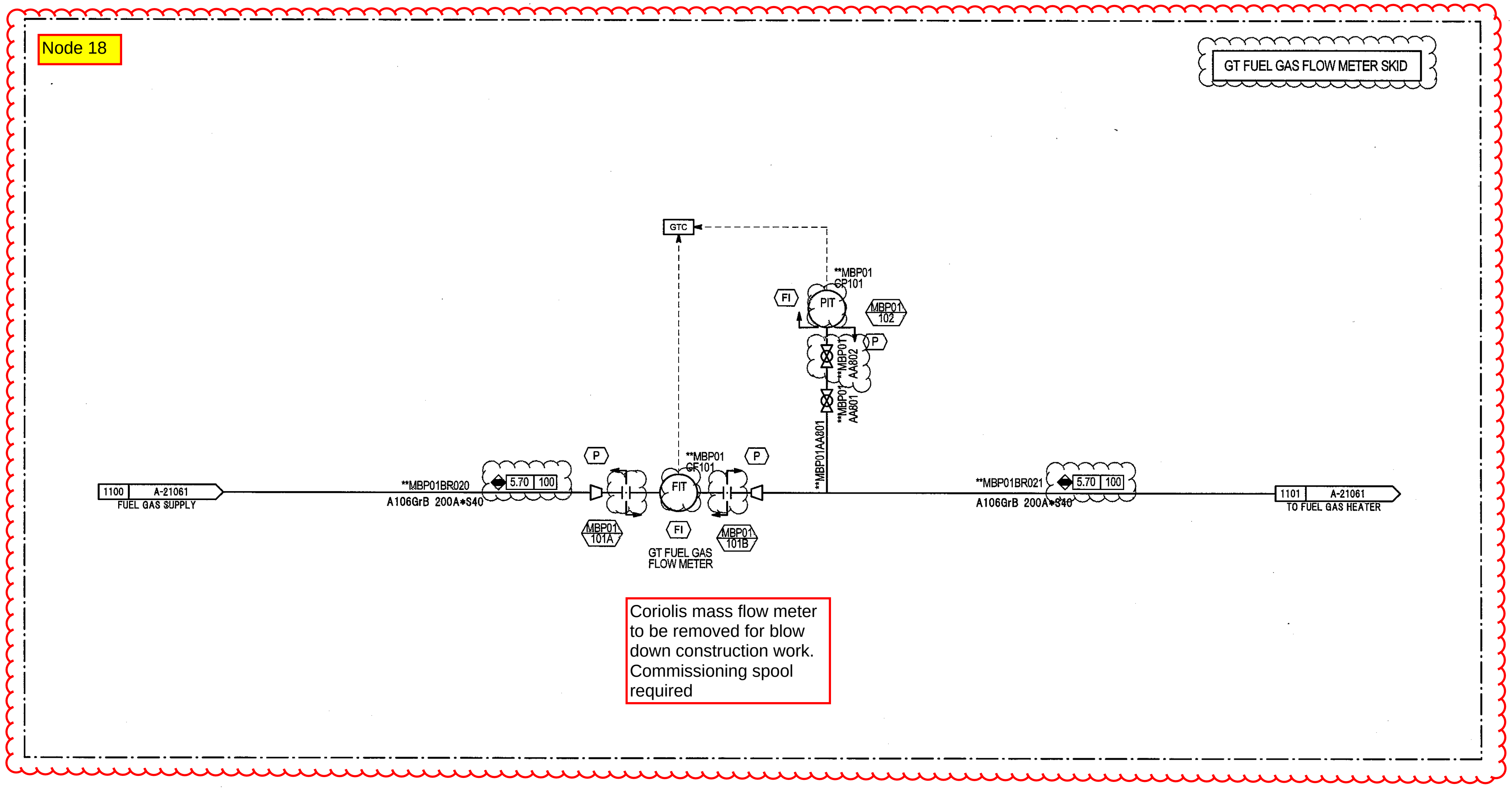
FOR INFORMATION

CAD (PI)

PLAN RECORD

R-0
-Internal issue.

R-1
2021.12.9
Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu
-Issue for customer.



出図
2021.12.13

PA CODE A-21068-B
DRAWING NO. S3-80424
R- 1

GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT ENGINEERING SECTION

This P&I Diagram is prepared based on MITSUBISHI HEAVY INDUSTRIES, LTD. standard design, Therefore, number of equipment,instruments, valves, and tag numbers shall not be changed without authorization of MITSUBISHI HEAVY INDUSTRIES, LTD.

Employer	snowyhydro LIMITED
Supplier	MITSUBISHI HEAVY INDUSTRIES
	Hunter Power Project
Title	M701F GAS TURBINE
	FUEL GAS FLOW METER P&I DIAGRAM
Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 8
Scale	～
PA CODE	A-21068-B
DWG. No.	S3-80424
Rev.	R- 1
Order No. / Item No.	6327H75 / 6000
Owner	snowyhydro
Department	GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

FOR INFORMATION

CAD (PI)	PLAN RECORD
R-0	-Internal issue.
R-1	2021.12.9 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.

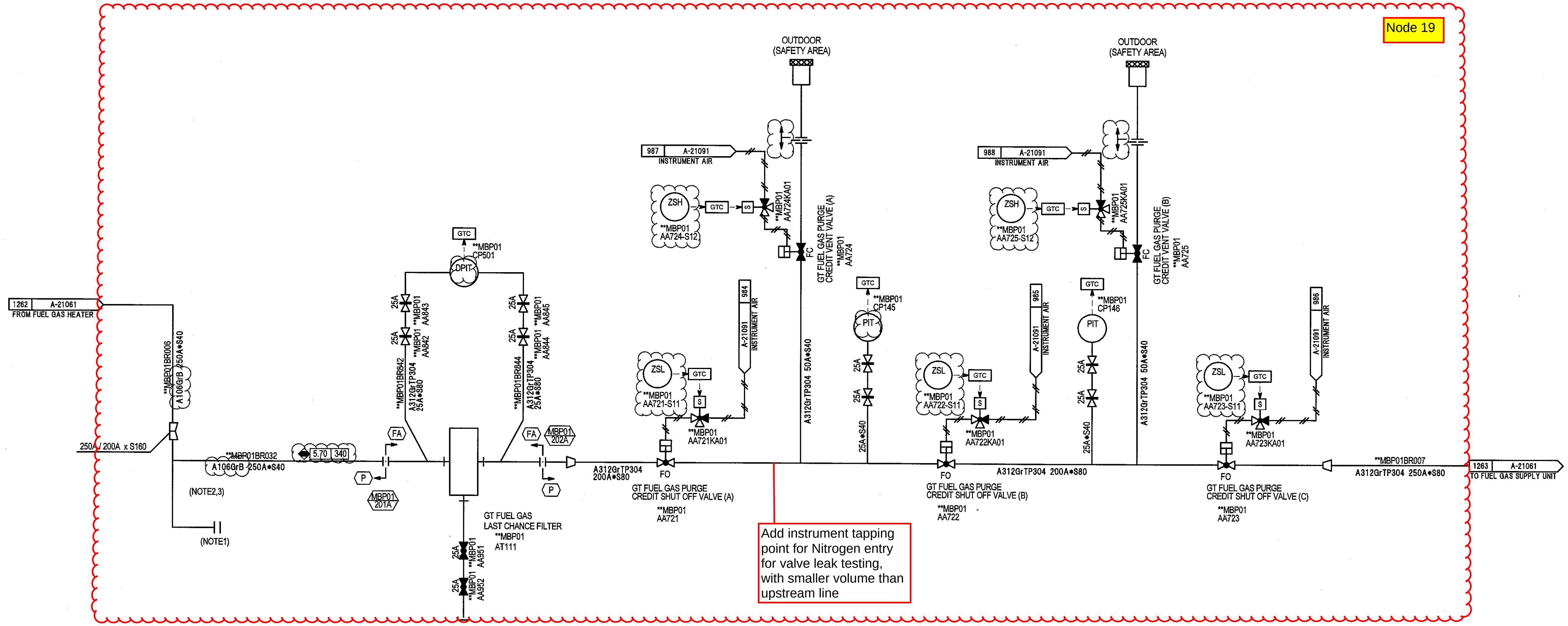
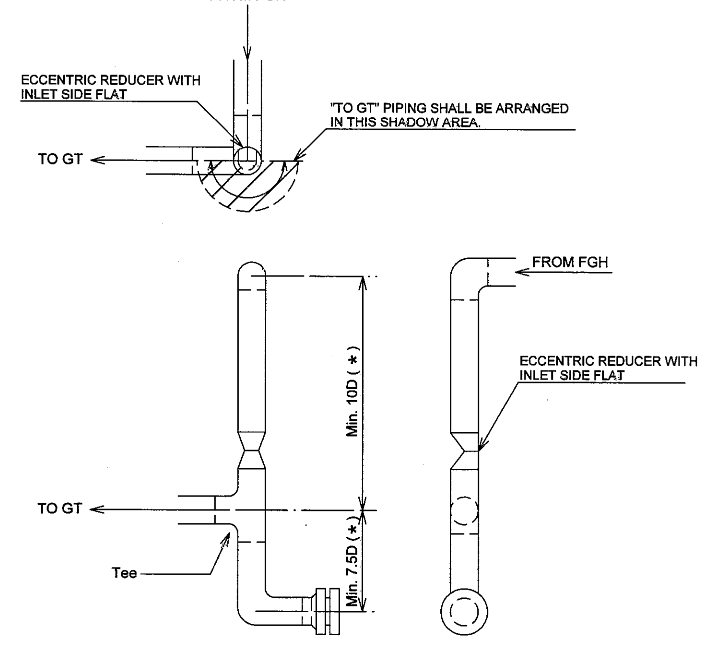


FIG. 1



(*) D : Nominal Pipe Diameter

出図 2021.12.13

NOTE

1. FLANGED CONNECTION SHALL BE PROVIDED FOR PIPING CLEANING.
2. THIS PIPING ARRANGEMENT SHALL BE INSTALLED BY "P" IN ORDER TO CAPTURE INCOMING FOREIGN PARTICLE.
3. THIS PIPING ARRANGEMENT SHALL BE APPLIED AS FIG. 1.

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

MARK	DESCRIPTION	MATERIAL	TEST PIECE	ARRANGE-MENTS	WORK-ING	SPARE	PER PIECE	TOTAL	REMARKS

Hunter Power Project

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 8

Title: M701F GAS TURBINE

FUEL GAS FILTER & PURGE CREDIT SYSTEM P&I DIAGRAM

PA CODE: A-21069-B
DWG. No.: S3-80425
Rev.: R- 1

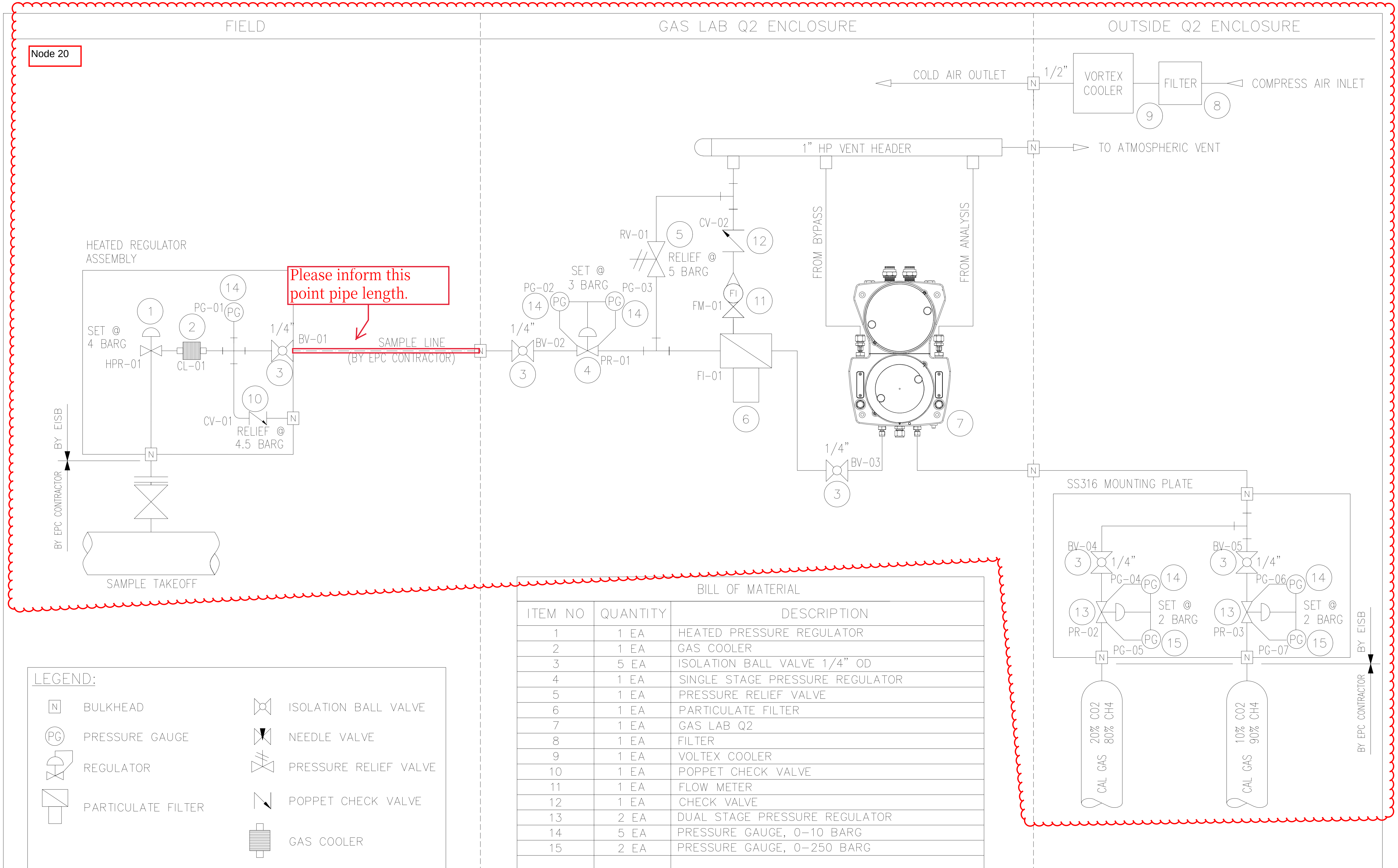
Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

snowyhydro 6327H75 6000 2021. 9. 8 Y.Tsukuda

GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

A-21069-B S3-80425 R- 1



BILL OF MATERIAL

ITEM NO	QUANTITY	DESCRIPTION
1	1 EA	HEATED PRESSURE REGULATOR
2	1 EA	GAS COOLER
3	5 EA	ISOLATION BALL VALVE 1/4" OD
4	1 EA	SINGLE STAGE PRESSURE REGULATOR
5	1 EA	PRESSURE RELIEF VALVE
6	1 EA	PARTICULATE FILTER
7	1 EA	GAS LAB Q2
8	1 EA	FILTER
9	1 EA	VOLTEX COOLER
10	1 EA	POPPET CHECK VALVE
11	1 EA	FLOW METER
12	1 EA	CHECK VALVE
13	2 EA	DUAL STAGE PRESSURE REGULATOR
14	5 EA	PRESSURE GAUGE, 0-10 BARG
15	2 EA	PRESSURE GAUGE, 0-250 BARG

NOTES :

1. ALL DIMENSION ARE IN MILIMETRES UNLESS OTHERWISE NOTED.
2. CALIBRATION GAS CYLINDERS SUPPLIED BY EPC CONTRACTOR.

REFERENCE DWG. NO.	DESCRIPTION	REV.	DESCRIPTION	DATE	DRAWN	CHKD.	APPD.	CHKD.	APPD.
-	-	A	ISSUED FOR APPROVAL	04.01.22	SAM	TS	DK	-	-

CONSULTANT · CLIENT

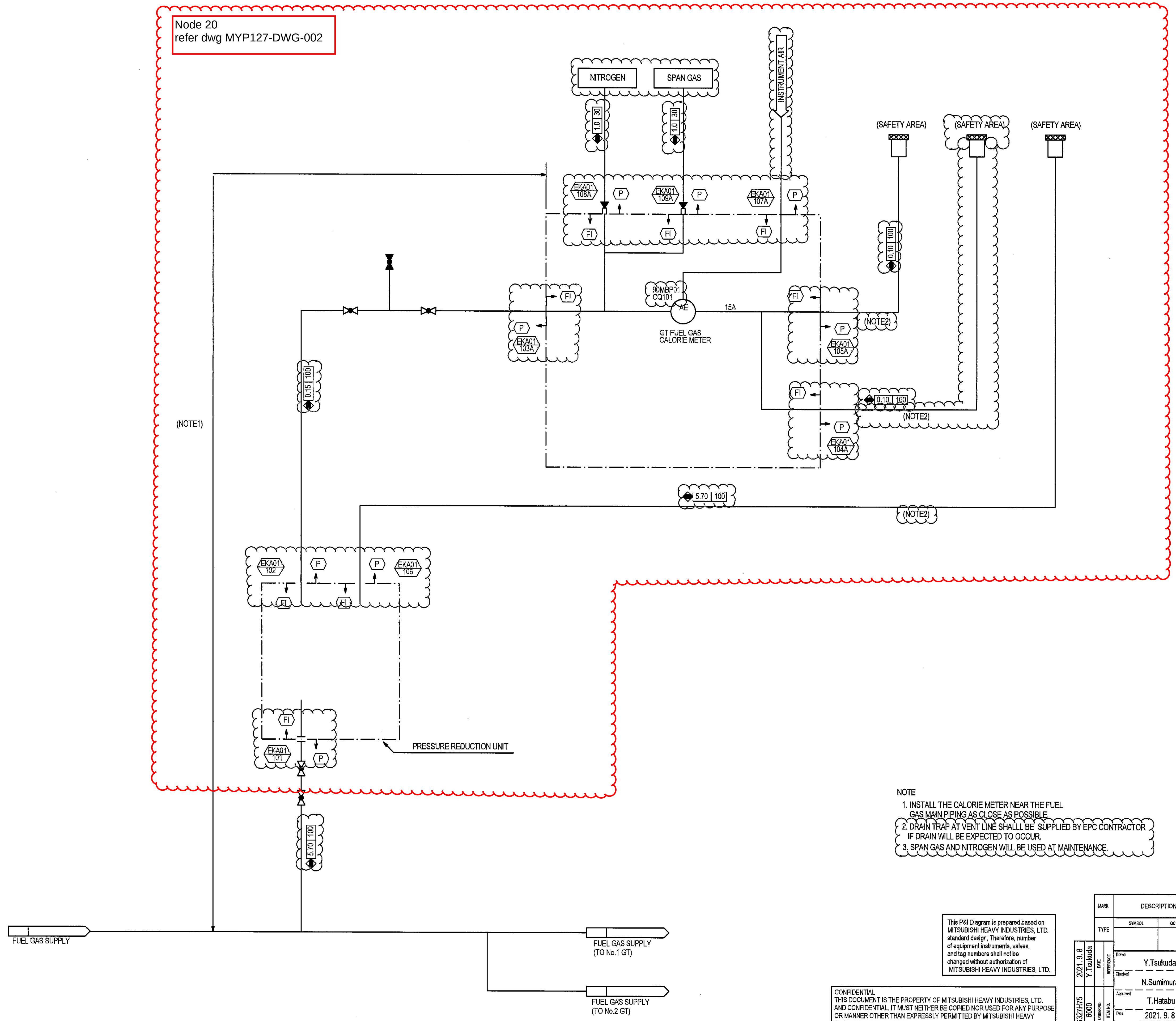
CLIENT : MITSUBISHI HEAVY INDUSTRIES

VENDOR : elster Instromet Honeywell

PROJECT : HUNTER POWER, AUSTRALIA (CALORIE METER PACKAGE)

TITLE : P&ID

SCALE : AS SHOWN	SIZE : A3	UNIT : MM	CAD FILE : MYP127-DWG-002	
JOB NO. : MYP127	SHEET : 1 OF 1		DRAWING NO. : MYP127-DWG-002	REV. : A



NOTE
1. INSTALL THE CALORIE METER NEAR THE FUEL GAS MAIN PIPING AS CLOSE AS POSSIBLE.
2. DRAIN TRAP AT VENT LINE SHALL BE SUPPLIED BY EPC CONTRACTOR IF DRAIN WILL BE EXPECTED TO OCCUR.
3. SPAN GAS AND NITROGEN WILL BE USED AT MAINTENANCE.

CAD (PI)

PLAN RECORD
R-0
-Internal issue.
R-1
2021.12.10
Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu
-Issue for customer.

出図 2021.12.14

FOR INFORMATION

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Employer: snowyhydro LIMITED
Supplier: MITSUBISHI HEAVY INDUSTRIES

MARK	DESCRIPTION	MATERIAL	TEST PIECE	ARRANGE-MENTS	WORK-ING	SPARE	PER PIECE	TOTAL	REMARKS

Hunter Power Project

Title: M701F GAS TURBINE
FUEL GAS CALORIE METER P&ID DIAGRAM

Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 8
Department	GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION
Scale	～
PA CODE	A-21070-B
DWG. No.	S3-80426
Rev.	R- 1

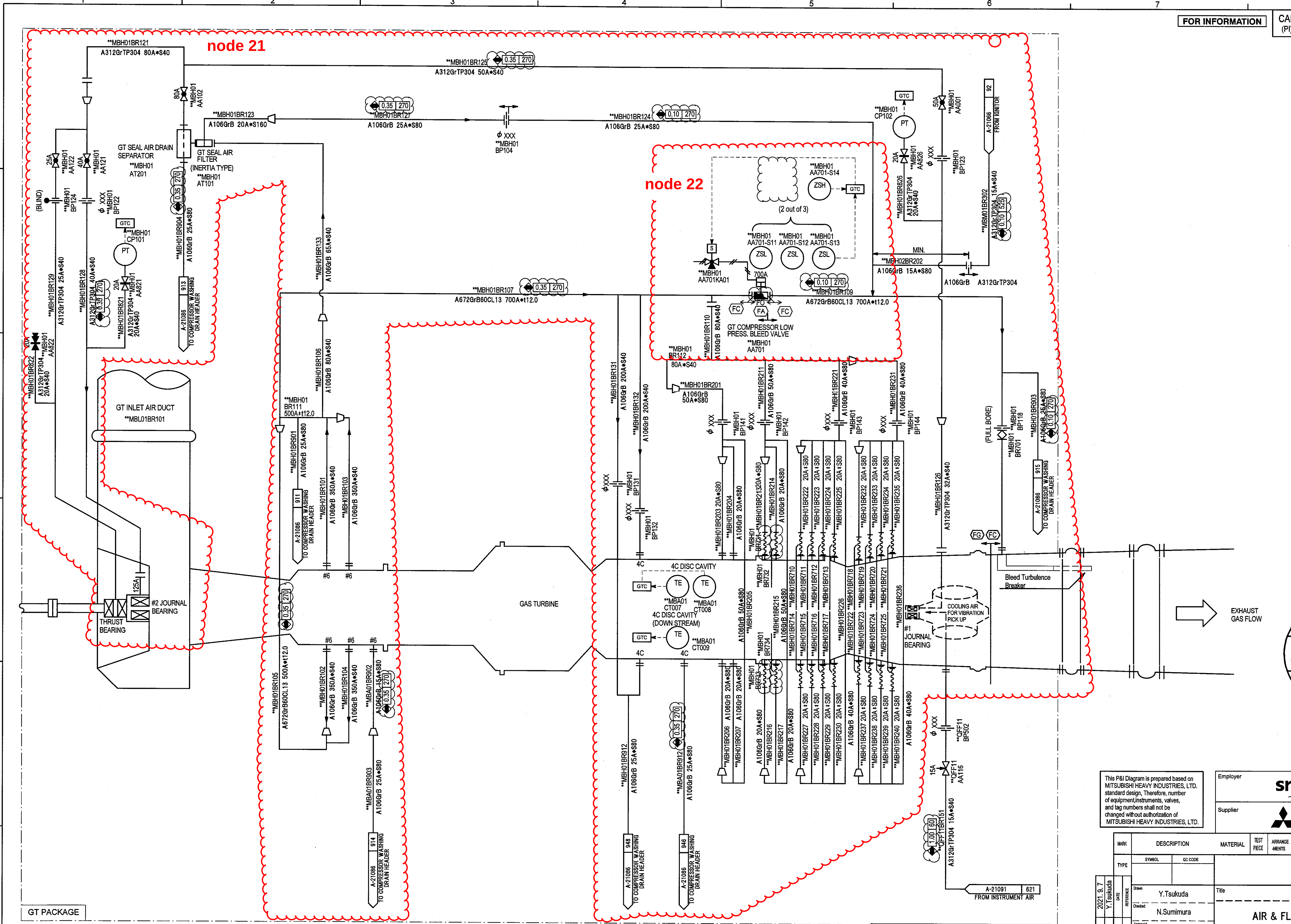
6327H75 6000 2021. 9. 8 Y.Tsukuda snowyhydro OWNER

Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

A-21070-B
S3-80426
R- 1
GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

FOR INFORMATION

CAD (PI)	PLAN RECORD
R-0	-Internal issue.
R-1	2021.12.14 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



This P&ID Diagram is prepared based on MITSUBISHI HEAVY INDUSTRIES, LTD. standard design, Therefore, number of equipment,instruments, valves, and tag numbers shall not be changed without authorization of MITSUBISHI HEAVY INDUSTRIES, LTD.

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 7

Title: M701F GAS TURBINE

AIR & FLUE GAS SYSTEM (1 OF 5)
P&I DIAGRAM

PA CODE: A-21081-B
DWG. No. S3-80427
Rev. R- 1

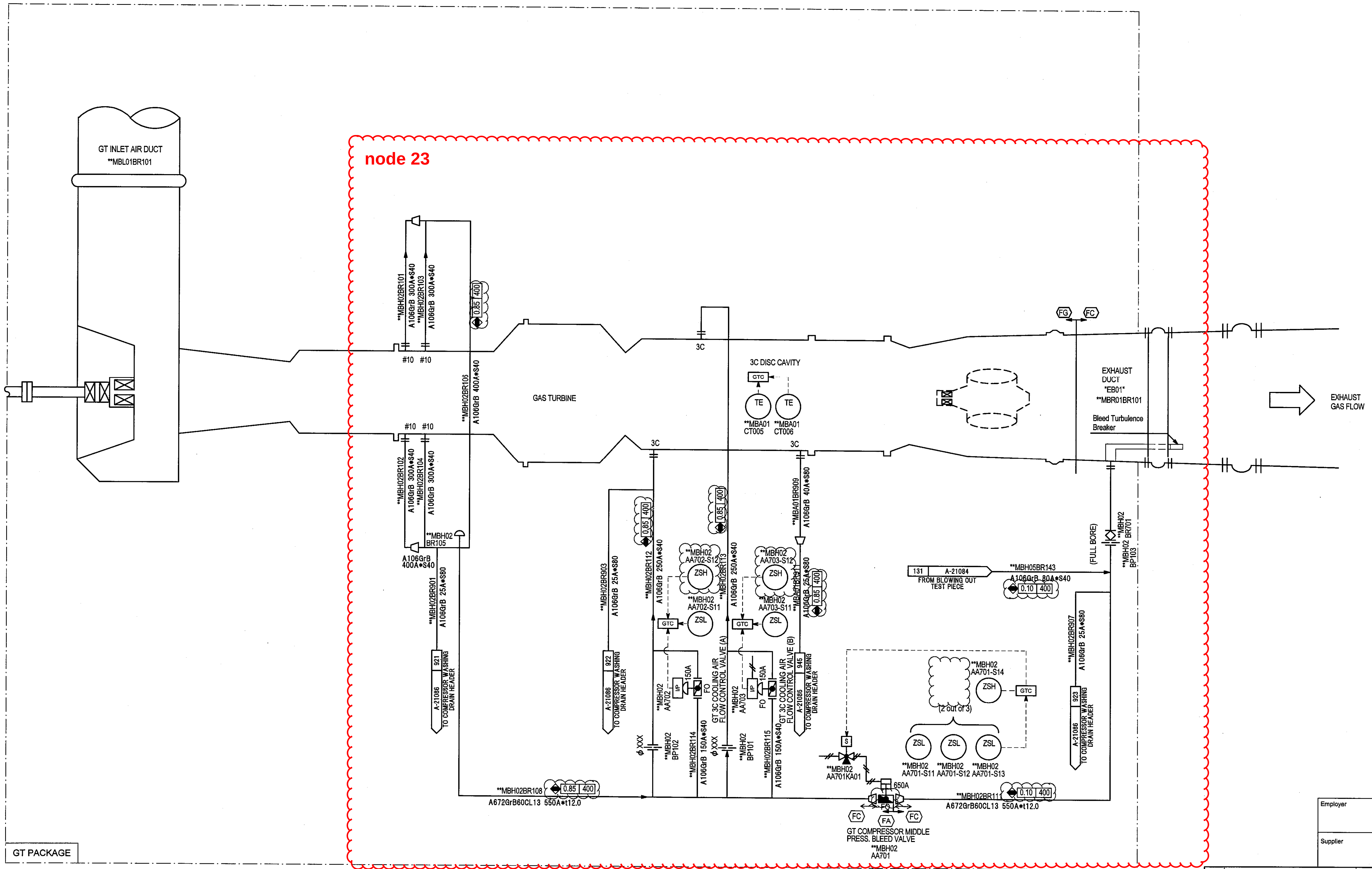
Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

FOR INFORMATION

CAD (PI)

PLAN RECORD
R-0
-Internal issue.
R-1
2021.12.14 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



出図
2021.12.15

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Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

Project	Hunter Power Project
Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 7
Title	M701F GAS TURBINE — AIR & FLUE GAS SYSTEM (2 OF 5) P&I DIAGRAM
PA CODE	A-21082-B
DWG. No.	S3-80428
Rev.	R- 1
Department	GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

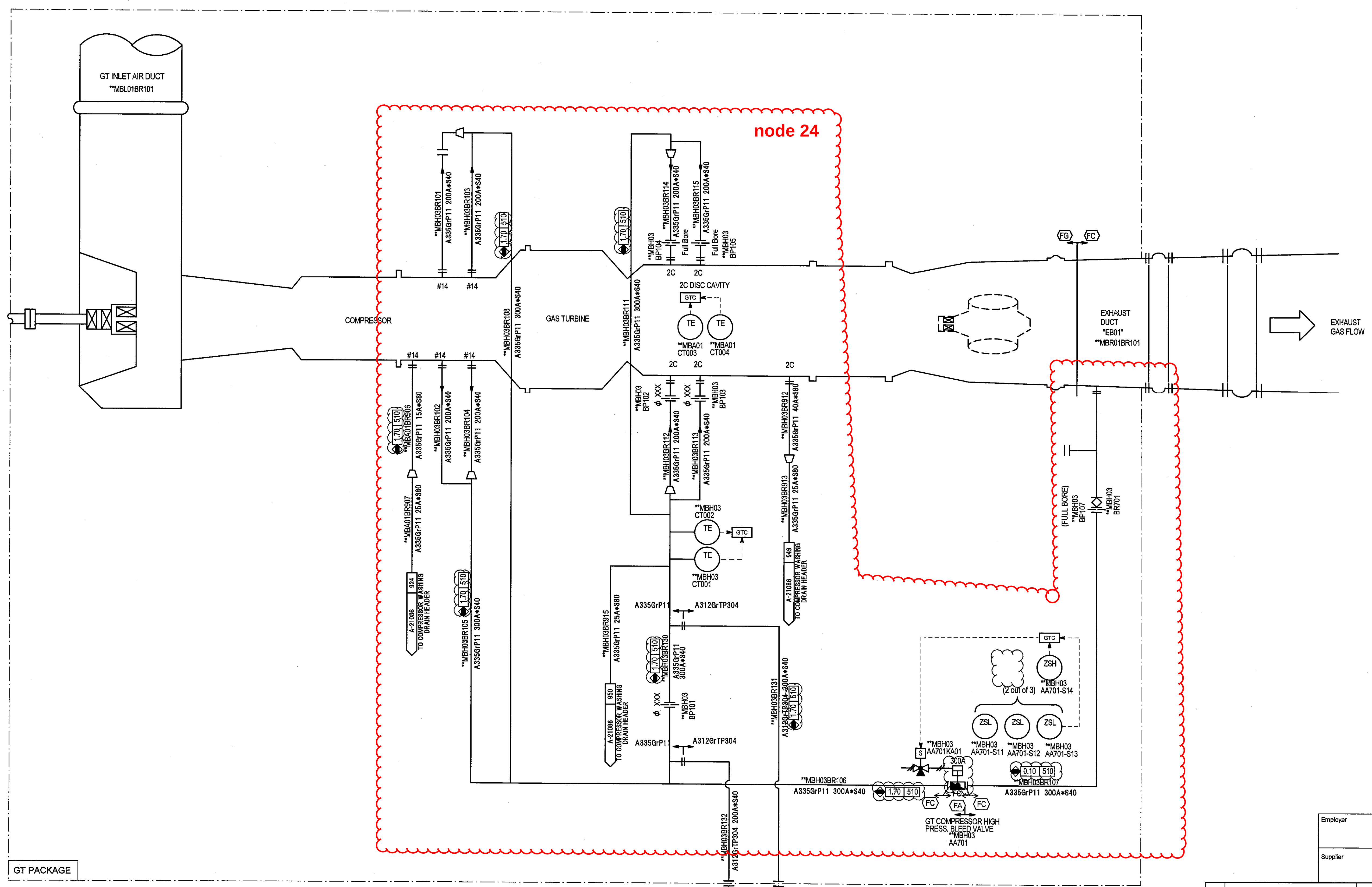
6327H75 6000 snowyhydro 2021. 9. 7 Y.Tsukuda

PA CODE A-21082-B
DRAWING NO. S3-80428
R- 1
GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

FOR INFORMATION

CAD (PI)

PLAN RECORD
R-0 -Internal issue.
R-1 2021.12.14 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



出図 2021.12.15

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Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

M701F GAS TURBINE

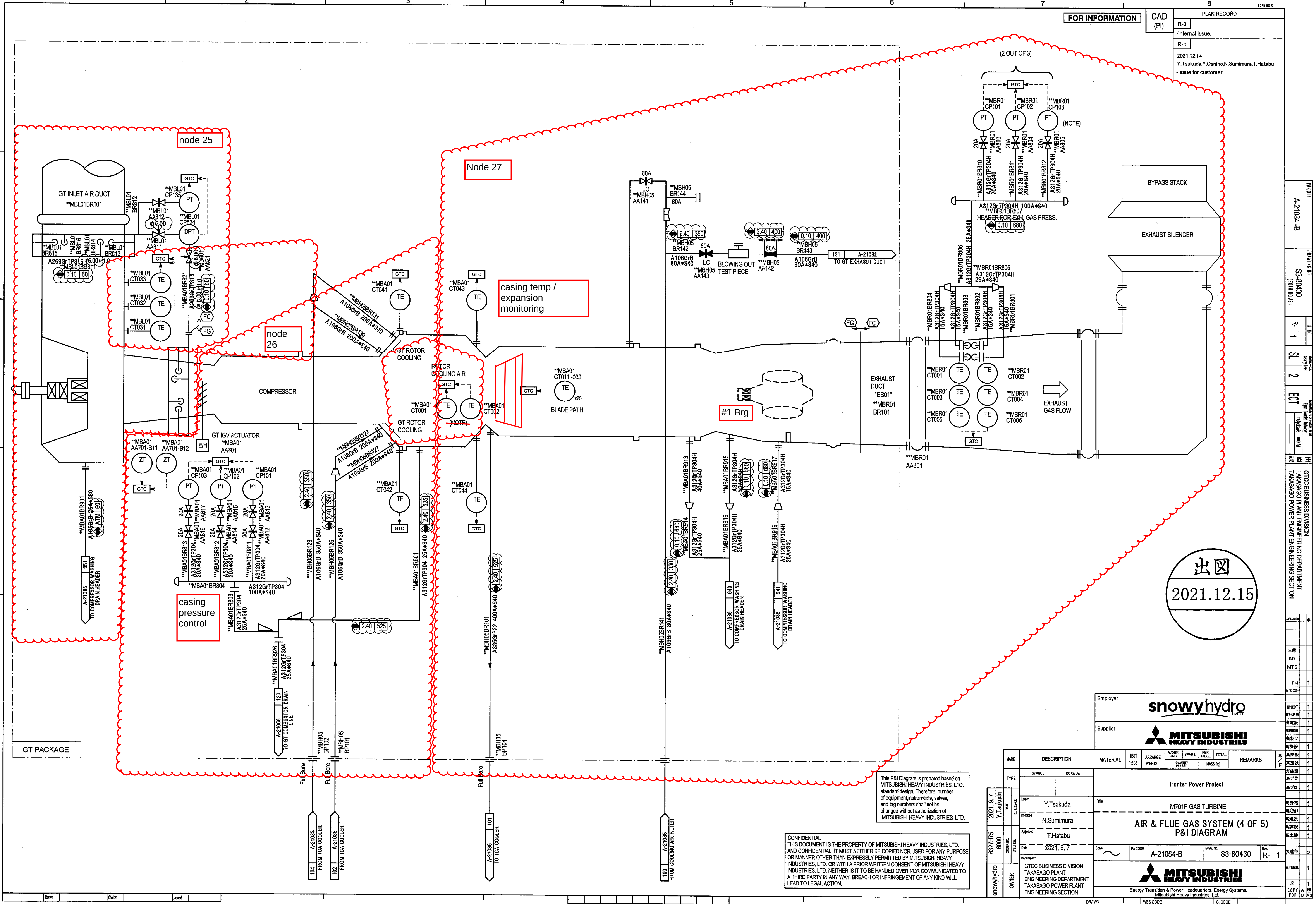
AIR & FLUE GAS SYSTEM (3 OF 5) P&I DIAGRAM

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 7

PA CODE: A-21083-B
DWG. No.: S3-80429
Rev.: R- 1

GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT ENGINEERING SECTION

Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.



FOR INFORMATION
CAD (PI)
PLAN RECORD
R-0
-Internal issue.
R-1
2021.12.14
Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu
-Issue for customer.
node 25
Node 27
node 26
casing temp / expansion monitoring
casing pressure control
#1 Brg
GT INLET AIR DUCT
**MBL01BR101
COMPRESSOR
GT IGV ACTUATOR
GT ROTOR COOLING
ROTOR COOLING AIR
BLADE PATH
BLOWING OUT TEST PIECE
TO GT EXHAUST DUCT
HEADER FOR EXH. GAS PRESS.
(2 OUT OF 3)
(NOTE)
BYPASS STACK
EXHAUST SILENCER
EXHAUST DUCT
"EB01"
**MBR01 BR101
EXHAUST GAS FLOW
GT PACKAGE
TO COMPRESSOR WASHING DRAIN HEADER
TO GT COMBUSTOR DRAIN LINE
FROM TCA COOLER
TO TCA COOLER
FROM COOLING AIR FILTER
Full Bore
出図
2021.12.15
This P&I Diagram is prepared based on MITSUBISHI HEAVY INDUSTRIES, LTD. standard design. Therefore, number of equipment,instruments, valves, and tag numbers shall not be changed without authorization of MITSUBISHI HEAVY INDUSTRIES, LTD.
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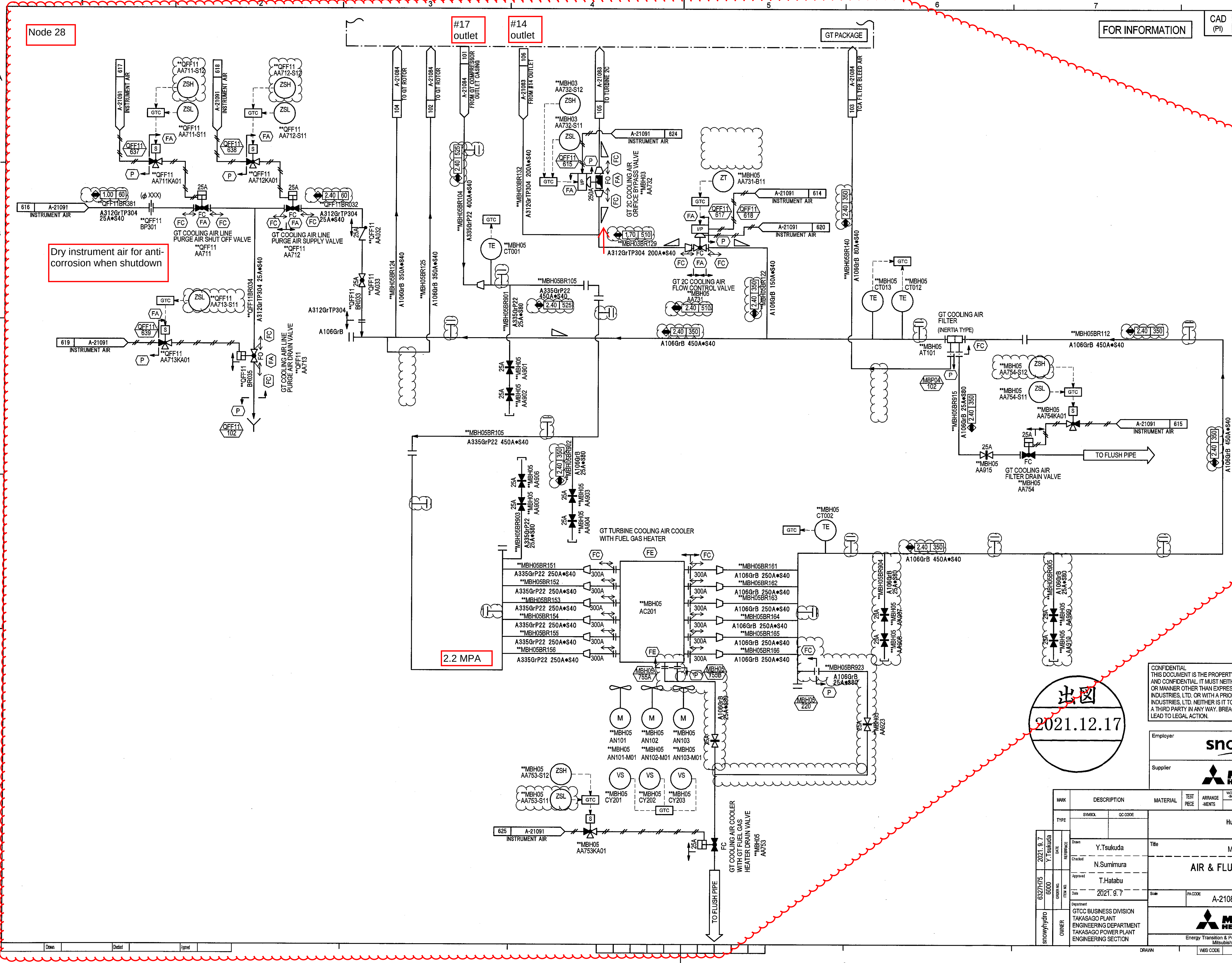
Employer
snowyhydro
Supplier
MITSUBISHI HEAVY INDUSTRIES
Hunter Power Project
M701F GAS TURBINE
AIR & FLUE GAS SYSTEM (4 OF 5)
P&I DIAGRAM
Drawn Y.Tsukuda
Checked N.Sumimura
Approved T.Hatabu
Date 2021. 9. 7
GTCC BUSINESS DIVISION
TAKASAGO PLANT
ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT
ENGINEERING SECTION
PA CODE A-21084-B
DWG. No. S3-80430
Rev. R- 1
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.
GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT ENGINEERING SECTION



CAD (PI)	PLAN RECORD
R-0	-Internal issue.
R-1	2021.12.16 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.

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出図 2021.12.17

Employer: snowy hydro LIMITED
Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

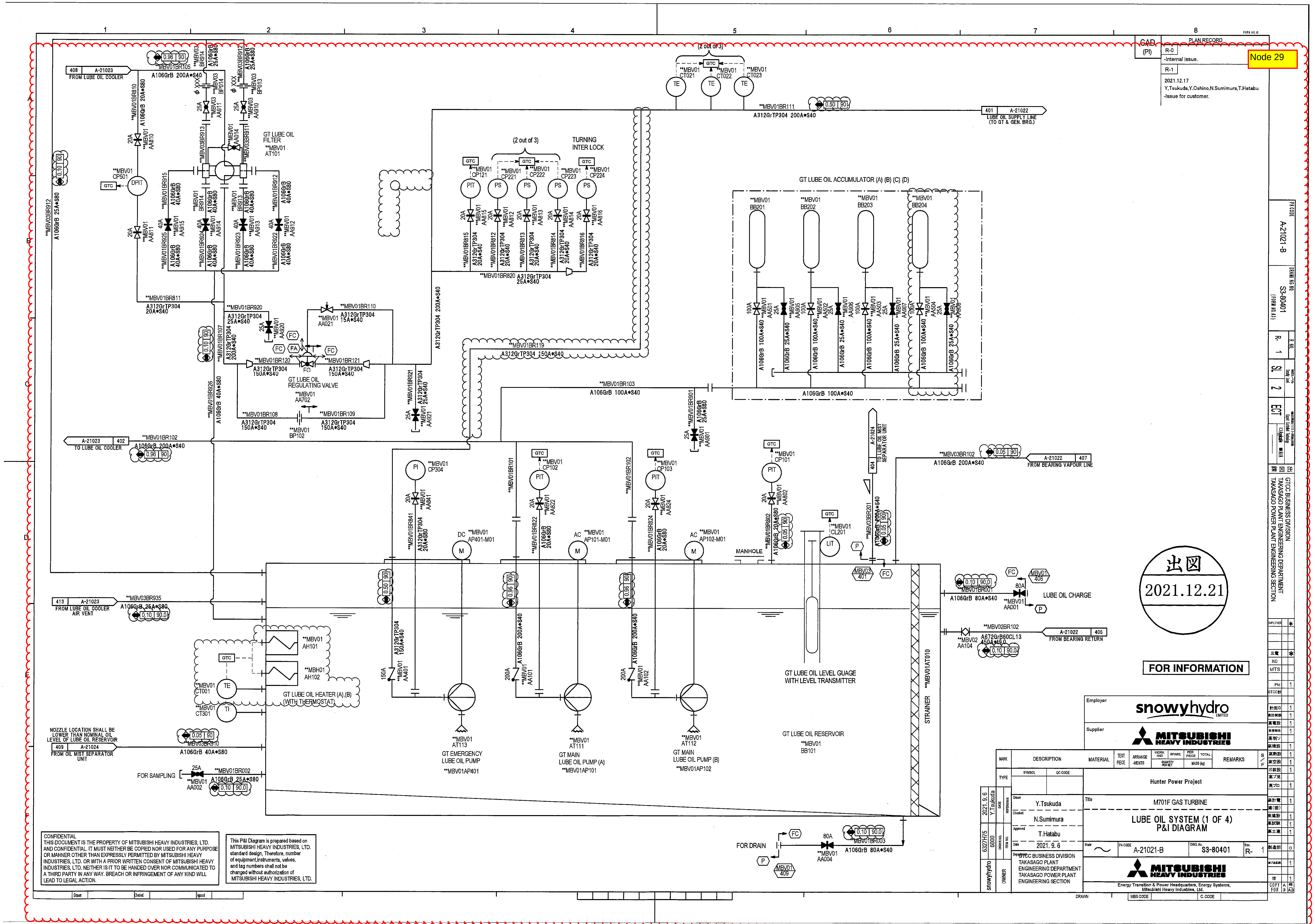
Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 7

Title: M701F GAS TURBINE
AIR & FLUE GAS SYSTEM (5 OF 5)
P&I DIAGRAM

PA CODE: A-21085-B
DWG.No. S3-80431
Rev. R- 1

Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.


Node 29
PLAN RECORD
R-0
-Internal issue.
R-1
2021.12.17
Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu
-Issue for customer.
CAD (PI)
FROM LUBE OIL COOLER
A106GrB 200A*S40
GT LUBE OIL FILTER
**MBV01 AT101
**MBV01 CP501
DPIT
(2 out of 3)
TURNING INTER LOCK
GTC
PIT
PS
**MBV01BR820 A312GrTP304 25A*S40
**MBV01BR111
A312GrTP304 200A*S40
401 A-21022
LUBE OIL SUPPLY LINE (TO GT & GEN. BRG.)
TE
**MBV01 CT021
**MBV01 CT022
**MBV01 CT023
GT LUBE OIL ACCUMULATOR (A) (B) (C) (D)
**MBV01 BB201
**MBV01 BB202
**MBV01 BB203
**MBV01 BB204
A106GrB 100A*S40
**MBV01BR103
**MBV01BR119
A312GrTP304 150A*S40
**MBV01BR811
A312GrTP304 20A*S40
**MBV01BR920
**MBV01BR110
**MBV01BR120
**MBV01BR121
GT LUBE OIL REGULATING VALVE
**MBV01 AA702
**MBV01BR108
**MBV01BR109
**MBV01 BP102
A-21023 402
TO LUBE OIL COOLER
**MBV01BR102
A106GrB 200A*S40
A-21024
TO LUBE OIL MIST SEPARATOR UNIT
**MBV03BR102
A106GrB 200A*S40
A-21022 407
FROM BEARING VAPOUR LINE
**MBV01 CP304
**MBV01 CP102
**MBV01 CP103
**MBV01 CP101
**MBV01 CL201
LIT
MANHOLE
DC **MBV01 AP401-M01
AC **MBV01 AP101-M01
AC **MBV01 AP102-M01
413 A-21023
FROM LUBE OIL COOLER AIR VENT
**MBV03BR935
A106GrB 25A*S80
**MBV01 AH101
**MBH01 AH102
GT LUBE OIL HEATER (A),(B) (WITH THERMOSTAT)
**MBV01 CT001
**MBV01 CT301
LUBE OIL CHARGE
**MBV01 AA001
A106GrB 80A*S40
**MBV02BR102
A672GrB60CL13 450A*S0
**MBV02 AA104
A-21022 405
FROM BEARING RETURN
STRAINER
**MBV01AT010
GT LUBE OIL LEVEL GUAGE WITH LEVEL TRANSMITTER
GT LUBE OIL RESERVOIR
**MBV01 BB101
**MBV01 AT113
GT EMERGENCY LUBE OIL PUMP
**MBV01AP401
**MBV01 AT111
GT MAIN LUBE OIL PUMP (A)
**MBV01AP101
**MBV01 AT112
GT MAIN LUBE OIL PUMP (B)
**MBV01AP102
NOZZLE LOCATION SHALL BE LOWER THAN NOMINAL OIL LEVEL OF LUBE OIL RESERVOIR
409 A-21024
FROM OIL MIST SEPARATOR UNIT
**MBV03BR910
A106GrB 40A*S80
FOR SAMPLING
**MBV01BR002
**MBV01 AA002
A106GrB 25A*S80
FOR DRAIN
**MBV01 AA004
**MBV01BR003
A106GrB 80A*S40
出図
2021.12.21
FOR INFORMATION
Employer
snowy hydro
Supplier
MITSUBISHI HEAVY INDUSTRIES
Hunter Power Project
M701F GAS TURBINE
LUBE OIL SYSTEM (1 OF 4) P&I DIAGRAM
Y.Tsukuda
N.Sumimura
T.Hatabu
2021. 9. 6
A-21021-B
S3-80401
R- 1
GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.
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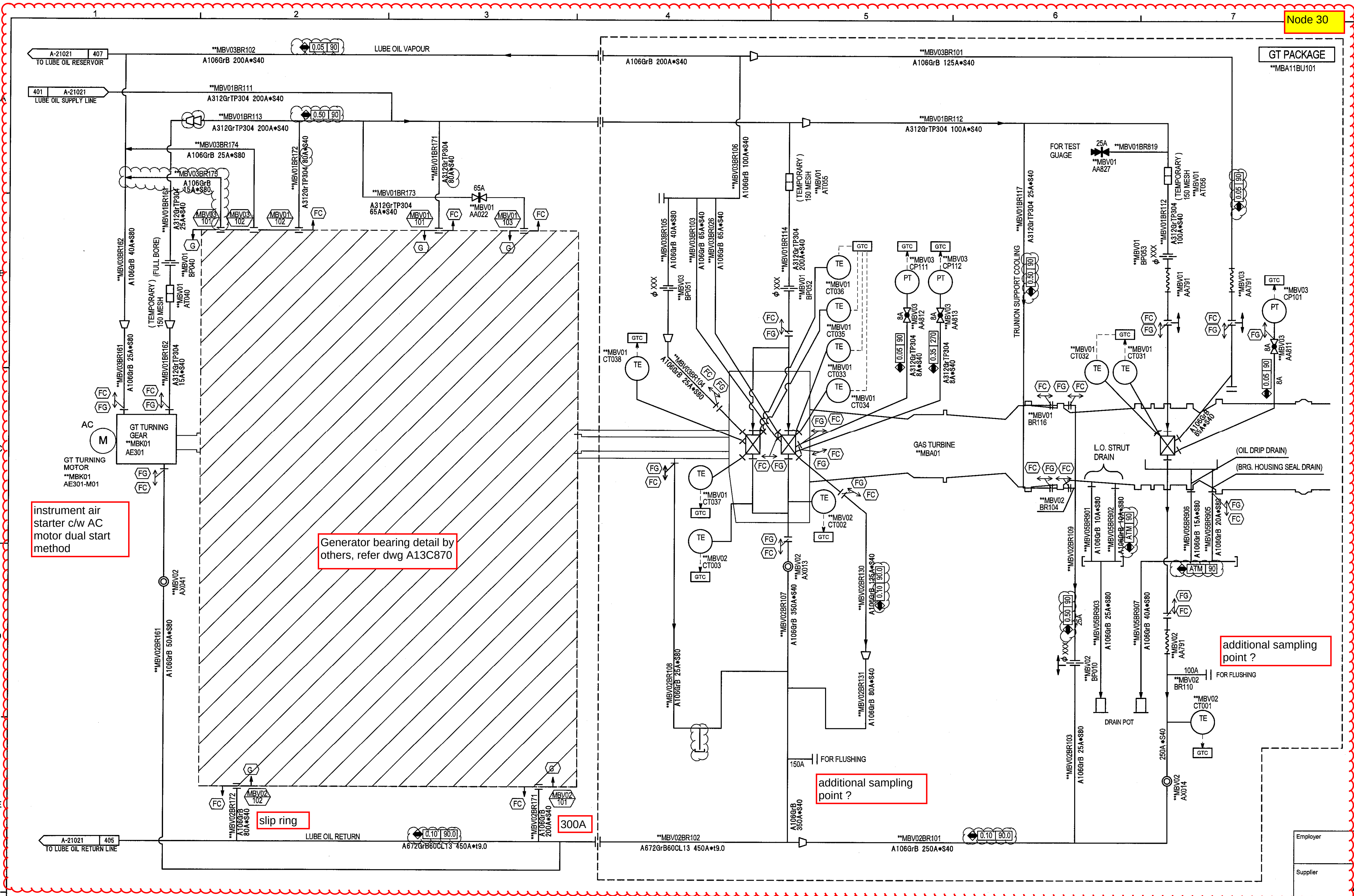


CAD (PI)

PLAN RECORD

R-0
-Internal issue.

R-1
2021.12.16
Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu
-Issue for customer.

出図
2021.12.17

FOR INFORMATION

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

This P&I Diagram is prepared based on MITSUBISHI HEAVY INDUSTRIES, LTD. standard design, Therefore, number of equipment,instruments, valves, and tag numbers shall not be changed without authorization of MITSUBISHI HEAVY INDUSTRIES, LTD.

Hunter Power Project

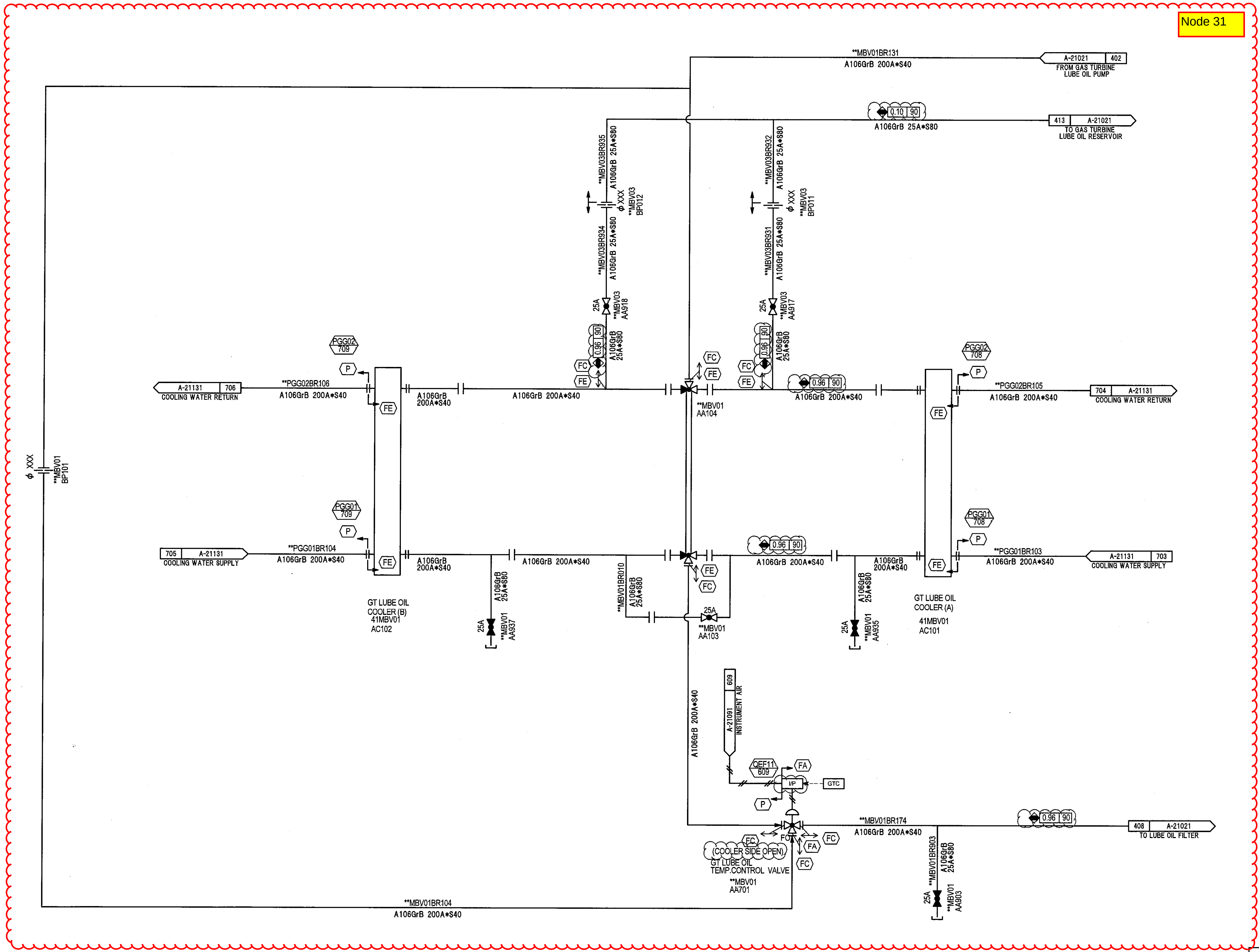
Title: M701F GAS TURBINE
LUBE OIL SYSTEM (2 OF 4)
P&I DIAGRAM

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 6

GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT ENGINEERING SECTION

PA CODE: A-21022-B
DWG. No.: S3-80402
Rev.: R- 1

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.



FOR INFORMATION

CAD (PI)	PLAN RECORD
R-0	-Internal issue.
R-1	2021.12.16 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.

出図 2021.12.17

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

This P&I Diagram is prepared based on Mitsubishi Power standard design, Therefore, number of equipment,instruments, valves, and tag numbers shall not be changed without authorization of Mitsubishi Power.

Hunter Power Project

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 6

Title: M701F GAS TURBINE
LUBE OIL SYSTEM (3 OF 4)
P&I DIAGRAM

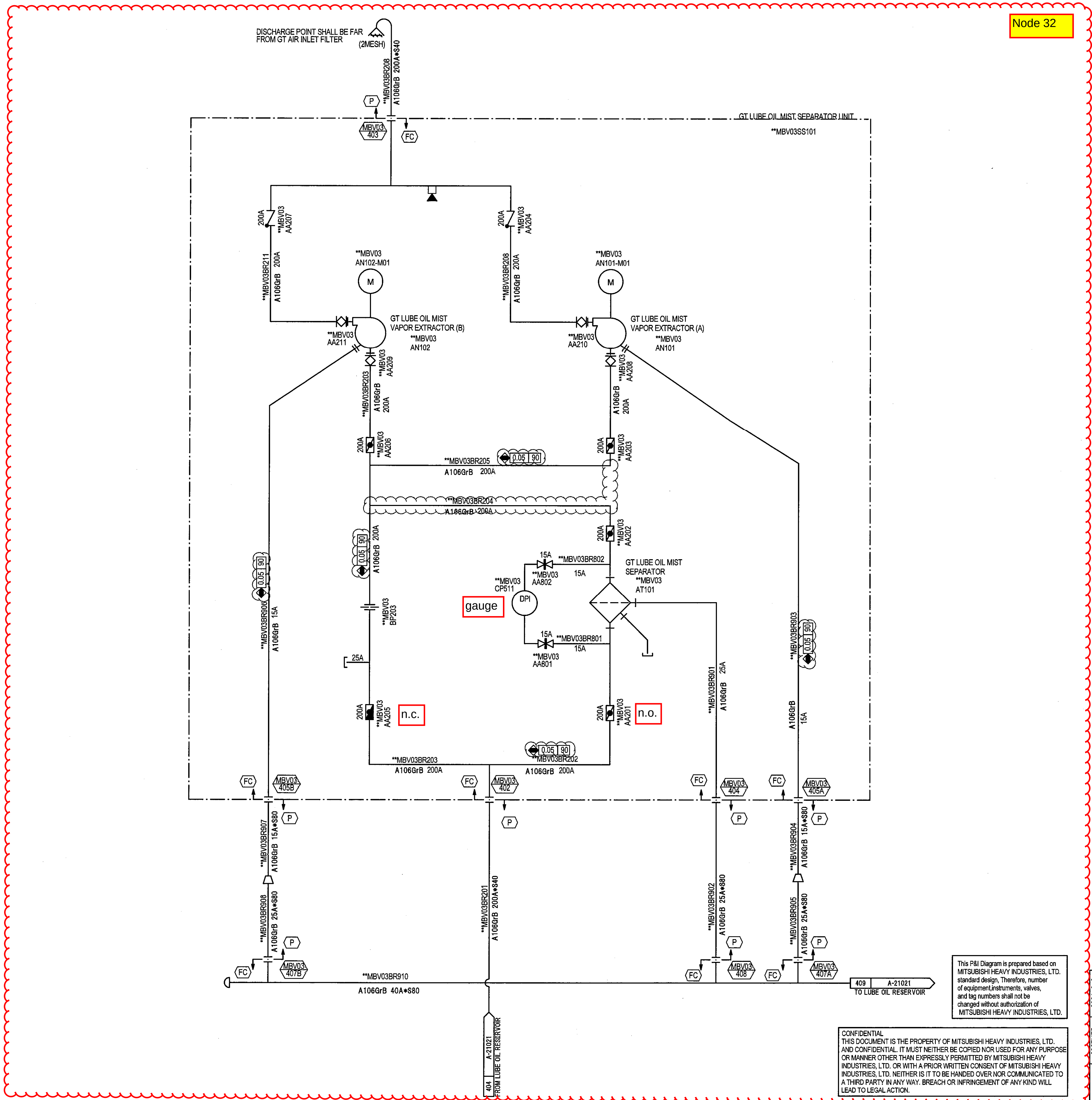
PA CODE: A-21023-B
DWG. No. S3-80403
Rev. R- 1

GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POSER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

FOR INFORMATION

CAD (PI)	PLAN RECORD
	R-0 -Internal issue.
	R-1 2021.12.16 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



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出図 2021.12.17

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 6

Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

Hunter Power Project

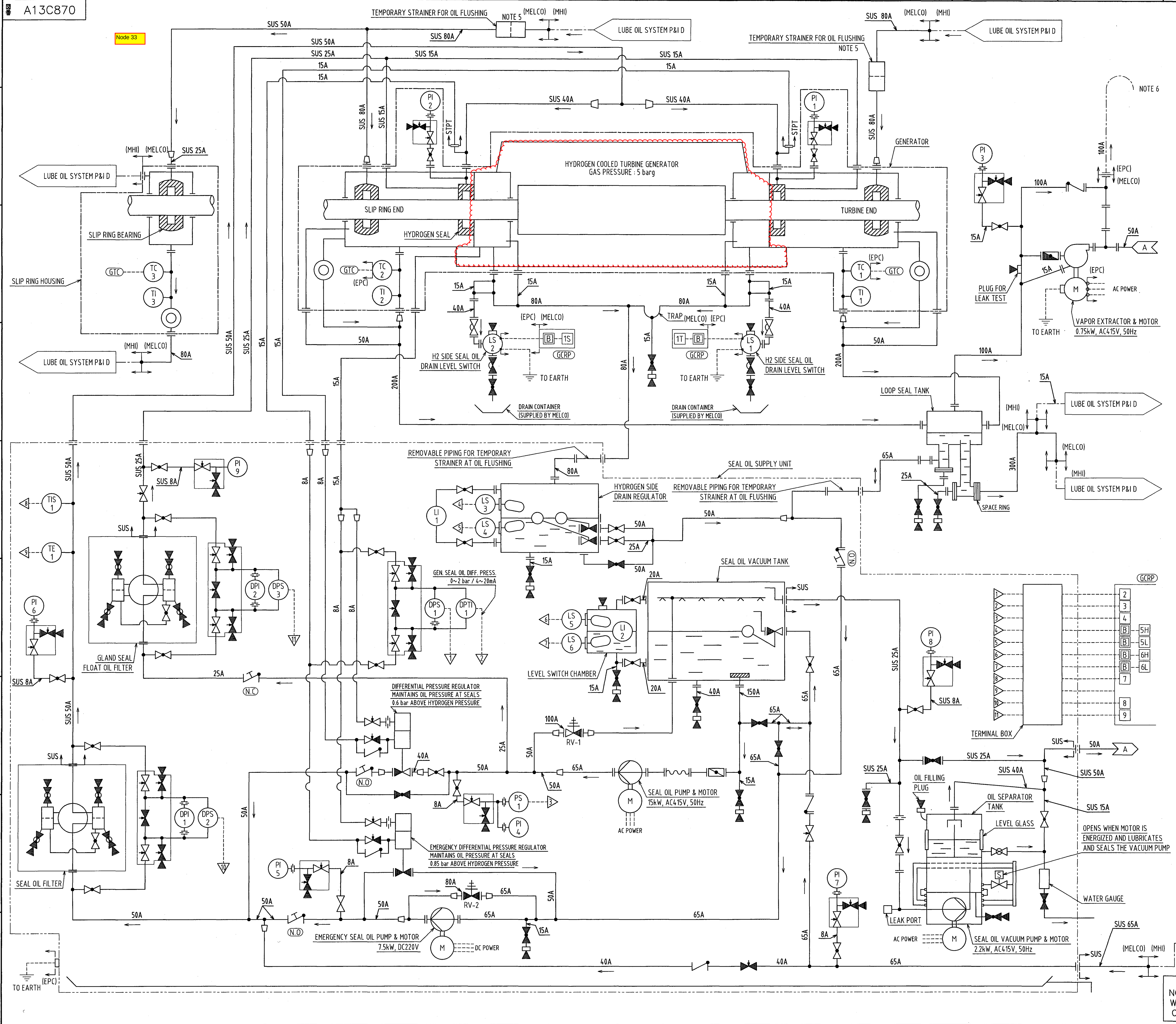
Title: M701F GAS TURBINE

LUBE OIL SYSTEM (4 OF 4) P&I DIAGRAM

PA CODE A-21024-B DWG. No. S3-80404 Rev. R- 1

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

A13C870



LEGEND

- VALVE (NORMALLY OPENED)
- VALVE (NORMALLY CLOSED)
- VALVE (NORMALLY THROTTLED)
- CHECK VALVE WITH LOCK DEVICE (NORMALLY OPENED)
- CHECK VALVE WITH LOCK DEVICE(NORMALLY CLOSED)
- CHECK VALVE
- CHECK VALVE WITH LOCK DEVICE
- BELLOWS VALVE
- RELIEF VALVE
- FIVE WAYS MANIFOLD
- TWO WAYS MANIFOLD
- SOLENOID VALVE
- GLOBE VALVE
- NEEDLE VALVE
- FLOAT VALVE
- BALL VALVE
- STRAINER
- ORIFICE
- ELECTRICAL WIRING
- FLEXIBLE PIPING
- BARRIER
- PLUG
- REDUCER
- GCRP: GENERATOR CONTROL AND PROTECTION RELAY PANEL
- GTC: GAS TURBINE CONTROL SYSTEM
- TEST VALVE
- FLOW SIGHT GLASS
- PI: PRESSURE INDICATOR
- TI: TEMPERATURE INDICATOR
- TIS: TEMPERATURE INDICATOR WITH SWITCH
- LS: LEVEL SWITCH
- LI: LEVEL INDICATOR
- PS: PRESSURE SWITCH
- DPTI: DIFF. PRESSURE TRANSMITTER WITH INDICATOR
- DPS: DIFF. PRESSURE SWITCH
- DPI: DIFF. PRESSURE INDICATOR
- TC: THERMOCOUPLE
- TE: TEMPERATURE ELEMENT

CHARACTER

SYMBOL	No.	RANGE	SET VALUE
PI	1	0~10 barg	-
	2	0~10 barg	-
	3	0~-25 mbarg	-
	4	-1~0~15 barg	-
	5	0~15 barg	-
	6	0~10 barg	-
	7	0~6 barg	-
	8	0~-1 barg	-
	9	0~15 barg	-
TI	1	0~100 ℃	-
	2	0~100 ℃	-
	3	0~100 ℃	-

SYMBOL	No.	RANGE	SET VALUE
TIS	1	0~100 ℃	60 ℃
LI	1	-120mm~+120mm	-
	2	-120mm~+120mm	-
DPTI	1	0~2 bar / 4~20 mA	-
TC	1	TYPE-E	-
	2	TYPE-E	-
	3	TYPE-E	-
TE	1	0~100℃	Pt100Ω at 0℃
DPI	1	0~1 bar	-
	2	0~1 bar	-

SYMBOL	No.	SET VALUE
LS	1	450 cm^3
	2	450 cm^3
	3	NL+100mm
	4	NL-100mm
	5	NL+100mm
	6	NL-100mm
DPS	1	0.45 bar (NOTE7)
	2	0.5 bar
	3	0.5 bar
PS	1	8 barg
(relief valve)	RV-1	9.5 barg
	RV-2	11.5 barg

ALARMS

1T	GEN. DRAIN OIL LEVEL (TURB. SIDE)	HIGH (≥ 450 cm^3)
1S	GEN. DRAIN OIL LEVEL (SLIP. SIDE)	HIGH (≥ 450 cm^3)
2	GEN. SEAL OIL DIFF. PRESS. -EMERGENCY SEAL OIL PUMP RUNNING -TURNING STARTING INTERLOCK	LOW (≤ 0.45 bar)
3	GEN. SEAL OIL DIFF. PRESS.	HIGH (≥ 1.5 bar MORE THAN 5 SECONDS)
4	GEN. SEAL OIL PUMP OUTLET PRESS. -EMERGENCY SEAL OIL PUMP RUNNING	LOW (≤ 8 barg)
5H	GEN. DRAIN REGULATOR OIL LEVEL	HIGH (≥ NL+100 mm)
5L	GEN. DRAIN REGULATOR OIL LEVEL	LOW (≤ NL-100 mm)
6H	GEN. SEAL OIL VACUUM TANK OIL LEVEL -SEAL OIL VACUUM PUMP STOP INTER LOCK	HIGH (≥ NL+100 mm)
6L	GEN. SEAL OIL VACUUM TANK OIL LEVEL	LOW (≤ NL-100 mm)
7	GEN. SEAL OIL SUPPLY TEMP.	HIGH (≥ 60℃)
8	GEN. SEAL OIL FILTER DIFF.PRESS.	HIGH (≥ 0.5 bar)
9	GEN. GLAND SEAL FLOAT OIL FILTER DIFF.PRESS.	HIGH (≥ 0.5 bar)

FOR APPROVAL

ENERGY SYSTEMS CENTER
DEC. 17. 2021
MITSUBISHI ELECTRIC CORP. JAPAN

NOTES

1. ALL PIPING MATERIAL SUPPLIED BY MELCO (IN THIS DRAWING) IS STPT EXCEPT OTHERWISE NOTED. (PIPING INSIDE EQUIPMENTS WILL BE SELECTED IN ACCORDANCE WITH MANUFACTURER'S STANDARD.)
   - ·STPT···STPT370-S CARBON STEEL PIPES FOR HIGH TEMPERATURE SERVICE (SEAMLESS) CONFORMING TO JAPANESE INDUSTRIAL STANDARD JIS G3456. SCH.NO IS 40 EXCEPT OTHERWISE NOTED.
   - ·SUS····SUS304TP-S STAINLESS STEEL PIPES (SEAMLESS) CONFORMING TO JAPANESE INDUSTRIAL STANDARD JIS G3459. SCH.NO IS 40 EXCEPT OTHERWISE NOTED.
2. TERMINAL POINTS BETWEEN EPC AND MELCO ARE BASED ON ANSI STANDARD. TERMINAL POINTS BETWEEN MHI AND MELCO ARE BASED ON ANSI STANDARD.
3. SCOPE OF SUPPLY SHOWN IN THIS DRAWING IS AS FOLLOWS.
   (EPC) | (MELCO): SUPPLIED BY EPC / SUPPLIED BY MELCO
   (MHI) | (MELCO): SUPPLIED BY MHI / SUPPLIED BY MELCO
4. ALL PIPES SHALL BE LAID WITH GRADIENT OF MORE THAN 1/50 TO PREVENT ACCUMULATION OF OIL OR MAKING AIR POCKET IN THE PIPES.
5. THE SCREEN FOR GENERATOR MAIN BEARING TEMPORARY OIL STRAINERS ARE USED AT FLUSHING AND SHALL BE TAKEN AWAY IN GENERATOR RUNNING. STRAINER MATERIAL SHALL BE STAINLESS STEEL.
6. ·VENT DIRECTION OF GENERATOR LOOP SEAL TANK SHALL BE TOWARD TO THE SAFE AREA SUCH AS NO PASSAGEWAY, NO ELECTRICAL EQUIPMENT, AND SO ON.
   ·VENT POINT OF GENERATOR LOOP SEAL TANK SHALL BE MORE THAN 2m ABOVE ROOF.
   ·VENT POINT OF GENERATOR LOOP SEAL TANK SHALL BE AS FAR AS POSSIBLE FROM AIR INTAKE OF GAS TURBINE.
7. DIFF. PRESS. BETWEEN SEAL OIL AND GAS AT SEAL RING 0.35bar + DIFF. ELEVATION HEAD BETWEEN SEAL OIL SIDE AND GAS SIDE 0.01MPa = 0.45bar

Employer: snowyhydro LIMITED
Supplier: MITSUBISHI ELECTRIC
Employer's DWG Number: HPP-MEL-MEC-OS-GEN-DRG-0001

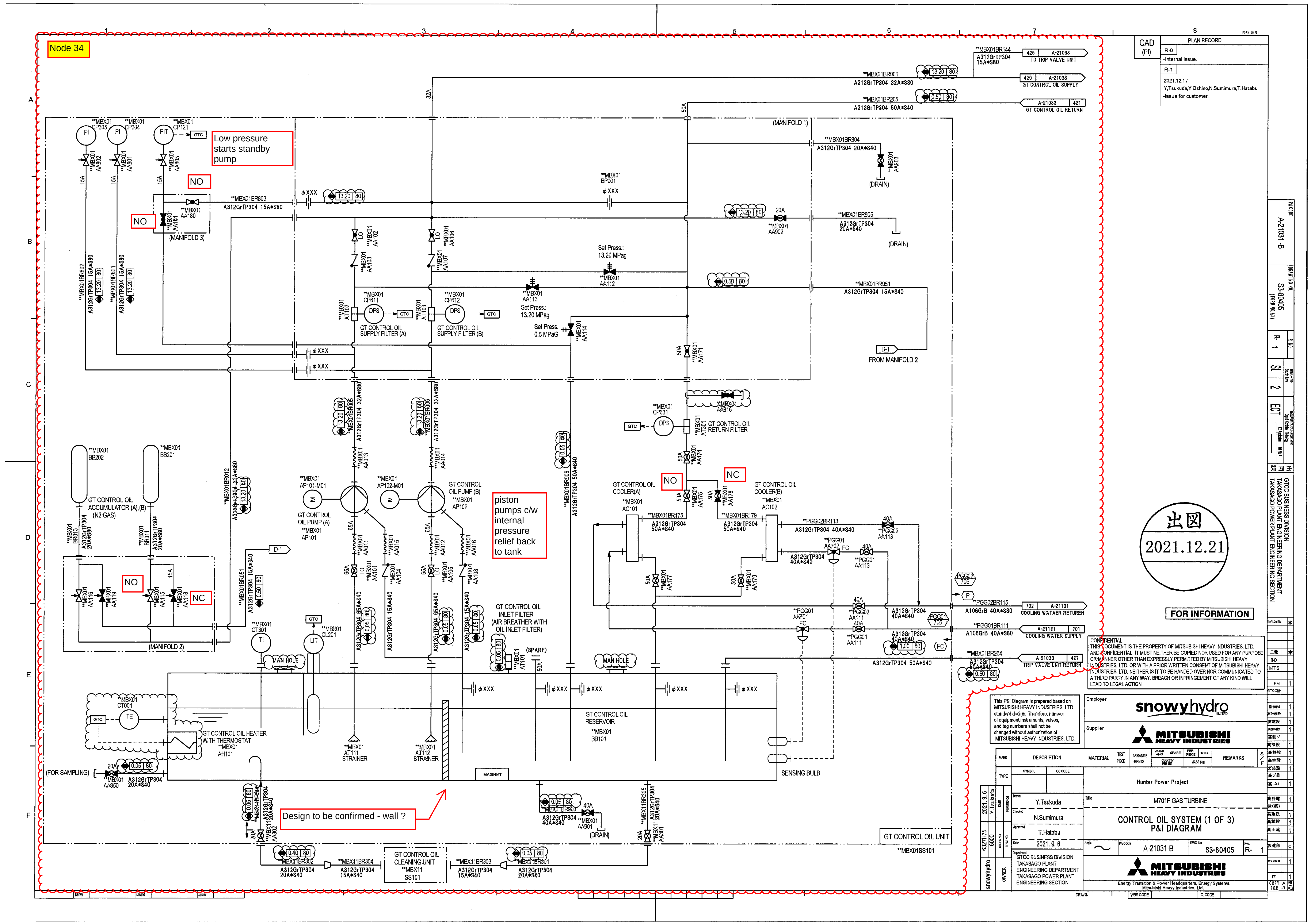
CHANGE: CAY6-03

MITSUBISHI ELECTRIC CORPORATION — Hunter Power Project

DIM.IN mm	DATE	2021-12-10
SCALE: NTS	DRAWN	R.Goto
	CHECKED	T.Ewra
	DESIGNED	
APPROVED		T. Osada

TITLE: GENERATOR SEAL OIL DIAGRAM FOR GT

DWG.NO: A13C870



Node 34
Low pressure starts standby pump
NO
NO
NO
NC
NO
NC
piston pumps c/w internal pressure relief back to tank
Design to be confirmed - wall ?
(MANIFOLD 1)
(MANIFOLD 2)
(MANIFOLD 3)
TO TRIP VALVE UNIT
GT CONTROL OIL SUPPLY
GT CONTROL OIL RETURN
FROM MANIFOLD 2
Set Press.: 13.20 MPag
Set Press.: 0.5 MPaG
GT CONTROL OIL SUPPLY FILTER (A)
GT CONTROL OIL SUPPLY FILTER (B)
GT CONTROL OIL RETURN FILTER
GT CONTROL OIL ACCUMULATOR (A),(B) (N2 GAS)
GT CONTROL OIL PUMP (A)
GT CONTROL OIL PUMP (B)
GT CONTROL OIL COOLER(A)
GT CONTROL OIL COOLER(B)
COOLING WATAER RETURN
COOLING WATER SUPPLY
TRIP VALVE UNIT RETURN
GT CONTROL OIL INLET FILTER (AIR BREATHER WITH OIL INLET FILTER)
GT CONTROL OIL RESERVOIR **MBX01 BB101
GT CONTROL OIL HEATER WITH THERMOSTAT **MBX01 AH101
**MBX01 AT111 STRAINER
**MBX01 AT112 STRAINER
MAN HOLE
MAGNET
SENSING BULB
(FOR SAMPLING)
(DRAIN)
(SPARE)
GT CONTROL OIL CLEANING UNIT **MBX11 SS101
GT CONTROL OIL UNIT **MBX01SS101
CAD (PI)
PLAN RECORD
R-0 -Internal issue.
R-1 2021.12.17 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.
出図 2021.12.21
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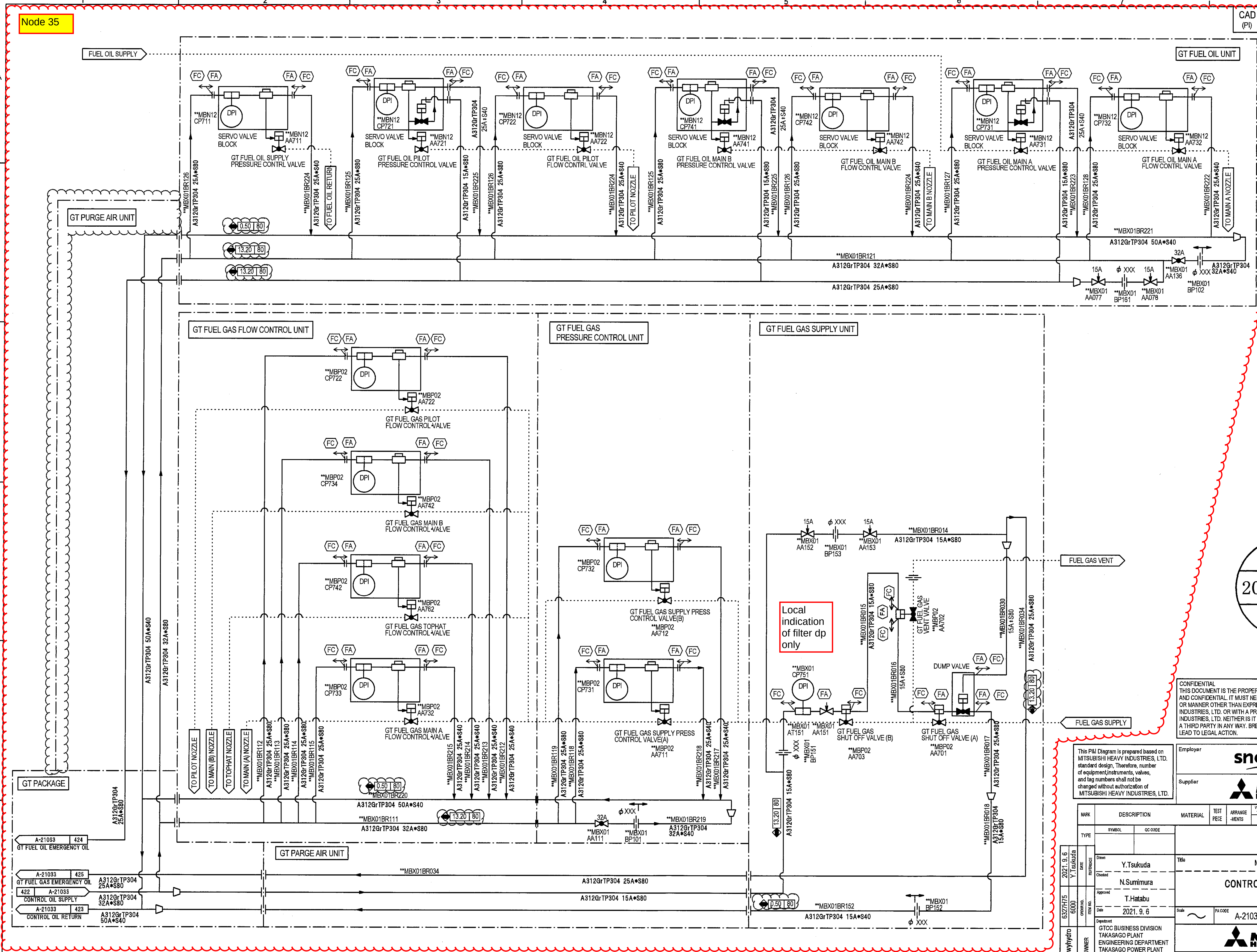
Employer snowyhydro
Supplier MITSUBISHI HEAVY INDUSTRIES
Hunter Power Project
M701F GAS TURBINE
CONTROL OIL SYSTEM (1 OF 3) P&I DIAGRAM
Drawn Y.Tsukuda
Checked N.Sumimura
Approved T.Hatabu
Date 2021. 9. 6
A-21031-B
S3-80405
R- 1
GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

Node 35



CAD (PI)

PLAN RECORD

R-0 -Internal issue.

R-1 2021.12.17 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer

出図 2021.12.21

FOR INFORMATION

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Employer: snowy hydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 6

Title: M701F GAS TURBINE

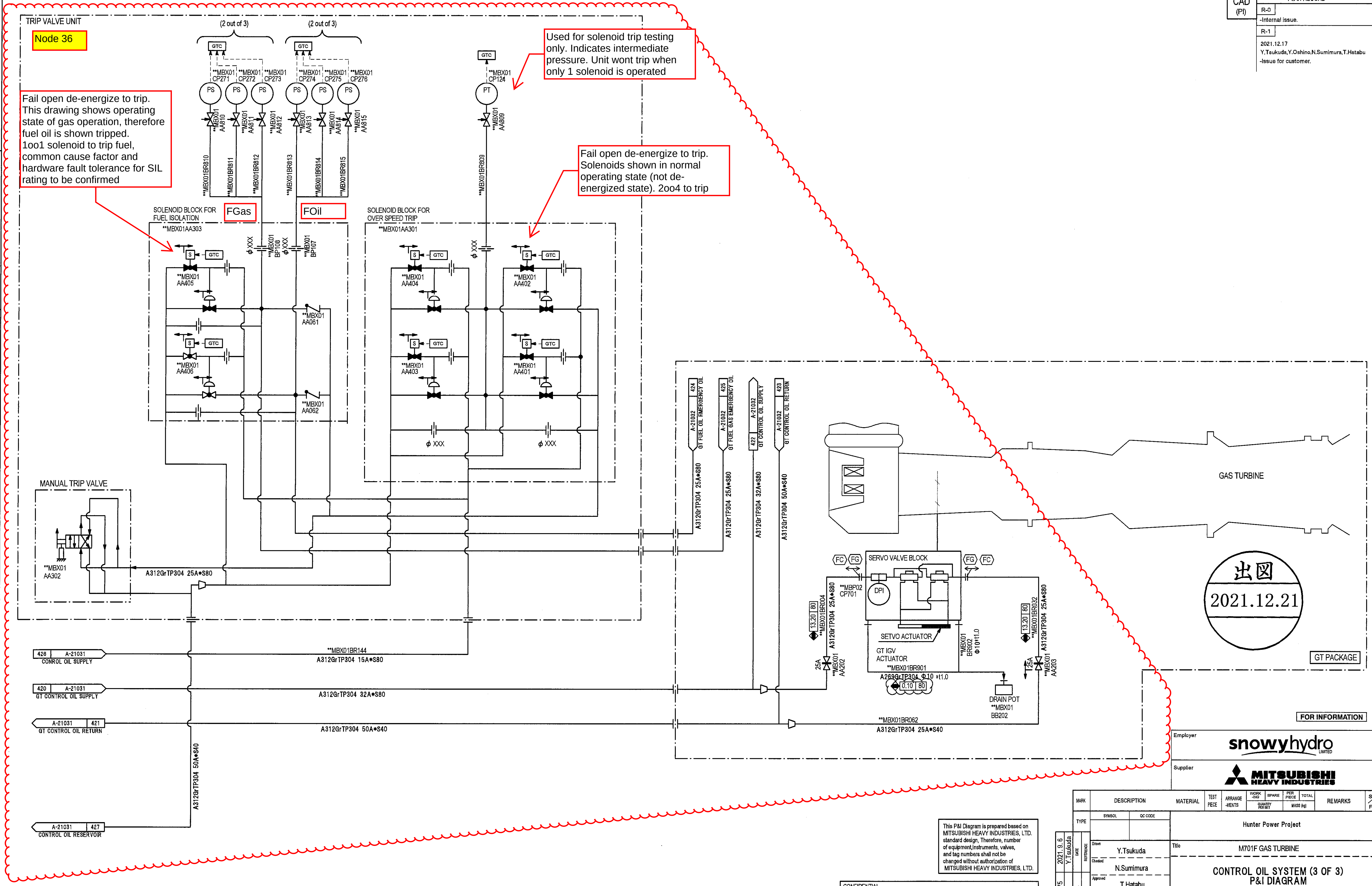
CONTROL OIL SYSTEM (2 OF 3) P&I DIAGRAM

PA CODE A-21032-B

DWG. No. S3-80406 Rev. R- 1

GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT ENGINEERING SECTION

Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.



CAD (PI)

PLAN RECORD

R-0 -Internal issue.

R-1 2021.12.17 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.

FOR INFORMATION

Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

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Hunter Power Project

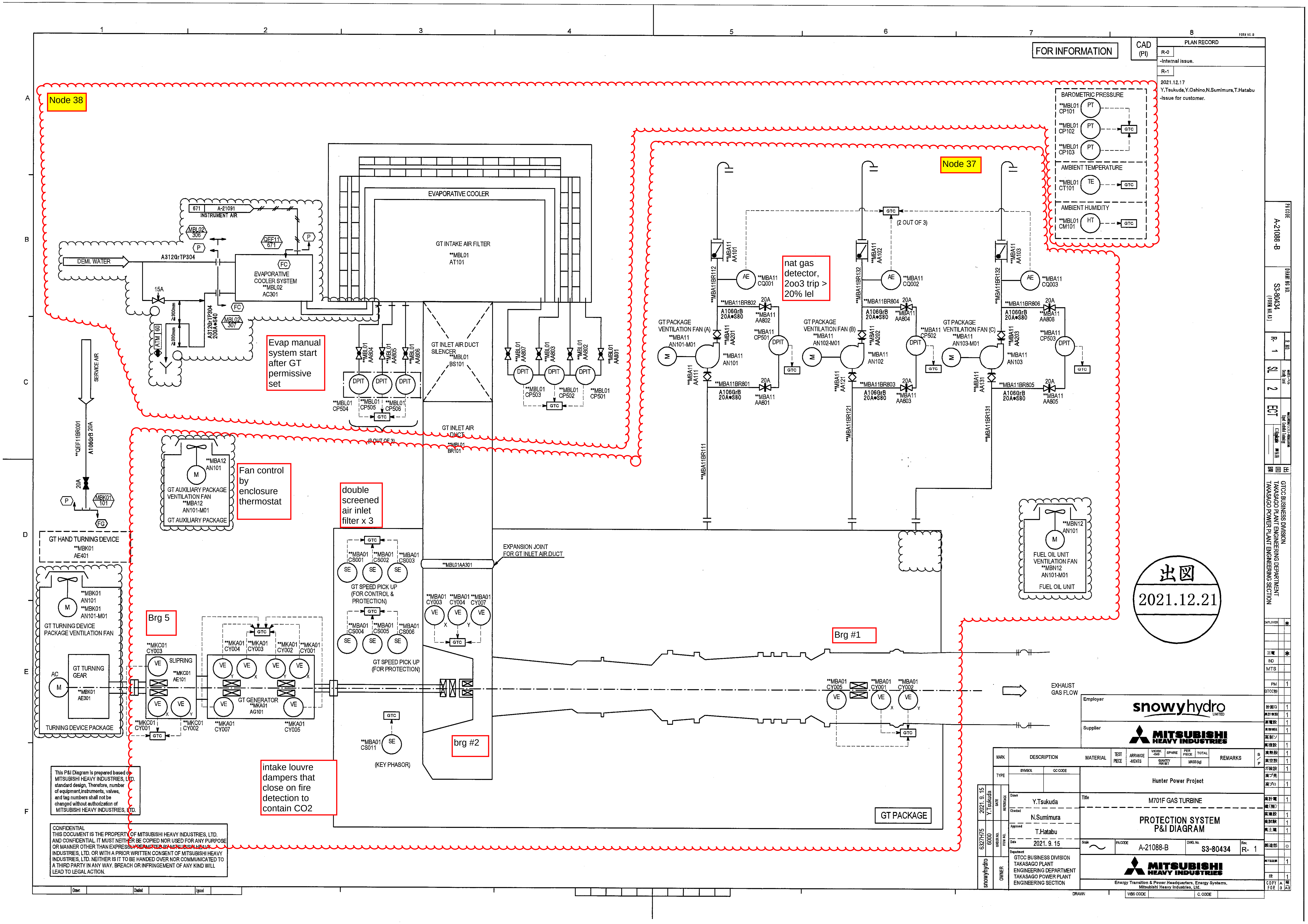
Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 6

Title: M701F GAS TURBINE
CONTROL OIL SYSTEM (3 OF 3) P&I DIAGRAM

PA CODE: A-21033-B
DWG. No.: S3-80407
Rev.: R- 1

GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.



FOR INFORMATION
CAD (PI)
PLAN RECORD
R-0
-Internal issue.
R-1
2021.12.17
Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu
-Issue for customer.
Node 38
Node 37
EVAPORATIVE COOLER
GT INTAKE AIR FILTER
**MBL01 AT101
INSTRUMENT AIR
DEMI. WATER
EVAPORATIVE COOLER SYSTEM
**MBL02 AC301
Evap manual system start after GT permissive set
GT INLET AIR DUCT SILENCER
**MBL01 BS101
GT INLET AIR DUCT
(2 OUT OF 3)
nat gas detector, 2oo3 trip > 20% lel
GT PACKAGE VENTILATION FAN (A)
GT PACKAGE VENTILATION FAN (B)
GT PACKAGE VENTILATION FAN (C)
BAROMETRIC PRESSURE
AMBIENT TEMPERATURE
AMBIENT HUMIDITY
SERVICE AIR
Fan control by enclosure thermostat
GT AUXILIARY PACKAGE VENTILATION FAN
GT AUXILIARY PACKAGE
double screened air inlet filter x 3
GT HAND TURNING DEVICE
**MBK01 AE401
GT TURNING DEVICE PACKAGE VENTILATION FAN
GT TURNING GEAR
TURNING DEVICE PACKAGE
Brg 5
SLIPRING
GT GENERATOR
GT SPEED PICK UP (FOR CONTROL & PROTECTION)
GT SPEED PICK UP (FOR PROTECTION)
EXPANSION JOINT FOR GT INLET AIR DUCT
(KEY PHASOR)
brg #2
Brg #1
intake louvre dampers that close on fire detection to contain CO2
FUEL OIL UNIT VENTILATION FAN
FUEL OIL UNIT
EXHAUST GAS FLOW
GT PACKAGE
出図
2021.12.21
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Employer
snowyhydro
Supplier
MITSUBISHI HEAVY INDUSTRIES
Hunter Power Project
M701F GAS TURBINE
PROTECTION SYSTEM P&I DIAGRAM
Drawn Y.Tsukuda
Checked N.Sumimura
Approved T.Hatabu
Date 2021. 9. 15
A-21088-B
S3-80434
R- 1
GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

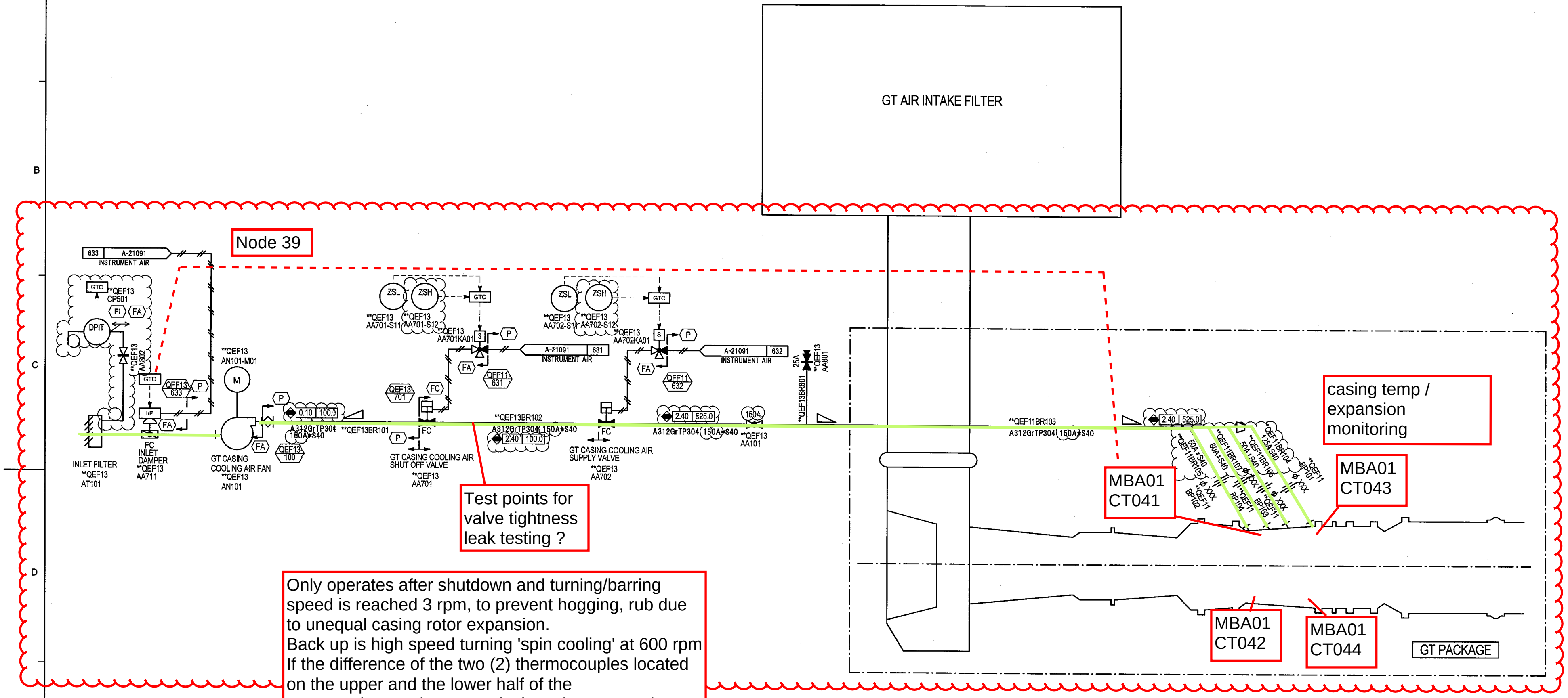
FOR INFORMATION

CAD (PI)

PLAN RECORD

R-0 -Internal issue.

R-1 2021.12.14 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



Only operates after shutdown and turning/barring speed is reached 3 rpm, to prevent hogging, rub due to unequal casing rotor expansion.
Back up is high speed turning 'spin cooling' at 600 rpm
If the difference of the two (2) thermocouples located on the upper and the lower half of the same casing section exceeds the reference setting, an alarm will be generated. This alarm does not allow GTC to initiate the normal starting sequence.

出図 2021.12.15

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Employer: snowyhydro LIMITED

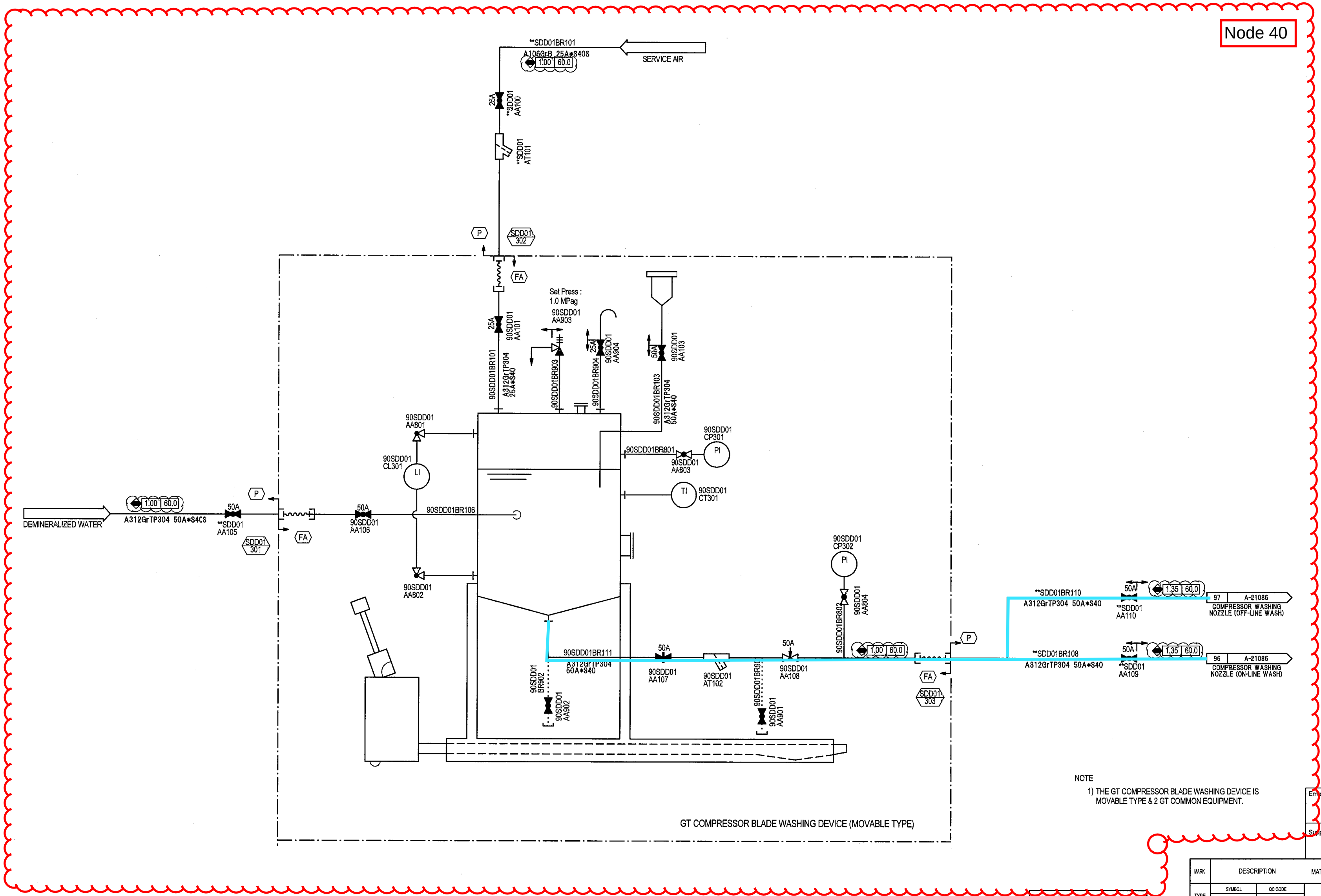
Supplier: MITSUBISHI HEAVY INDUSTRIES

Project	Hunter Power Project
Title	M701F GAS TURBINE — GT CASING COOLING SYSTEM P&I DIAGRAM
Drawn	Y.Tsukuda
Checked	N.Sumimura
Approved	T.Hatabu
Date	2021. 9. 15
Order No. / Item No.	6327H75 / 6000
Owner	snowyhydro
Department	GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION
PA CODE	A-21090-B
DWG. No.	S3-80435
Rev.	R- 1

Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.

FOR INFORMATION

CAD (PI)	PLAN RECORD
	R-0 -Internal issue.
	R-1 2021.12.15 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.



出図 2021.12.17

NOTE

1) THE GT COMPRESSOR BLADE WASHING DEVICE IS MOVABLE TYPE & 2 GT COMMON EQUIPMENT.

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Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

Hunter Power Project

Title: M701F GAS TURBINE

GT WASHING & DRAIN SYSTEM (2 OF 2) P&I DIAGRAM

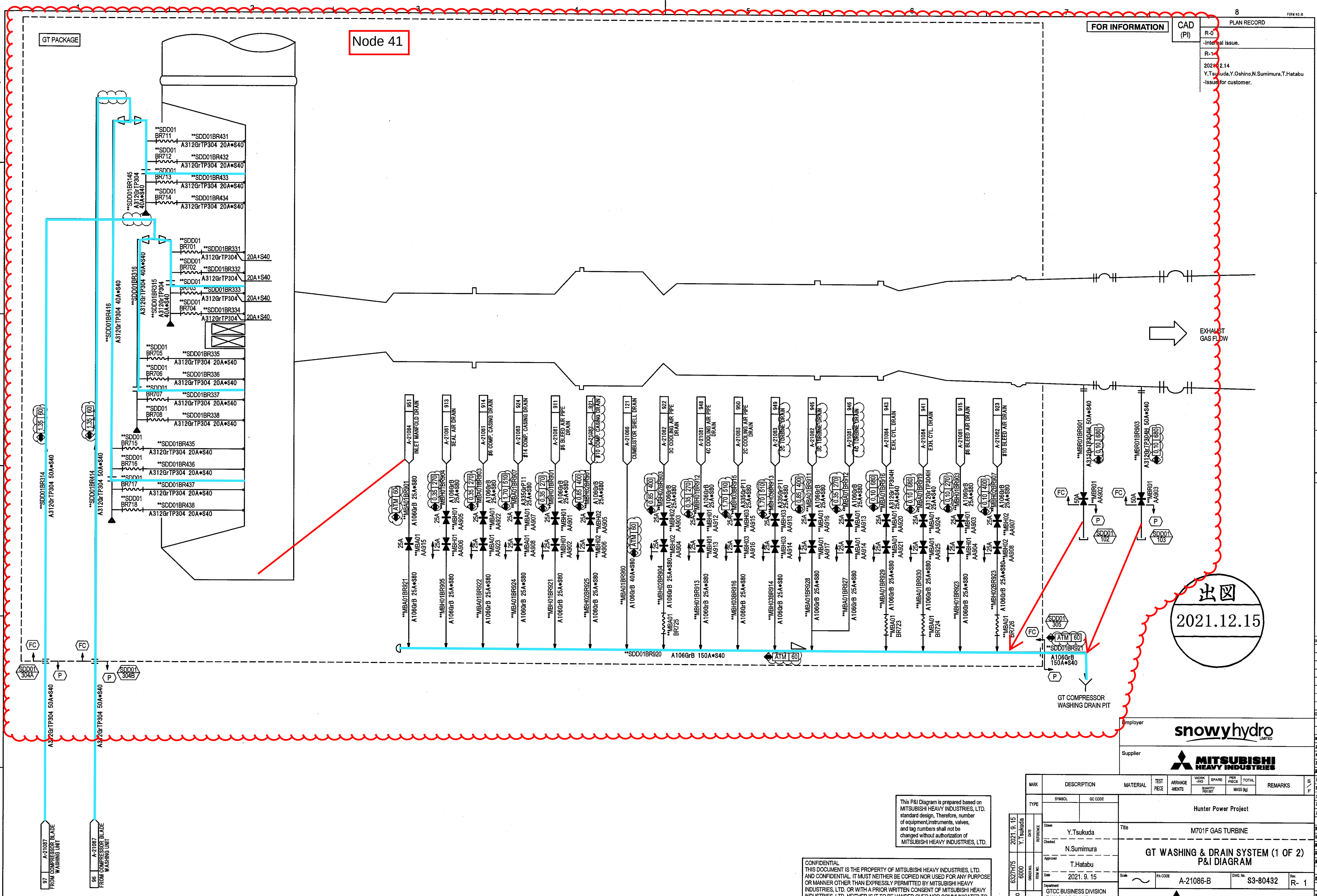
Drawn	Checked	Approved	Date
Y.Tsukuda	N.Sumimura	T.Hatabu	2021. 9. 15

Department: GTCC BUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

PA CODE: A-21087-B DWG. No. S3-80433 Rev. R- 1

MITSUBISHI HEAVY INDUSTRIES

Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.



Employer: snowyhydro LIMITED

Supplier: MITSUBISHI HEAVY INDUSTRIES

This P&ID Diagram is prepared based on MITSUBISHI HEAVY INDUSTRIES, LTD. standard design, Therefore, number of equipment,instruments, valves, and tag numbers shall not be changed without authorization of MITSUBISHI HEAVY INDUSTRIES, LTD.

MARK	DESCRIPTION	MATERIAL	TEST PIECE	ARRANGE-MENTS	WORK-ING	SPARE	PER PIECE	TOTAL	REMARKS

Hunter Power Project

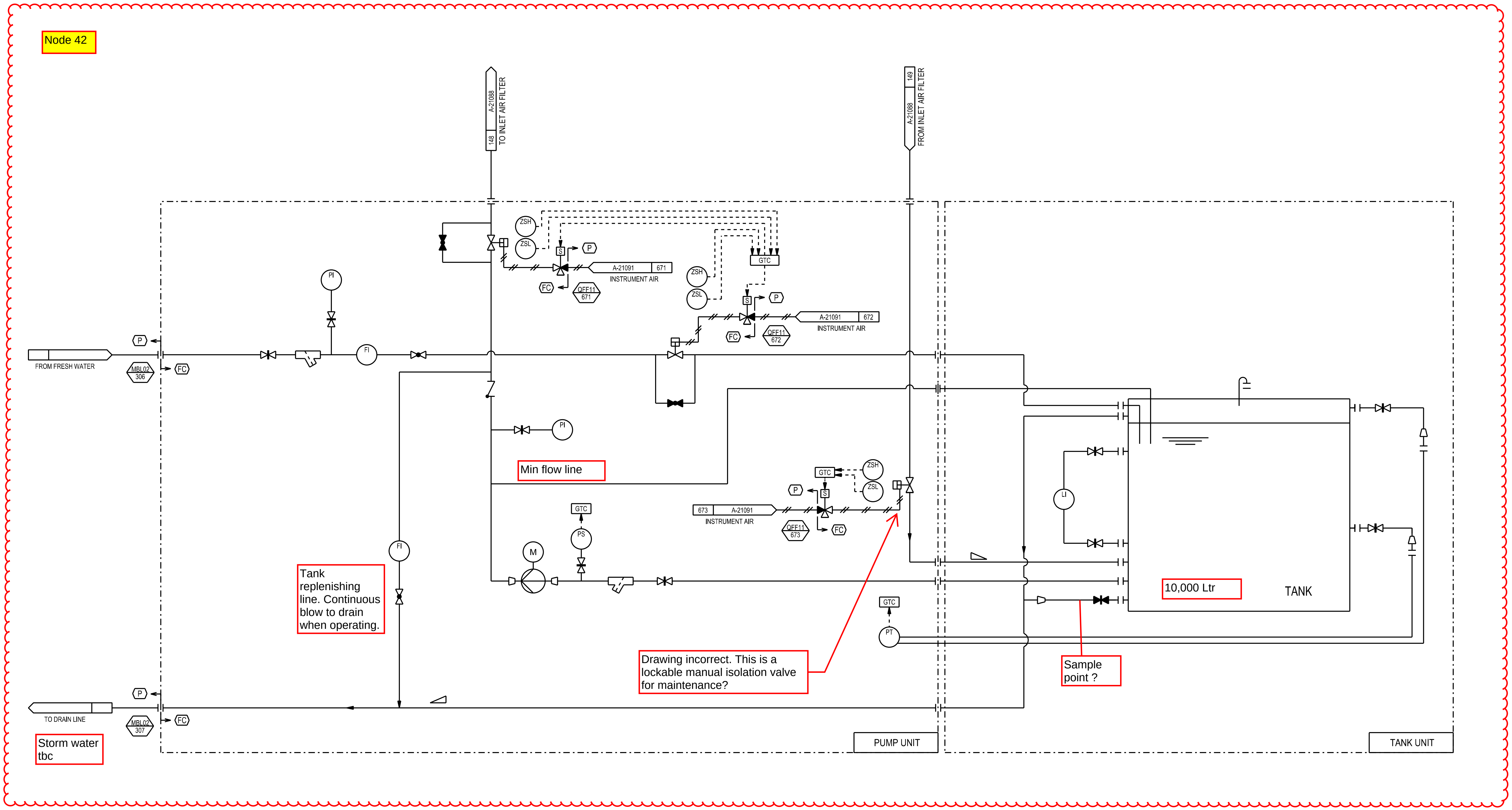
Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 15

Title: M701F GAS TURBINE
GT WASHING & DRAIN SYSTEM (1 OF 2) P&I DIAGRAM

PA CODE: A-21086-B
DWG. No.: S3-80432
Rev.: R- 1

GTCC BUSINESS DIVISION
TAKASAGO PLANT ENGINEERING DEPARTMENT
TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI HEAVY INDUSTRIES
Energy Transition & Power Headquarters, Energy Systems, Mitsubishi Heavy Industries, Ltd.



CAD (MS)

PLAN RECORD

PRELIMINARY

SOME MODIFICATION WILL BE CONSIDERED ON DETAILED DESIGN STAGE.

MARK	DESCRIPTION	MATERIAL	TEST PIECE	ARRANGE-MENTS	WORK-ING / SPARE (QUANTITY PER SET)	PER PIECE / TOTAL (MASS (kg))	REMARKS	S/F

Snowy Hydro / Kurri Kurri Gas-fired Power Station

Title: M701F GAS TURBINE
P&I DIAGRAM
EVAPORATIVE COOLER SYSTEM
(PUMP/TANK UNIT)

Scale	PA CODE	DWG. No.	Rev.
~	C-50011	M4-H9043-41	R- 0

ORDER NO. 825G184 ITEM NO. 6000

Department: POWER SYSTEMS PROJECT ENGINEERING DEPARTMENT GAS TURBINE APPLICATION ENGINEERING SECTION

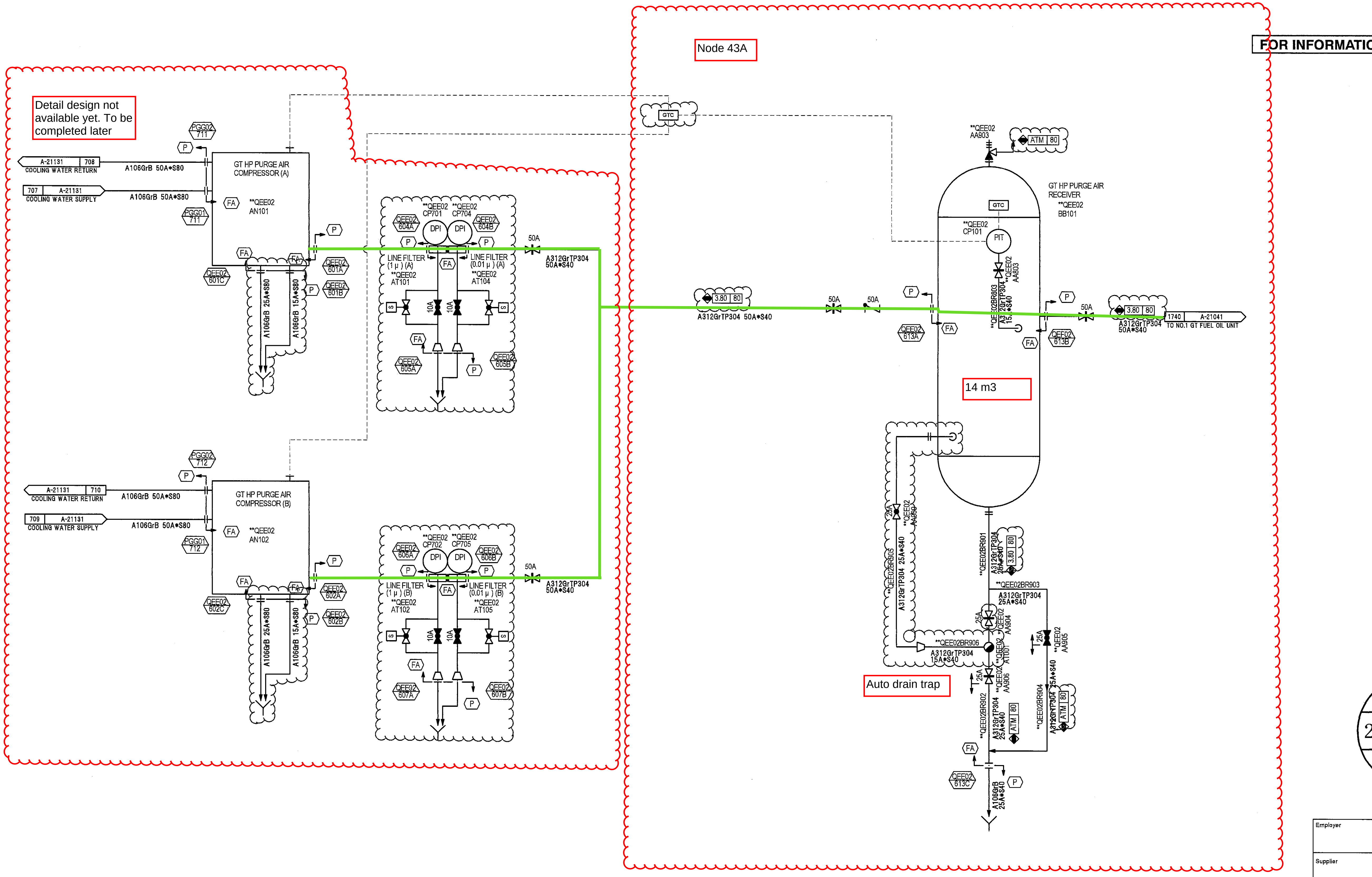
MITSUBISHI POWER

Project Management Division, Engineering Headquarters, Mitsubishi Power, Ltd.

DRAWN 2020/02/16

C. CODE

COPY FOR



CAD (PI)	PLAN RECORD
	R-0 -Internal issue.
	R-1 2021.12.9 Y.Tsukuda,Y.Oshino,N.Sumimura,T.Hatabu -Issue for customer.

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Employer: snowyhydro LIMITED
Supplier: MITSUBISHI POWER

Hunter Power Project

Title: M701F GAS TURBINE
PURGE AIR SYSTEM P&I DIAGRAM

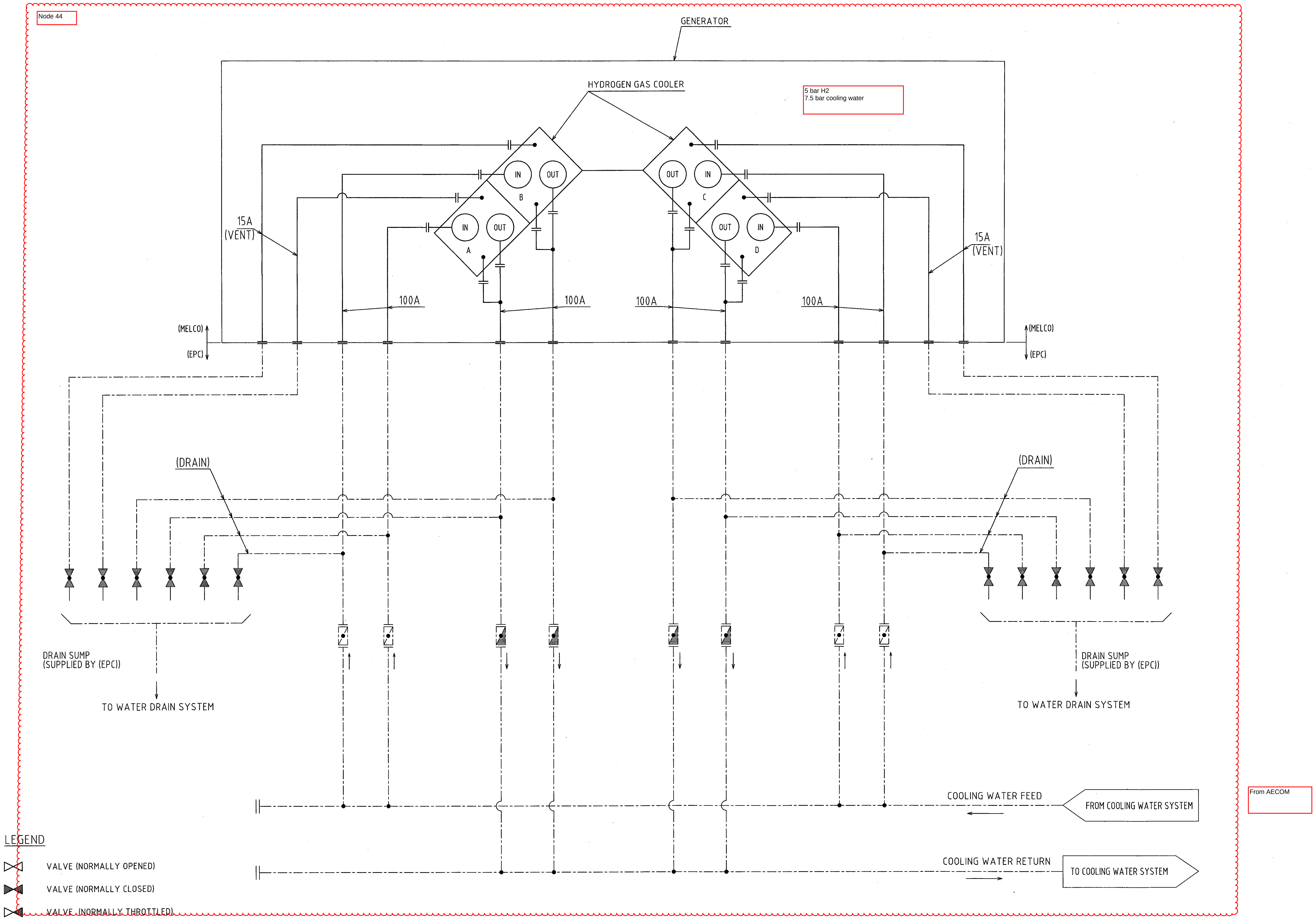
Drawn: Y.Tsukuda
Checked: N.Sumimura
Approved: T.Hatabu
Date: 2021. 9. 10

PA CODE: A-21100-B
DWG No.: S3-80414
Rev.: R- 1

Department: GTCBUSINESS DIVISION TAKASAGO PLANT ENGINEERING DEPARTMENT TAKASAGO POWER PLANT ENGINEERING SECTION

MITSUBISHI POWER
Project Management Division, Engineering Headquarters, Mitsubishi Power, Ltd.

A13C942



LEGEND

- VALVE (NORMALLY OPENED)
- VALVE (NORMALLY CLOSED)
- VALVE (NORMALLY THROTTLED)
- BUTTERFLY VALVE (NORMALLY OPENED)
- BUTTERFLY VALVE (NORMALLY THROTTLED)
- GLOBE VALVE

NOTES

1. ALL PIPING MATERIAL SUPPLIED BY MELCO (IN THIS DRAWING) IS STPT EXCEPT OTHERWISE NOTED.
   ・STPT・・・STPT370-S CARBON STEEL PIPES FOR HIGH TEMPERATURE SERVICE (SEAMLESS)
   CONFORMING TO JAPANESE INDUSTRIAL STANDARD JIS G3456.
   SCH.NO IS 40 EXCEPT OTHERWISE NOTED.
   PIPING INSIDE EQUIPMENTS WILL BE SELECTED IN ACCORDANCE WITH MANUFACTURER'S STANDARD.
2. TERMINAL POINTS BETWEEN OTHERS AND MELCO ARE BASED ON ANSI STANDARD.
3. SCOPE OF SUPPLY SHOWN IN THIS DRAWING IS AS FOLLOWS.

(EPC) | (MELCO)

SUPPLIED BY EPC　SUPPLIED BY MELCO

FOR APPROVAL

ENERGY SYSTEMS CENTER
DEC. 17. 2021
MITSUBISHI ELECTRIC CORP. JAPAN

Employer	snowyhydro LIMITED
Supplier	MITSUBISHI ELECTRIC
Employer's DWG Number	HPP-MEL-MEC-CL-GEN-DRG-0001

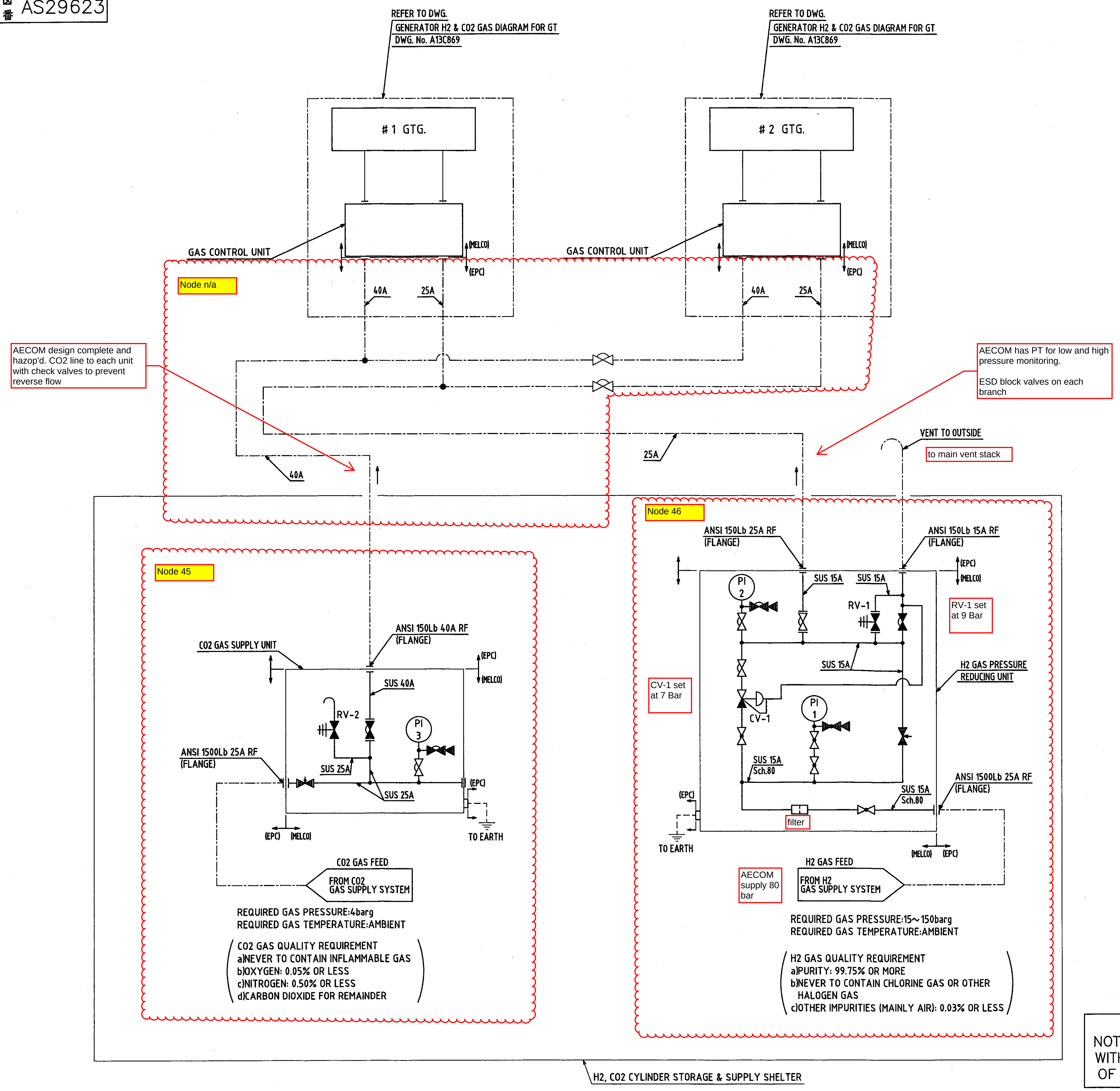
CHANGE CAY6-03

MITSUBISHI ELECTRIC CORPORATION

Hunter Power Project

DIM.IN	mm
SCALE	NTS
DATE	2021-12-10
DRAWN	R.Goto
CHECKED	T.Eura, H.Okamoto
DESIGNED	K.Tabata
APPROVED	T.Osada
TITLE	GENERATOR COOLING WATER DIAGRAM FOR GT
DWG.NO	A13C868

AS29623



LEGEND

- VALVE (NORMALLY OPENED)
- VALVE (NORMALLY CLOSED)
- VALVE (NORMALLY THROTTLED)
- GLOBE VALVE
- BELLOWS VALVE
- NEEDLE VALVE
- RELIEF VALVE
- PRESSURE CONTROL VALVE
- PI PRESSURE INDICATOR
- FILTER
- PLUG

CHARACTER

SYMBOL	No.	RANGE	SET VALUE
PI	1	0~250 barg	-
	2	0~16 barg	-
	3	0~6 barg	-

SYMBOL	No.	SET VALUE
	RV-1	9 barg
	RV-2	5 barg
	CV-1	7 barg

NOTES

1. ALL PIPING MATERIAL SUPPLIED BY MELCO (IN THIS DRAWING) IS STPT EXCEPT OTHERWISE NOTED.
   - STPT・・・・STPT370-S CARBON STEEL PIPES FOR HIGH TEMPERATURE SERVICE (SEAMLESS) CONFORMING TO JAPANESE INDUSTRIAL STANDARD JIS G3456. SCH.NO IS 40 EXCEPT OTHERWISE NOTED.
   - SUS ・・・・SUS304TP-S STAINLESS STEEL PIPES (SEAMLESS) CONFORMING TO JAPANESE INDUSTRIAL STANDARD JIS G3459. SCH.NO IS 40 EXCEPT AS NOTED.

   PIPING INSIDE EQUIPMENTS WILL BE SELECTED IN ACCORDANCE WITH MANUFACTURE'S STANDARD.
2. TERMINAL POINTS BETWEEN OTHERS AND MELCO ARE BASED ON ANSI STANDARD.
3. SCOPE OF SUPPLY SHOWN IN THIS DRAWING IS AS FOLLOWS.

(EPC) | (MELCO)
SUPPLIED BY EPC — SUPPLIED BY MELCO

FOR APPROVAL

ENERGY SYSTEMS CENTER
DEC. 17. 2021
MITSUBISHI ELECTRIC CORP. JAPAN

Employer: snowy hydro LIMITED

Supplier: MITSUBISHI ELECTRIC

Employer's DWG Number: HPP-MEL-MEC-HY-GEN-DRG-0002

MITSUBISHI ELECTRIC CORPORATION

Hunter Power Project

TITLE: GENERATOR H2 & CO2 GAS SUPPLY SYSTEM DIAGRAM FOR GT

mm	作成日付 DATE	2021-12-10	承認 APPROVED
尺度 SCALE	作成 DRAWN	R.Goto, K.Hosoda	
1:20	照査 CHECKED	T.Ewra, N.Chamoto	
~~NTS~~	設計 DESIGNED	K.Takase	T.Osada

DWG No. AS29623 —

改番 CHANGE: CAY6-03

A13C869

LEGEND

- VALVE (NORMALLY OPENED)
- VALVE (NORMALLY CLOSED)
- VALVE (NORMALLY THROTTLED)
- BELLOWS VALVE
- BALL VALVE
- THREE WAY BALL VALVE
- FOUR WAY SOLENOID VALVE
- PRESSURE REDUCING VALVE
- FLOW CONTROL VALVE
- SPRING RETURN VALVE
- NEEDLE VALVE
- PI PRESSURE INDICATOR
- PS PRESSURE SWITCH
- DPI DIFFERENTIAL PRESSURE INDICATOR
- FI FLOW INDICATOR
- LS LEVEL SWITCH
- ZS LIMIT SWITCH
- PT PRESSURE TRANSMITTER
- TI TEMPERATURE INDICATOR
- TS TEMPERATURE SWITCH
- AE GAS PURITY DETECTOR
- AI GAS PURITY MONITOR
- M MOTOR
- BLOWER
- PLUG
- REDUCER
- FILTER
- FILTER & REGULATOR
- AIR LINE
- CABLE
- B BARRIER
- GCRP GENERATOR CONTROL AND PROTECTION RELAY PANEL
- GTC GAS TURBINE CONTROL PANEL

NOTES

1. ALL PIPING MATERIAL SUPPLIED BY MELCO (IN THIS DRAWING) IS STPT EXCEPT OTHERWISE NOTED.
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   - SUS · · · · SUS304TP-S STAINLESS STEEL PIPES (SEAMLESS) CONFORMING TO JAPANESE INDUSTRIAL STANDARD JIS G3459. SCH.NO IS 40 EXCEPT AS NOTED.

   PIPING INSIDE EQUIPMENTS WILL BE SELECTED IN ACCORDANCE WITH MANUFACTURE'S STANDARD.
2. "A" IS A FLEXIBLE TUBE WHICH SHOULD BE CONNECTED TO THE REMOVABLE LINK WHEN PURGING CARBON DIOXIDE GAS BY AIR. THE FLEXIBLE TUBE SHALL BE DISCONNECTED AND CLOSED BY BLIND FLANGE DURING GENERATOR OPERATION.
3. CONNECTION OF TERMINAL POINT IS BASED ON ANSI STANDARDS 150Lb RF FLANGE EXCEPT OTHERWISE NOTED.
4. SCOPE OF SUPPLY SHOWN IN THIS DRAWING IS AS FOLLOWS.

   (EPC) | (MELCO)

   SUPPLIED BY EPC — SUPPLIED BY MELCO
5. PIPES MARKED 1/50 SHALL BE SLOPED AT THE PATE OF MINIMUM 1/50 NOT TO MAKE DRAIN SUMP IN THE PIPELINE.
6. ·GAS VENT DIRECTION SHALL BE TOWARD TO THE SAFE AREA SUCH AS NO PASSAGEWAY, NO ELECTRICAL EQUIPMENT, AND SO ON.
   ·GAS VENT POINT SHALL BE MORE THAN 2m ABOVE ROOF.
   ·GAS VENT POINT SHALL BE AS FAR AS POSSIBLE FROM AIR INTAKE OF GAS TURBINE.

CHARACTER

SYMBOL	No.	RANGE	SET VALUE
PI	1	0~10 barg	-
	2	0~16 barg	-
	3	0~10 barg	-
	4	0~0.5 barg	-
PT	1	0~10 barg	-
DPI	1	0~100 mbar	-
FI	1	200~2000mℓ/min	-
	2	200~2000mℓ/min	-
	3	5~50ℓ/min	-
TI	1	0~300 ℃	-

SYMBOL	No.	RANGE	SET VALUE
AI	1	H2 in Air 85~100% H2 in CO2 0~100% Air in CO2 0~100%	-

SYMBOL	No.	SET VALUE
LS	1	450 cm³
	2	450 cm³
PS	1	6 barg
TS	1	250℃
(pressure reducing valve)	CV-1	5 barg
	CV-2	0.1~0.3 barg

ALARMS

- 1 H2 GAS PURITY ------------------------ LOW (≤ 90%)
- 2A 2B H2 GAS PRESSURE ------------------------ HIGH OR LOW(≥ 5.35barg/≤ 4.8barg)
- 2C H2 GAS PRESSURE ------------------------ LOW (FOR DRAIN REGULATOR OIL LEVEL HIGH ALARM ~~INTER LOCK~~) (≤ 1.5barg) inhibit
- 3 GAS PURITY MONITOR ------------------------ ABNORMAL
- 4A 4B WATER DETECTOR LEVEL ------------------------ HIGH(≥ 450cm³)
- 5 H2 GAS SUPPLY PRESSURE ------------------------LOW(≤ 6 barg)

Employer: snowyhydro

Supplier: MITSUBISHI ELECTRIC

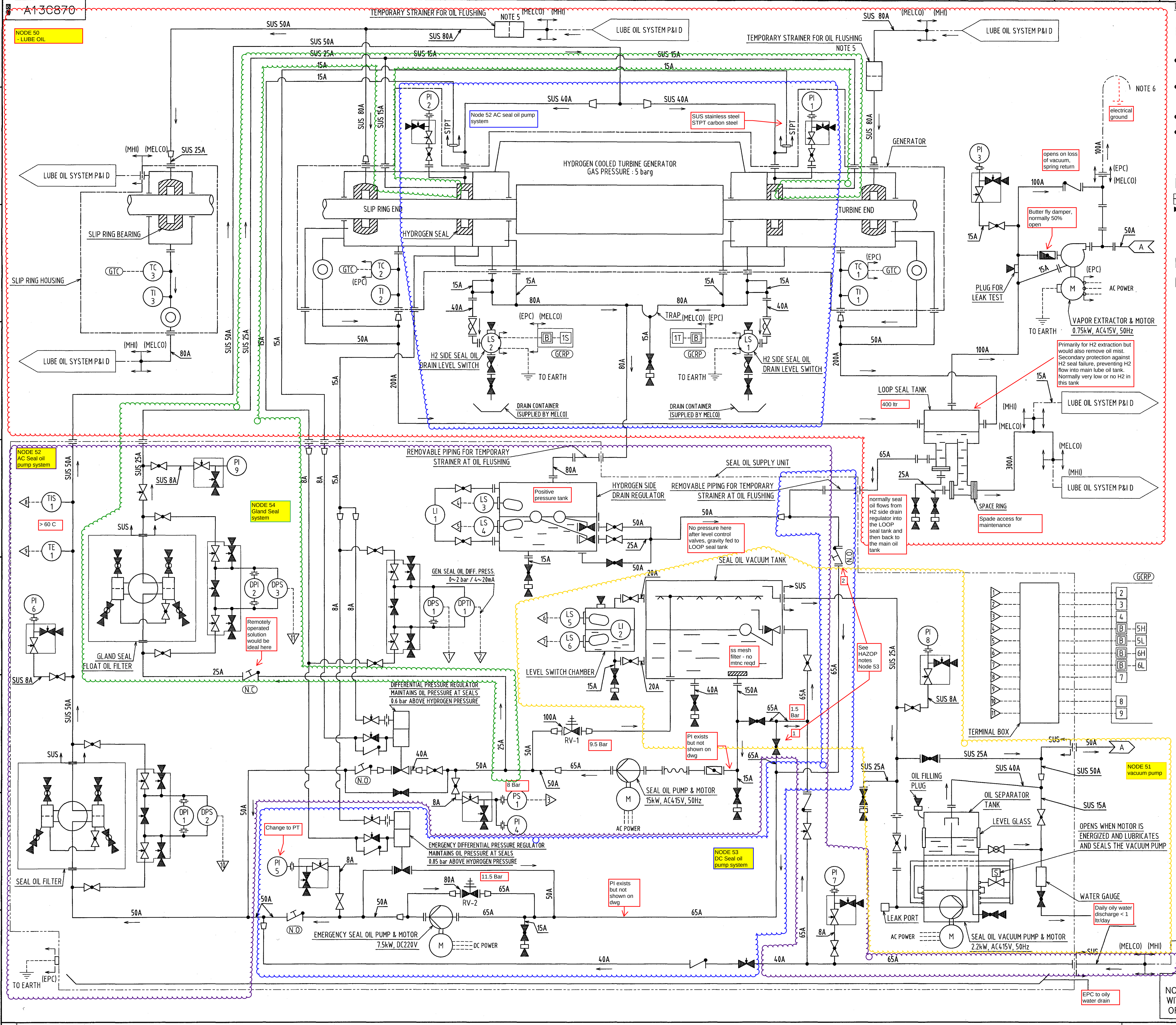
Employer's DWG Number: HPP-MEL-MEC-HY-GEN-DRG-0001

CHANGE CAY6-03

MITSUBISHI ELECTRIC CORPORATION

DIM.IN mm	DATE 2021-12-10	APPROVED	Hunter Power Project
SCALE NTS	DRAWN R.Goto		TITLE: GENERATOR H2 & CO2 GAS DIAGRAM FOR GT
	CHECKED T.Eura	T.Ozada	DWG.NO A13C869
	DESIGNED		

A13C870



LEGEND

- VALVE (NORMALLY OPENED)
- VALVE (NORMALLY CLOSED)
- VALVE (NORMALLY THROTTLED)
- CHECK VALVE WITH LOCK DEVICE (NORMALLY OPENED)
- CHECK VALVE WITH LOCK DEVICE(NORMALLY CLOSED)
- CHECK VALVE
- CHECK VALVE WITH LOCK DEVICE
- BELLOWS VALVE
- RELIEF VALVE
- FIVE WAYS MANIFOLD
- TWO WAYS MANIFOLD
- SOLENOID VALVE
- GLOBE VALVE
- NEEDLE VALVE
- FLOAT VALVE
- BALL VALVE
- STRAINER
- ORIFICE
- ELECTRICAL WIRING
- FLEXIBLE PIPING
- BARRIER
- PLUG
- REDUCER
- GCRP GENERATOR CONTROL AND PROTECTION RELAY PANEL
- GTC GAS TURBINE CONTROL SYSTEM
- TEST VALVE
- FLOW SIGHT GLASS
- PI PRESSURE INDICATOR
- TI TEMPERATURE INDICATOR
- TIS TEMPERATURE INDICATOR WITH SWITCH
- LS LEVEL SWITCH
- LI LEVEL INDICATOR
- PS PRESSURE SWITCH
- DPTI DIFF. PRESSURE TRANSMITTER WITH INDICATOR
- DPS DIFF. PRESSURE SWITCH
- DPI DIFF. PRESSURE INDICATOR
- TC THERMOCOUPLE
- TE TEMPERATURE ELEMENT

CHARACTER

SYMBOL	No.	RANGE	SET VALUE
PI	1	0~10 barg	-
	2	0~10 barg	-
	3	0~-25 mbarg	-
	4	-1~0~15 barg	-
	5	0~15 barg	-
	6	0~10 barg	-
	7	0~6 barg	-
	8	0~-1 barg	-
	9	0~15 barg	-
TI	1	0~100 ℃	-
	2	0~100 ℃	-
	3	0~100 ℃	-

SYMBOL	No.	RANGE	SET VALUE
TIS	1	0~100 ℃	60 ℃
LI	1	-120mm~+120mm	-
	2	-120mm~+120mm	-
DPTI	1	0~2 bar / 4~20 mA	-
TC	1	TYPE-E	-
	2	TYPE-E	-
	3	TYPE-E	-
TE	1	0~100℃	Pt100Ω at 0℃
DPI	1	0~1 bar	-
	2	0~1 bar	-

SYMBOL	No.	SET VALUE
LS	1	450 cm³
	2	450 cm³
	3	NL+100mm
	4	NL-100mm
	5	NL+100mm
	6	NL-100mm
DPS	1	0.45 bar (NOTE7)
	2	0.5 bar
	3	0.5 bar
PS	1	8 barg
(relief valve)	RV-1	9.5 barg
	RV-2	11.5 barg

ALARMS

- 1T GEN. DRAIN OIL LEVEL (TURB. SIDE) ---------- HIGH (≥ 450 cm³)
- 1S GEN. DRAIN OIL LEVEL (SLIP. SIDE) ---------- HIGH (≥ 450 cm³)
- 2 GEN. SEAL OIL DIFF. PRESS. ---------- LOW (≤ 0.45 bar)
  - -EMERGENCY SEAL OIL PUMP RUNNING
  - -TURNING STARTING INTERLOCK
- 3 GEN. SEAL OIL DIFF. PRESS. ---------- HIGH (≥ 1.5 bar MORE THAN 5 SECONDS)
- 4 GEN. SEAL OIL PUMP OUTLET PRESS. ---------- LOW (≤ 8 barg)
  - -EMERGENCY SEAL OIL PUMP RUNNING
- 5H GEN. DRAIN REGULATOR OIL LEVEL ---------- HIGH (≥ NL+100 mm)
- 5L GEN. DRAIN REGULATOR OIL LEVEL ---------- LOW (≤ NL-100 mm)
- 6H GEN. SEAL OIL VACUUM TANK OIL LEVEL ---------- HIGH (≥ NL+100 mm)
  - -SEAL OIL VACUUM PUMP STOP INTER LOCK
- 6L GEN. SEAL OIL VACUUM TANK OIL LEVEL ---------- LOW (≤ NL-100 mm)
- 7 GEN. SEAL OIL SUPPLY TEMP. ---------- HIGH (≥ 60℃)
- 8 GEN. SEAL OIL FILTER DIFF.PRESS. ---------- HIGH (≥ 0.5 bar)
- 9 GEN. GLAND SEAL FLOAT OIL FILTER DIFF.PRESS. ---------- HIGH (≥ 0.5 bar)

FOR APPROVAL

ENERGY SYSTEMS CENTER
DEC. 17. 2021
MITSUBISHI ELECTRIC CORP. JAPAN

NOTES

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   - ·STPT···STPT370-S CARBON STEEL PIPES FOR HIGH TEMPERATURE SERVICE (SEAMLESS) CONFORMING TO JAPANESE INDUSTRIAL STANDARD JIS G3456. SCH.NO IS 40 EXCEPT OTHERWISE NOTED.
   - ·SUS····SUS304TP-S STAINLESS STEEL PIPES (SEAMLESS) CONFORMING TO JAPANESE INDUSTRIAL STANDARD JIS G3459. SCH.NO IS 40 EXCEPT OTHERWISE NOTED.
2. TERMINAL POINTS BETWEEN EPC AND MELCO ARE BASED ON ANSI STANDARD. TERMINAL POINTS BETWEEN MHI AND MELCO ARE BASED ON ANSI STANDARD.
3. SCOPE OF SUPPLY SHOWN IN THIS DRAWING IS AS FOLLOWS.
   (EPC) | (MELCO) — SUPPLIED BY EPC / SUPPLIED BY MELCO
   (MHI) | (MELCO) — SUPPLIED BY MHI / SUPPLIED BY MELCO
4. ALL PIPES SHALL BE LAID WITH GRADIENT OF MORE THAN 1/50 TO PREVENT ACCUMULATION OF OIL OR MAKING AIR POCKET IN THE PIPES.
5. THE SCREEN FOR GENERATOR MAIN BEARING TEMPORARY OIL STRAINERS ARE USED AT FLUSHING AND SHALL BE TAKEN AWAY IN GENERATOR RUNNING. STRAINER MATERIAL SHALL BE STAINLESS STEEL.
6. ·VENT DIRECTION OF GENERATOR LOOP SEAL TANK SHALL BE TOWARD TO THE SAFE AREA SUCH AS NO PASSAGEWAY, NO ELECTRICAL EQUIPMENT, AND SO ON.
   ·VENT POINT OF GENERATOR LOOP SEAL TANK SHALL BE MORE THAN 2m ABOVE ROOF.
   ·VENT POINT OF GENERATOR LOOP SEAL TANK SHALL BE AS FAR AS POSSIBLE FROM AIR INTAKE OF GAS TURBINE.
7. DIFF. PRESS. BETWEEN SEAL OIL AND GAS AT SEAL RING 0.35bar + DIFF. ELEVATION HEAD BETWEEN SEAL OIL SIDE AND GAS SIDE 0.01MPa = 0.45bar

Employer: snowyhydro LIMITED
Supplier: MITSUBISHI ELECTRIC
Employer's DWG Number: HPP-MEL-MEC-OS-GEN-DRG-0001

出図先 ( )	
~~DIM.IN mm~~	尺度 SCALE : NTS
MITSUBISHI ELECTRIC CORPORATION	Hunter Power Project
作成日付 DATE	2021-12-10
作成 DRAWN	R.Goto, K.Miura
照査 CHECKED	T.Eura, N.Okamoto
設計 DESIGNED	K.Takase
検認 APPROVED	T. Osada
TITLE	GENERATOR SEAL OIL DIAGRAM FOR GT
DWG.NO	A13C870

CHANGE 改定 CAY6-03

A1(594×841mm)

Appendix 2: Study records

Note on study records

Column 4 'Likelihood' and column 5 'Severity' represent the possibility and consequence of a hazard without taken credit for the safety protection layer (SPL).

Column 8 'Likelihood with SPL' and column 9 'Severity with SPL' represent the possibility and consequence of a hazard taken credit for the correct operation of the SPL. The consequence remains the same, only the frequency is modified.

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 1 - Fuel Oil - High pressure Pump Dwg A-21045 - Fuel oil system 5 of 5											
Pressure High	FO forwarding pump deadhead	FO release	Certain	Negligible	Low		Rare	Minor	Low	1 MPA line rating, supply side	1. Confirm forwarding pump deadhead pressure and prv
	FO blocked in thermal expansion	FO release	Unlikely	Minor	Low		Unlikely	Minor	Low	1 MPA line rating, supply side	2. Review bunding requirements around FO pumps
	Blocked filter	Unit trip - loss of production	Unlikely	Minor	Low	PS MBN12CP211	Unlikely	Minor	Low	Duplex filter with manual change over	3. Confirm $ cost per unit trip / 1 hr outage
Pressure Low	No forwarding supply / AC power out	Unit trip - loss of production	Unlikely	Minor	Low	PS MBN12CP211	Unlikely	Minor	Low		4. All ball valves to be lockable 5. SHL to review who supplies instrumentation at MHI interfaces
Pressure Low											
Pressure No or not											
Pressure Vacuum											
Temperature High										Forwarding pipework designed for 50 C. Locked Open MBN12AA124	
Temperature Low	Ambient temperature	Unit fail to start	Possible	Minor	Medium		Possible	Minor	Medium	Increased viscosity, low flow high pressure. Combustion problem potential. Design -5 C, site has experience -6 C. 11 C	6. AECOM to consider heat tracing for FO dwg 2of 5. Start up temperature should be 11 deg C. Alternative may be an enclosure for the pump and piping
Temperature – No or not											
Flow / Level – High	Manual valves out of position									Lockable valves	
Flow / Level – Low											
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High										Winding temperatures are monitored	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 2 - Fuel Oil - Manifold pressure control Dwg A-21042 - Fuel oil system 2 of 5											
Pressure High	BPCS - Control loop failure									Flow control valves, would compensate	
Pressure Low	BPCS - Control loop failure	Unit trip - loss of production	Unlikely	Minor	Low	PT MBN12CP118, MBN12CP119	Unlikely	Minor	Low		
Pressure No or not	BPCS - Instrument failure	Unit trip - loss of production	Unlikely	Minor	Low		Unlikely	Minor	Low	MHI to check logic	
Pressure Vacuum											
Temperature High			Rare	Minor	Low		Rare	Minor	Low		
Temperature Low										Refer pump node. Screw pump	
Temperature – No or not											
Flow / Level – High	BPCS - Control loop failure	Unit trip - loss of production	Unlikely	Minor	Low	PT MBN12CP118, MBN12CP119	Unlikely	Minor	Low		
Flow / Level – Low											7. The screw pump has no min flow bypass return line. The HP pump only starts when burners are to be lit. When no burner flow the manifold pressure control valve acts as the min flow control. MHI to confirm forwarding pump flow rate through HP screw pump when shutdown
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late										MHI to check if forwarding pumps can recirculate through the screw pump. FYI only	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 3 - Fuel Oil - Pilot flow control	Dwg A-21042 - Fuel oil system 2 of 5										
Pressure High	BPCS - Control loop failure	Excessive start fuel, machine damage, exh temp hi hi, overspeed	UnLikely	Major	Medium	Blade path temperature Overspeed protection	Rare	Minor	Low		
		Excessive start fuel, machine damage, exh temp hi hi	UnLikely	Minor	Low	PDIT MBN12CP521 MBN12CP522	Rare	Minor	Low	Not large enough to create catastrophic failure	
Pressure Low	BPCS - Control loop failure	Unit trip - loss of production	UnLikely	Minor	Low						
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low	Ambient temperature	Unit fail to start	Possible	Minor	Medium		Possible	Minor	Medium		
Temperature – No or not											
Flow / Level – High										Same as high pressure	
Flow / Level – Low										Same as low pressure	
Flow / Level – No or not										Can lose 1, both = trip	
Flow / Level – Reverse	Loss of purge air when gas firing	Nozzle over temp, maintenance cost minor	UnLikely	Minor	Low	Limit switch alarm	Rare	Minor	Low		
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow										Same as high pressure	
Utility failure - instr. air / oil / power		Unit trip - loss of production	UnLikely	Minor	Low		UnLikely	Minor	Low	Instant fail close	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 4 - Fuel Oil - Main flow control Dwg A-21042 - Fuel oil system 2 of 5											
Pressure High	BPCS - Control loop failure	Excessive start fuel, machine damage, exh temp hi hi, overspeed	UnLikely	Severe	High	Blade path temperature	Rare	Severe	Medium	Compressor surge, only on run up, not on over fuelling	
Pressure Low	BPCS - Control loop failure	Excessive start fuel, machine damage, exh temp hi hi	UnLikely	Minor	Low	PDIT MBN12CP521 MBN12CP522	Rare	Minor	Low		
Pressure No or not	BPCS - Control loop failure	Unit trip - loss of production	UnLikely	Minor	Low		UnLikely	Minor	Low		
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not	Ambient temperature	Unit fail to start	Possible	Minor	Medium		Possible	Minor	Medium		
Flow / Level – High						Overspeed protection				Same as high pressure	
Flow / Level – Low										Same as high pressure	
Flow / Level – No or not										Same as low pressure	
Flow / Level – Reverse										Can lose 1, both = trip	
Vibration – High Low or not	Loss of purge air when gas firing	Nozzle over temp, maintenance cost minor	UnLikely	Minor	Low	Limit switch alarm	Rare	Minor	Low		
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow										Slow response on fouling / varnish common problem with E/H. Valve position is monitored, alarms and trips unit	
Utility failure - instr. air / oil / power										Same as high pressure	
Volts / Amps High		Unit trip - loss of production	UnLikely	Minor	Low		UnLikely	Minor	Low	Instant fail close	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 5 - Fuel Oil - Flow divider Dwg A-21043 - Fuel oil system 3 of 5											
Pressure High											
Pressure Low	MBN13BR310 out of position on start up	Unit trip - loss of production	UnLikely	Minor	Low	Blade path temperature	UnLikely	Minor	Low		
	MBN13AA901 out of position, drain valves									All manual ball valves to be lockable	8. MHI manual ball valves should all be lockable type, i.e. flow divider drain valves. SHL to discuss requirements with MHI
Pressure No or not										Flow divider has no speed indication but has never shown to be a problem. Would be fail to start scenario	
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High										Flow is controlled before divider. Divider just splits it into 20 equal streams	
Flow / Level – Low										Same as low pressure	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase										Air ingress not considered possible	
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow										Slow fail to start	
Utility failure - instr. air / oil / power										Fail open valves. Confirm limit switches qty	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 6 - Fuel Oil - Burners Dwg A-21044 - Fuel oil system 4 of 5											
Pressure High										Refer high flow	
Pressure Low										Refer low flow	
Pressure Low											
Pressure No or not											
Pressure Vacuum											
Temperature High	BPCS - Control loop failure	Exhaust gas temp Hi Hi - machine damage	UnLikely	Severe	High	Blade path temperature	Rare	Severe	Medium		
Temperature Low	Flame out	Flame out, potential reignition explosion	Possible	Severe	High	Blade path temperature	Rare	Severe	Medium		
Temperature – No or not											
Flow / Level – High	BPCS - Control loop failure	Exhaust gas temp Hi Hi - machine damage	UnLikely	Severe	High	Blade path temperature	Rare	Severe	Medium		
Flow / Level – Low	Flame out	Flame out, potential reignition explosion	Possible	Severe	High	Blade path temperature	Rare	Severe	Medium	No flame detectors only blade path temperature. New improved design	9. Pantac to review blade path flameout voting logic. One or multiple burners, adjacent burners, single or duplex t/c. No optical flame detectors
Flow / Level – No or not											
Flow / Level – Reverse										Refer purge air, low consequence	
Vibration – High Low or not	High frequency combustion	Machine damage - burner tubes	Possible	Major	High	Combustion pressure monitoring trip	UnLikely	Major	Medium	Combustion humming sensors, high frequency combustion will trip the unit. Low frequency is monitored. Is humming more serious for gas fuel?	10. MHI to advise combustion frequency sensor criticality. Commissioning tool or protection
As well as - concentration / two phase											
Other then - impurities / contamination										No history of fuel quality minerals, silica's causing problems at Colongra. Diesel run times expected to be quite short, insufficient to see major damage to first stage buckets	11. SHL investigating additional diesel fuel quality reports
Timing / Sequence - Early / Late										No purge precombustion as part of the run up.	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 7 - Fuel Oil - Drain tank Dwg A-21045 - Fuel oil system 5 of 5											
Pressure High	Potential oil surge from oil to drain volume / velocity	Backflow through atmospheric vent, oil escapes								Overflow open to atmosphere and pit. Backflow unlikely with 15 m tall vent line	
Pressure Low										Overflow open to atmosphere and pit	
Pressure No or not											
Pressure Vacuum										Overflow open to atmosphere and pit	
Temperature High										Diesel fuel may be heat traced but not considered a hazard, 60 Deg C max, design 80 C. Typical operation 10 - 20 C	
Temperature Low										Minus 6 C is the lowest temp on site recorded. Tank is gravity fed, so low or below ground level	
Temperature – No or not											
Flow / Level – High	BPCS - Level control failure	Potential overflow to oily water system	Possible	Negligible	Low		Possible	Negligible	Low	MBN13AA701 FO Pilot drain valve is fail closed valves and if fail open, unit would fail to start. Drain tank bund drains to oil drain pit	12. MHI to confirm if there is a drain tank Hi level start permissive. Unit wont start with high level
Flow / Level – Low	BPCS - Level control failure	Pump runs dry, damage pump	Possible	Negligible	Low		Possible	Negligible	Low		
Flow / Level – No or not										Loss of LT = no pump start	
Flow / Level – Reverse										Refer high pressure, vent height. Double check valves to prevent return flow into drain tank. Forwarding pumps and tank head upstream pressure	13. SHL to confirm with operations to see if small lines have been problematic with non-return valves failing / passing
Vibration – High Low or not											14. AECOM to consider drain pit discharge hi alarm to start pump and hi hi to alarm to remote operations
As well as - concentration / two phase										Oily water minor issue	15. AECOM Fuel oil discharge to oily water pit detection to be considered in design
Other then - impurities / contamination										Pump has strainer on inlet	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 8 - Fuel Oil - Water injection Dwg A-21043 - Fuel oil system 3 of 5											
Pressure High										Designed accordingly	
Pressure Low	BPCS - Flow control	Emissions / run back	Possible	Negligible	Low		Possible	Negligible	Low		16. MHI to confirm at what load level water injection is enabled. Also when water injection is not correct the unit would go to run back load, where water injection is turned off.
Pressure Low	BPCS - Flow control	Emissions / run back	Possible	Negligible	Low		Possible	Negligible	Low		17. SHL to confirm action required when water injection is off, i.e. valley will try to restart water injection 3 times and max operating time without water injection is 15 minutes. Automatic shutdown required, tbc and advise to MHI or add into station controls
Pressure Low	BPCS - Flow control	Emissions / run back	Possible	Negligible	Low		Possible	Negligible	Low		18. Oily water pit to be covered with rain shelter
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low	Low ambient temperature	Emissions / run back	Possible	Negligible	Low		Possible	Negligible	Low	Existing item for AECOM, is water piping lagging required	
Temperature – No or not											
Flow / Level – High	BPCS - Flow control	Emissions / run back	Possible	Negligible	Low		Possible	Negligible	Low		
Flow / Level – High	Drain valve out of position	Emissions / run back	Possible	Negligible	Low		Possible	Negligible	Low	Oily water drain pit design not completed yet	
Flow / Level – High	Drain valve out of position	Oily water pit over flow	Possible	Minor	Medium		Possible	Minor	Medium	Oily water drain pit design not completed yet	19. AECOM to consider valve failure, excessive flow to oily water pit overflow during runback time. Flow balance required. MHI to advise oily water flow rate and volumes expected during normal operating conditions and if one of the drain valves fails open, MBN13AA735,AA736,AA737 based on SHL RFI document
Flow / Level – Low										Same as low pressure	20. Water injection flow transmitter is a single point of failure which would cause diesel outage, so it is critical for operation. Redundancy for valve control per fuel oil control should be considered. MBU02CP531.
Flow / Level – No or not	BPCS - Instrument failure	Loss of production	Possible	Minor	Medium		Possible	Minor	Medium	Same as low pressure. Run back to preload at 50% production loss and then shutdown after 15 minutes (tbc)	21. Single point of failure mode analysis should be completed at a suitable time. SHL internal item
Flow / Level – No or not	BPCS - Instrument failure	Loss of production	Possible	Minor	Medium		Possible	Minor	Medium		22. Outage, run back, emergency trip restart time cost analysis required for Risk Assessment decision around device fault tolerance, i.e. trip or 1 hours outage = 800k, additional instrument = 10k installed
Flow / Level – Reverse										There is no check valve on the HP WI pump outlet. There would be have to be a triple failure before fuel oil could flow back into the demin system	
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late										Overwatering metal quenching, unlikely event and no history. Would cause run back	
Timing / Sequence - Fast / Slow	BPCS - Valve position	Emissions / run back	Possible	Negligible	Low	Combustion pressure monitoring trip	Rare	Negligible	Low	Potential for flame out during commissioning tuning but unlikely after plant commissioned unless valve position control fails	
Utility failure - instr. air / oil / power										All valves fail closed. Trouble would cause run back	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 9 - Fuel Oil - Purge credit block valves Dwg A-21046 - Fuel oil purge credit system											
Pressure High										Every thing designed fit for purpose. Purge credit saves 5 minutes start up time. Purge credit based on normal scheduled shutdown and limited to a fixed time.	23. Purge credit details are not well understood by Operations. There is a manual, Operating Procedure(S4-96597), that describes it in more detail. Type B compliance, intermittent or continuous turning and start and re-purge credit are all good questions. Potentially every 8 days the unit needs repurging, which can lead to more blade wear (wobbling in root) and starter problems. This item to be revisited by Operations with MHI detail input.
Pressure Low	Loss of purge medium	5 minutes additional start time	Possible	Negligible	Low		Possible	Negligible	Low		
Pressure No or not	BPCS - Instrument failure	Loss of purge credit	Possible	Negligible	Low		Possible	Negligible	Low	Do we need the N2 vent valve QJA05AA714 ? Standard MHI design based on AS3814	
Pressure Vacuum											
Temperature High										Fit for purpose pipeline application	
Temperature Low										Ambient limit minus 6 C	
Temperature – No or not											
Flow / Level – High	FO Drain valve out of position will flow to pit	Potential overflow to oily water system	UnLikely	Negligible	Low		UnLikely	Negligible	Low		24. MHI to review if fuel oil from the fuel oil purge credit can go to the tank not the pit as it is clean fuel. Environmental credit
	N2 vent valve out of position will flow to atmosphere	Extra N2 consumption	UnLikely	Negligible	Low		UnLikely	Negligible	Low		25. Fuel oil purge credit valves only have a single limit switch, preference for both open and closed indication, all valves (block, drain, N2). AECOM supply these valves
Flow / Level – Low	BPSC - Valve out of position	Fail to start - Loss of production	UnLikely	Negligible	Low		UnLikely	Negligible	Low		
		Loss of purge credit - Loss of production	UnLikely	Negligible	Low		UnLikely	Negligible	Low		
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase										A small plug of purge credit air and N2 will be entrained in the fuel oil feed but this is not a problem	
Other then - impurities / contamination											
Timing / Sequence - Early / Late										Covered in low flow, negligible impacts	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power										Valves fail to run strategy. No safety concerns, just loss of purge credit	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 10 - Fuel Gas - Supply Dwg A-21061 - Fuel gas system 1 of 7											
Pressure High										This node was covered by AECOM hazop as they are supplying this system. HAZOP report to be reviewed by this team on Day 3	
NODE No. 11 - Fuel Gas - Supply pressure control Dwg A-21062 - Fuel gas system 2 of 7											
Pressure High	APA gas yard failure	Potential loss of containment, explosion	Rare	Major	Medium	2oo3 High pressure trip and 5 block valves in series	Rare	Major	Medium	Service air supply 5.7 Bar, regulated further downstream. Multiple PRVs also	
Pressure Low	APA gas yard failure	Loss of production	UnLikely	Negligible	Low	2oo3 Low pressure trip and 5 block valves in series	UnLikely	Negligible	Low	APA gas yard has the WBHs and pressure regs. 4.4 MPA supply	
Pressure No or not										Redundant transmitters	
Pressure Vacuum											
Temperature High	Heater change over valve failure leading to combustion instability	Loss of production	UnLikely	Negligible	Low	2oo3 High temperature trip and 5 block valves in series	Rare	Negligible	Low	AECOM hazop suggest it is possible on part load based on 220 C setpoint. Control valve fail mode to heater	
Temperature Low	Heater change over valve failure leading to combustion instability	Loss of efficiency, loss of production, run back	UnLikely	Negligible	Low	Combustion pressure monitoring trip	UnLikely	Negligible	Low	Run back on low temp	
Temperature – No or not	2oo3 sensor unlikely										
Flow / Level – High	Vent valve out of position	Potential gas cloud explosion, environmental release	UnLikely	Moderate	Medium	Vent valve position trip	Rare	Moderate	Low		26. MHI to check logic. Gas vent valve out of position during operation should be a trip. Redundant limit switches may be.
Flow / Level – Low										The 2 x 100% coalescer has double block and bleed for maintenance but AS3814 needs an isolation valve close to the unit	27. AECOM should review vent valve position failure actions
Flow / Level – No or not											28. AECOM to review appliance manual isolation valve per AS3814 requirements within 5m of the appliance. Paul van Dyk to confirm AS3814 clause requirements
Flow / Level – Reverse	QEF14AA703 seal failure or incorrect position when gas firing	Excessive gas venting	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Colongra pressure / integrity test valves every 4years. Valley test unit valves annually. Odorised gas, small leak may be able to be detected. Large leak audible	29. Tapping points for pressure testing / leak testing valves not shown on P&ID. Additional testing points may be required. SHL to review based on length of pipework and valve locations.
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late										Vents closed before blocks opened. Purge closed before gas opened. Confirm timings during SAT (No FAT).	30. MHI to review AS3814 section 2.13 requirement for sufficient test points to verify the integrity of shutoff valve / train.
Timing / Sequence - Fast / Slow										Potential for small gas vent time	
Utility failure - instr. air / oil / power										Failsafe design. All valves fail to safe position	
Volts / Amps High										24VDC control voltage. DC-ve grounded system	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 12 - Fuel Gas - Flow control Dwg A-21063 - Fuel gas system 3 of 7											
Pressure High	BPCS - Valve position or DPT flow meter	Excessive start fuel, machine damage, exh temp hi hi, overspeed	UnLikely	Major	Medium	Gas control valve position trip	Rare	Moderate	Low	Overfueling on start up / light off	
						Blade path temperature				Overfueling on start up / light off, potential for duct explosion, ignition time 10 seconds. For the purpose of the HAZOP the main question is there a single point of failure and what would be consequence of a critical time pressure excursion / explosion. Multiple burner lines, pilot gas is the smallest but lights off with Main A as well. MHI think over fuelling on start up is not realistic possibility with 1 out of 4 fuel lines and blade path temp trip. The light off is based on a fixed valve position. The DPT sensor is protection for the dual redundant valve position error (tbc). Any position error the unit will trip.	31. RFI for the purpose of the HAZOP the main question, is there a single point of failure (DPT) and what would be consequence of a critical time pressure excursion explosion. Is DPT control or protection, refer control description fig 2.9.1
Pressure Low	BPCS - Control loop failure	Loss of production	UnLikely	Negligible	Low	Blade path temperature				Fail to start of slow acceleration	
Pressure No or not										Fuel control drift from setpoint for Main A Main B or Tophat was discussed and would eventually lead to combustion humming trip	
Pressure Vacuum											
Temperature High						2oo3 High gas temperature trip					
Temperature Low											
Temperature – No or not											
Flow / Level – High										Same as high pressure	
Flow / Level – Low											
Flow / Level – No or not										Unit will trip on hi or low DPT signal	
Flow / Level – Reverse										Not possible normally but if gas pilot control valve not shut tight some hot sweep air may enter manifold and potential for condensate. Considered immaterial	
Vibration – High Low or not										Pigtail tube connections to burners take up vibration / expansion requirements, refer next node dwg 4 of 7	
As well as - concentration / two phase										MHI have provided fuel spec requirements. On top of APA knockout pot, AECOM also provide additional filter the fuel.	
Other then - impurities / contamination	Ambient air condensation possible as units mostly not operating. Stainless steel pipes and heated gas									Pigging part of APA scope. MHI also have last chance filter.	
Timing / Sequence - Early / Late										Same as high and low pressure	
Timing / Sequence - Fast / Slow						Overspeed protection	Rare	Major	Medium	Potential for overspeed if slow control or fail to start both have protection	
Utility failure - instr. air / oil / power	Fail close valve	Loss of production	UnLikely	Negligible	Low		UnLikely	Negligible	Low		
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 13 - Fuel Gas - Pilot and Main B burners Dwg A-21064 - Fuel gas system 4 of 7											
Pressure High										Similar to preceding node	
Pressure Low											
Pressure No or not										MBP03CP126 only monitoring manifold pressure. Failure alarm only	
Pressure Vacuum											
Temperature High	Shutdown normal operation									Designed accordingly, heat dissipates through pigtail connections	
Temperature Low											
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low											
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination	Possible welding debris, construction materials	Foreign object damage	UnLikely	Major	Medium		Rare	Major	Medium	Commissioning filter skid temporary installation to collect any construction debris	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 14 - Fuel Gas - Top Hat and Main A burners Dwg A-21065 - Fuel gas system 5 of 7											
Pressure High	Combustion problems					Blade path temperature				Refer preceding nodes.	
Pressure Low	Instrument air supply fault	Fail to start - Loss of production	UnLikely	Negligible	Low	Blade path temperature	Rare	Negligible	Low	Igniter extraction fails, spring return	
Pressure No or not											
Pressure Vacuum											
Temperature High	BPCS - Control loop failure	Potential reduced blade life	UnLikely	Negligible	Low	2oo3 High temperature trip and 5 block valves in series Blade path temperature Exhaust gas pressure Hi Hi trip	Rare	Negligible	Low	Normally on MW control, blade path and exhaust temp trips	
Temperature Low	Flame out	Loss of production	UnLikely	Negligible	Low	Blade path temperature	Rare	Negligible	Low		
Temperature – No or not											
Flow / Level – High										Refer flow control nodes	
Flow / Level – Low											
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not	BPCS - control loop leading to combustion instability	Potential corn cob of power turbine from stressed combustion components (burners, buckets)	UnLikely	Severe	High	Combustion pressure monitoring trip	Rare	Severe	Medium	Too lean high frequency, too rich low frequency. Blades will be contained within casing	
Vibration – High Low or not	Rotor out of balance	Bearing damage	UnLikely	Major	Medium	Rotor vibration hi hi trip	Rare	Moderate	Low		
As well as - concentration / two phase											
Other then - impurities / contamination										Commissioning filter skid temporary installation to collect any construction debris	
Timing / Sequence - Early / Late	Fail to ignite	Loss of production	Possible	Negligible	Low	Blade path temperature	Possible	Negligible	Low	Trip prevent more serious consequence	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power	Fail to ignite	Loss of production	Possible	Negligible	Low	Blade path temperature	Possible	Negligible	Low	Loss of ignition worst case scenario	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 15 - Fuel Gas - Combustor drain valves Dwg A-21066 - Fuel gas system 6 of 7											
Pressure High											
Pressure Low											
Pressure No or not											
Pressure Vacuum											
Temperature High										normal flow 0.1 nmch. If both valves failed to open could potentially to flashing off the diesel but normal operation is < 60 Celsius	32. MHI to confirm temperature rating of pipework after MBA01AA704, burner drain valve. Rating drops from 525 to 60 Celsius
Temperature Low											
Temperature – No or not											
Flow / Level – High	Operator error fail to drain water wash liquid from combustor section	Loss of production - fail to ignite and potential for quenching and detergent to oily water pit	Possible	Negligible	Low	Blade path temperature	Possible	Negligible	Low	Operator error could overfill the combustion section? Also has happened with failed heat exchanger tube. If operator fails to open MBA01AA931 detergent could enter oily pit, as the unit fails to start and then automatically opens the drain valves.	33. Water wash procedure has many manual valves which could potentially lead to false start by flooded combustion chamber and subsequently detergent flow into the oil water pit. SHL to develop a water wash procedure with 2 operators to cross check. Water washing drain header could also have small amounts of diesel residue from liquid fuel false start.
Flow / Level – Low											
Flow / Level – No or not										same scenario as high flow	
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase										Water wash oily water separator pit contains detergents, diesel and demin water	
Other then - impurities / contamination										Demin water with potential for fuel	
Timing / Sequence - Early / Late										refer above	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power	Drain valve open position is a start permissive										
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 16 - Fuel Gas - Burners Dwg A-21066 - Fuel gas system 6 of 7											
Pressure High										NODE 16 SAME AS OIL BURNER NODE 6	
Pressure Low											
Pressure Low											
Pressure No or not											
Pressure Vacuum											
Temperature High	BPCS - Control loop failure	Exhaust gas temp Hi Hi - machine damage	UnLikely	Severe	High	Blade path temperature	Rare	Severe	Medium		
Temperature Low	Flame out	Flame out, potential reignition explosion	Possible	Severe	High	Blade path temperature	Rare	Severe	Medium		
Temperature – No or not											
Flow / Level – High	BPCS - Control loop failure	Exhaust gas temp Hi Hi - machine damage	UnLikely	Severe	High	Blade path temperature	Rare	Severe	Medium		
Flow / Level – Low	Flame out	Flame out, potential reignition explosion	Possible	Severe	High	Blade path temperature	Rare	Severe	Medium	No flame detectors only blade path temperature. New improved design	
Flow / Level – No or not											
Flow / Level – Reverse										Refer purge air, low consequence	
Vibration – High Low or not	High frequency combustion	Machine damage - burner tubes	Possible	Major	High	Combustion pressure monitoring trip	UnLikely	Major	Medium	Combustion humming sensors, high frequency combustion will trip the unit. Low frequency is monitored. Is humming more serious for gas fuel?	
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late										No purge precombustion as part of the run up.	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 17 - Fuel Gas - GT sweep (purge air) Dwg A-21067 - Fuel gas system 7 of 7											
Pressure High										CPD recirculated through the burner	
Pressure Low											
Pressure No or not											
Pressure Vacuum											
Temperature High	Check valve may not be gas tight	Potential flash back, combustion problem but only at full load	Rare	Negligible	Low	Fuel transfer limited to part load	Rare	Negligible	Low	Potential for air gas in pipe at close to auto ignition at full load therefore fuel transfer is limited to part load	
Temperature Low											
Temperature – No or not											
Flow / Level – High	MBH05AA712 vent valve out of position	Combustion problems unlikely, coking potential	UnLikely	Negligible	Low	Blade path temperature	Rare	Negligible	Low	Sweep air venting, potential for nozzle coking Alarm only, does not inhibit liquid firing	
Flow / Level – Low	MBH05AA711 or AA713 fail to open, valve out of position	Combustion problems unlikely, coking potential	UnLikely	Negligible	Low	Blade path temperature	Rare	Negligible	Low	Sweep air blocked, potential for nozzle coking Alarm only, does not inhibit liquid firing. Valves fitted with multiple limit switches	
Flow / Level – No or not											
Flow / Level – Reverse	Check valve may not be gas tight and AA713 not closed	Potential for auto ignition in pipework at full load but this is not considered possible with the vent open to the atmosphere	UnLikely	Major	Medium	Sweep air block valve out of position auto shutdown	Rare	Major	Medium	AA711 or AA713 out of position is a shutdown, 2oo3 limit switches	30. MHI to review AS3814 section 2.13 requirement for sufficient test points to verify the integrity of shutoff valve / train.
Vibration – High Low or not											
As well as - concentration / two phase										Refer reverse flow auto ignition scenario	
Other then - impurities / contamination	Potential coke from burners or products of combustion condensation, negligible impact									Self draining lines	
Timing / Sequence - Early / Late										Refer reverse flow auto ignition scenario	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 18 - Fuel Gas - Flow meter Dwg A-21068 - Fuel gas flow meter											
Pressure High										APA regulated supply	
Pressure Low											
Pressure No or not	MBP01CP101 failure	Loss of flow compensation	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Just monitoring and alarm	
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High										Flow meter would be removed for construction pipe blow down	34. Commissioning spool required for flow meter, that will need to be removed for pipe blow down activities. Mark up P&ID
Flow / Level – Low											
Flow / Level – No or not										Same as pressure, loss of monitoring only	
Flow / Level – Reverse	Venting prior to flow meter	No consequence									
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 19 - Fuel Gas - Filter and purge credit Dwg A-21069 - Fuel gas filter and purge credit system											
Pressure High											
Pressure Low	Blocked filter	Potential low pressure flame out - loss of production	UnLikely	Negligible	Low	Filter dP alarm	Rare	Negligible	Low		
Pressure No or not	BPCS - loop failure	Loss of purge credit	UnLikely	Negligible	Low						
Pressure Vacuum											
Temperature High										Heater design limited	
Temperature Low											
Temperature – No or not											
Flow / Level – High	BPCS - Solenoid fail open	Excessive gas venting	UnLikely	Negligible	Low	Vent valve position trip	Rare	Negligible	Low	Annual inspection leak testing would pick up small leaks. Limit switch would pick up full open stuck	
Flow / Level – Low	Valve fails to open	Loss of purge credit	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Valve position alarms and start permissives	
Flow / Level – No or not											
Flow / Level – Reverse										Possible if venting upstream	
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination										APA and power island coalescers	
Timing / Sequence - Early / Late										venting gas but designed to AS3814 vent close before block open?	
Timing / Sequence - Fast / Slow										AECOM HAZOP is considering additional N2 purge tapping point	35. Add instrument tapping point for Nitrogen entry for valve leak testing, with smaller volume than upstream line
Utility failure - instr. air / oil / power	Instrument air supply fault	Loss of purge credit	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Valves fail to run strategy. No safety concerns, just loss of purge credit	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 20 - Fuel Gas - Calorie meter Dwg A-21070 & MYP127-DWG-002 - Fuell gas Calorie meter package											
Pressure High			UnLikely	Negligible	Low		UnLikely	Negligible	Low	Multiple regs and relief on gas side but only single reg on cal gas bottles	36. Calorie meter. 1. Cal gas bottles only have single regulator and no relief valve. Potential single point of failure. Is meter rated for cal gas pressure. 2. If reg fails, is it possible to reverse flow cal gas into the gas line? 3. Why is there a flow meter in the vent line?
Pressure Low	Regulator fails closed	Loss of combustion trim monitoring	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Used for combustion trim and combustion pressure fluctuation monitoring. Fails over to values read 30 seconds before to maintain operation on loss of instrument	
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low										Heated pressure reg in design	
Temperature – No or not											
Flow / Level – High										1/4" valves only allows low flow rates	
Flow / Level – Low										Same as low pressure	
Flow / Level – No or not										Same as low pressure	
Flow / Level – Reverse										Refer high pressure.	
Vibration – High Low or not											
As well as - concentration / two phase										We are not considering Hydrogen although this may be incorporated at a later date	
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power										Used for combustion trim and combustion pressure fluctuation monitoring. Fails over to values read 30 seconds before to maintain operation on loss of instrument	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 21 - Air & Flue Gas - Seal air Dwg A-21081 - Air & Flue gas 1 of 5											
Pressure High	Compressor surge	No experience with damage from surge	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Flow restricted with orifices. Sealing air used to contain oil in bearing and cooling casing	
Pressure Low										Cyclonic filter cannot block and air from compressor is very clean	
Pressure No or not	BPCS - Instrument failure									Alarm only	
Pressure Vacuum											
Temperature High											
Temperature Low	Potential for condensation but no experience with adverse consequences										
Temperature – No or not											
Flow / Level – High										Flow restricted with orifice	
Flow / Level – Low										same as low pressure	37. All ball valves to be lockable. Evan to confirm who is responsible for providing the pad locking system for all the manual isolation valves and to ensure the valves have lock tabs, refer also action item 4. Also send sample photos to MHI. The requirement is in the tender specification section 2.3
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase	Condensation									Water wash into seal air system is knocked out by separator after cyclonic filter	
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power	BPCS - Instrument failure									Monitoring only	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 22 - Air & Flue Gas - GT LP Bleed valve Dwg A-21081 - Air & Flue gas 1 of 5											
Pressure High	Valve, MBH01AA701, fails to open on shutdown	Compressor surge	UnLikely	Minor	Low		UnLikely	Minor	Low	MHI to check with engineering to confirm how many surges a machine is likely to see before consequential damages, i.e.. Oil seals, filter house, blade failure, etc. MHI advise that it is scary for Operator but unlikely to result in damage	
Pressure Low	Valve fails to close on start up	Reduced capability	UnLikely	Negligible	Low	Valve out of position shutdown	UnLikely	Negligible	Low	2oo3 closed limit switches	
Pressure No or not											
Pressure Vacuum											
Temperature High										Seal air prevent back flow	
Temperature Low											
Temperature – No or not											
Flow / Level – High										Same as pressure.	
Flow / Level – Low										Same as pressure.	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late		Surge								Refer pressure	
Timing / Sequence - Fast / Slow		Surge								Refer pressure	
Utility failure - instr. air / oil / power	Power or air failure		UnLikely	Negligible	Low	Valve out of position shutdown	UnLikely	Negligible	Low		
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 23 - Air & Flue Gas - GT MP Bleed valve Dwg A-21082 - Air & Flue gas 2 of 5											
Pressure High										Surge same scenarios as LP. The following for cooling air flow control	
Pressure Low											
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High	BPCS - valve position	Potentially reduced mechanical life	UnLikely	Negligible	Low	Start permissive	Rare	Negligible	Low	Valves close at full speed / load. Marginal concern, alarm only. Potentially long term consequences	
Flow / Level – Low	BPCS - valve position	Potentially reduced mechanical life	UnLikely	Negligible	Low	Start permissive	Rare	Negligible	Low		
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 24 - Air & Flue Gas - GT HP Bleed valve Dwg A-21083 - Air & Flue gas 3 of 5											
Pressure High	BPCS - valve position	Potentially reduced mechanical life	UnLikely	Negligible	Low	Start permissive	Rare	Negligible	Low	Same as MP surge scenario and heating control scenario	
Pressure High	Compressor surge	Potential mechanical damage	UnLikely	Negligible	Low	IGV out of position trip	Rare	Negligible	Low	Single surge events not considered catastrophic, refer node above. Dual redundant IGV position trip	
Pressure High	BPCS - IGV position fault	Combustion trouble or compressor surge or efficiency loss or fail to start high torque load on compressor	UnLikely	Negligible	Low	IGV out of position trip	UnLikely	Negligible	Low	IGV has mechanical minimum and maximum stop	
Pressure Low	BPCS - IGV position fault	Combustion trouble or compressor surge or efficiency loss or fail to start high torque load on compressor	UnLikely	Negligible	Low	IGV out of position trip	UnLikely	Negligible	Low	Inlet flow has no effect on combustion controls, it is only a long term diagnostic tool. Failure no consequence	
Pressure Low	BPCS - Bleed valve open	Loss of start permissive or reduced load	UnLikely	Negligible	Low	Valve out of position shutdown	UnLikely	Negligible	Low		
Pressure No or not										2oo3 casing pressure transmitters	
Pressure Vacuum										same as surge pressure high	
Temperature High										Designed for site ambient conditions	
Temperature Low										Designed for site ambient conditions	
Temperature – No or not										2oo3 inlet temp transmitters	
Flow / Level – High	BPCS - Bleed valve open	Loss of start permissive or reduced load	UnLikely	Negligible	Low	Valve out of position shutdown	UnLikely	Negligible	Low		
Flow / Level – Low	BPCS - Bleed closed on shutdown	Surge	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Already shutdown, trip won't work	
Flow / Level – No or not										Frozen filter house, refer that node	
Flow / Level – Reverse										Refer compressor surge	
Vibration – High Low or not	Imbalance or FOB	Blade failure	UnLikely	Major	Medium	Shaft vibration Hi Hi trip	Rare	Major	Medium		
As well as - concentration / two phase										Designed for site ambient conditions. Water wash demin water and detergents	
Other then - impurities / contamination										Bush fire covered in filter house node	
Timing / Sequence - Early / Late										Refer pressure for IGV and bleed valve position fault	
Timing / Sequence - Fast / Slow										Refer pressure for IGV and bleed valve position fault	
Utility failure - instr. air / oil / power	BPCS - power or oil fault	Surge on shutdown or combustion problems	UnLikely	Negligible	Low	IGV out of position trip	Rare	Negligible	Low	Bleed valves fail safe open.	38. MHI to confirm failure mode of IGV, i.e. fail last position, fail ramp closed on loss of control oil or power?
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 25 - Air & Flue Gas - Inlet duct flow Dwg A-21084 - Air & Flue gas 4 of 5											
Pressure High	Duct back pressure or combustion problems	Bearing No 1 damage due to insufficient seal air pressure	UnLikely	Major	Medium	2oo3 Exhaust pressure Hi Hi trip	Rare	Major	Medium		
		Stack damage potential	Rare	Major	Medium		Rare	Major	Medium	More serious for HRSG application, not for open cycle. Possible silencer but remote for this application.	
Pressure High											
Pressure Low											
Pressure No or not										2oo3 = run, 1oo2 = run alarm, 1oo1 = run alarm	39. 2oo3 trip voting degradation to be reviewed on a trip by trip basis by SHL, 2oo3, 1oo2 or 2oo2 and 1oo1 = trip or run?
Pressure Vacuum											
Temperature High	BPCS - control failure	Blade failure	UnLikely	Major	Medium	Blade path temperature	Rare	Major	Medium	Blade path are dual element thermocouples	9. Pantac to review blade path flameout voting logic. One or multiple burners, adjacent burners, single or duplex t/c. No optical flame detectors
						NooM Exhaust temp Hi Hi trip	Rare	Major	Medium		
		Exhaust gas temp Hi Hi - machine damage	UnLikely	Major	Medium	Blade path temperature	Rare	Major	Medium		
		Blade failure	UnLikely	Major	Medium	NooM Exhaust temp Hi Hi trip	Rare	Major	Medium	Blowdown line is normally closed. Commissioning pipe clean only	
Temperature Low	Flame out	Potential re-ignition and duct explosion	Possible	Severe	High	Blade path temperature	Rare	Severe	Medium	Same as fuel oil but probably less likely	
Temperature – No or not										Loss of thermocouple signal is a trip. Voting to be confirmed. Dual element	
Flow / Level – High	Expansion joint failure	Potential for fire	Rare	Negligible	Low		Rare	Negligible	Low		
Flow / Level – Low											
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not										Brg 1 vibration sensors are on air intake P&ID. Stack noise emissions are still being worked through by MHI and supplier for the site attenuation requirements	
As well as - concentration / two phase	Fail to ignite	Loss of production	Possible	Severe	High	Blade path temperature	Rare	Severe	Medium		
As well as - concentration / two phase	Stack failure, blowing steel debris (bits of silencer, stack wall, ducts) into the yard. After many years of operation	Potential fatality	Rare	Severe	Medium		Rare	Severe	Medium	Metal blown from stack has happened at many stations, most of them old except Laverton. > 30 years Hallett, Jeeralang, Somerton. MHI have not experienced any failures for this machine type yet	
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power	Loss of aviation control power	Compliance	UnLikely	Negligible	Low	DCS general electrical monitoring	Rare	Negligible	Low	Stack aviation lighting may be required. Stack design not finished yet.	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 26 - Air & Flue Gas - Air compressor Dwg A-21084 - Air & Flue gas 4 of 5											
Pressure High											
Pressure Low	BPCS - valve control	Loss of production - Potential GT Rotor creep or rub, reduced component life	UnLikely	Minor	Low	Automatic Runback	Rare	Minor	Low	MBH05AA731 fails closed, so air always to rotor. No immediate consequences. Valve position alarm	
		Rotor cooling labyrinth blockage over time	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Loss of dry purge air would potentially increase rotor casing corrosion through condensation. Normally starts 12 hours after shutdown. Carbon steel corrosion potential	
Pressure No or not											
Pressure Vacuum											
Temperature High										Same as low pressure for GT Rotor. All 3 cooler fans are required but spray water is not likely to be needed	
Temperature Low										Not realistic	
Temperature – No or not										MBH05CT002 just monitoring MBH05CT012/13 for fan control MBA01CT001/2 GT rotor temp, 1 can fail, 2nd fault = alarm only	
Flow / Level – High										Same as high pressure	
Flow / Level – Low										Same as low pressure	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not	Cooling fan blade fault or loss	Motor bearing damage	UnLikely	Negligible	Low	Shaft vibration Hi Hi trip	Rare	Negligible	Low	Fan blades are enclosed cannot fly off	
As well as - concentration / two phase										MBH05AA753 only open on start up and shutdown	
Other then - impurities / contamination										Inlet filter house therefore clean air	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High	Cooling fan motor fault	Loss of cooling	UnLikely	Minor	Low	Automatic Runback	Rare	Minor	Low	VSD Drive and bypass contactor. Details not apparent for HAZOP	
Volts / Amps Low	MCC fault	Loss of cooling	UnLikely	Minor	Low	Automatic Runback	Rare	Minor	Low		
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 27 - Air & Flue Gas - Combustor and Exhaust Dwg A-21084 - Air & Flue gas 4 of 5											
Pressure High	Duct back pressure or combustion problems	Bearing No 1 damage due to insufficient seal air pressure	UnLikely	Major	Medium	2oo3 Exhaust pressure Hi Hi trip	Rare	Major	Medium		
		Stack damage potential	Rare	Major	Medium		Rare	Major	Medium	More serious for HRSG application, not for open cycle. Possible silencer but remote for this application.	
Pressure Low											
Pressure No or not										2oo3 = run, 1oo2 = run alarm, 1oo1 = run alarm	39. 2oo3 trip voting degradation to be reviewed on a trip by trip basis by SHL, 2oo3, 1oo2 or 2oo2 and 1oo1 = trip or run?
Pressure Vacuum											
Temperature High	BPCS - control failure	Blade failure	UnLikely	Major	Medium	Blade path temperature NooM Exhaust temp Hi Hi trip	Rare	Major	Medium	Blade path are dual element thermocouples	9. Pantac to review blade path flameout voting logic. One or multiple burners, adjacent burners, single or duplex t/c. No optical flame detectors
Temperature High	BPCS - control failure	Exhaust gas temp Hi Hi - machine damage	UnLikely	Major	Medium	Blade path temperature	Rare	Major	Medium	Blowdown line is normally closed. Commissioning pipe clean only	
Temperature Low	Flame out	Potential re-ignition and duct explosion	Possible	Severe	High	Blade path temperature	Rare	Severe	Medium	Same as fuel oil but probably less likely	
Temperature – No or not										Loss of thermocouple signal is a trip. Voting to be confirmed. Dual element	
Flow / Level – High	Expansion joint failure	Potential for fire	Rare	Negligible	Low		Rare	Negligible	Low		
Flow / Level – Low											
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not										Brg 1 vibration sensors are on air intake P&ID. Stack noise emissions are still being worked through by MHI and supplier for the site attenuation requirements	
As well as - concentration / two phase	Fail to ignite	Loss of production	Possible	Severe	High	Blade path temperature	Rare	Severe	Medium		
As well as - concentration / two phase	Stack failure, blowing steel debris (bits of silencer, stack wall, ducts) into the yard. After many years of operation	Potential fatality	Rare	Severe	Medium		Rare	Severe	Medium	Metal blown from stack has happened at many stations, most of them old except Laverton. > 30 years Hallett, Jeeralang, Somerton. MHI have not experienced any failures for this machine type yet	
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow									0		
Utility failure - instr. air / oil / power	Loss of aviation control power	Compliance	UnLikely	Negligible	Low	DCS general electrical monitoring	Rare	Negligible	0	Stack aviation lighting may be required. Stack design not finished yet.	
Volts / Amps High									0		
Volts / Amps Low									0		
Volts / Amps - No or Not									0		

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 28 - Air & Flue Gas - GT Cooling air supply Dwg A-21085 - Air & Flue gas 5 of 5											
Pressure High											
Pressure Low	BPCS - valve control	Loss of production - Potential GT Rotor creep or rub, reduced component life	UnLikely	Minor	Low	Automatic Runback	Rare	Minor	Low	MBH05AA731 fails closed, so air always to rotor. No immediate consequences. Valve position alarm	
		Rotor cooling labyrinth blockage over time	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Loss of dry purge air would potentially increase rotor casing corrosion through condensation. Normally starts 12 hours after shutdown. Carbon steel corrosion potential	
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low										Same as low pressure for GT Rotor. All 3 cooler fans are required but spray water is not likely to be needed	
Temperature – No or not										Not realistic	
Flow / Level – High										MBH05CT002 just monitoring MBH05CT012/13 for fan control MBA01CT001/2 GT rotor temp, 1 can fail, 2nd fault = alarm only	
Flow / Level – Low										Same as high pressure	
Flow / Level – No or not										Same as low pressure	
Flow / Level – Reverse											
Vibration – High Low or not										Fan blades are enclosed cannot fly off	
As well as - concentration / two phase	Cooling fan blade fault or loss	Motor bearing damage	UnLikely	Negligible	Low	Shaft vibration Hi Hi trip	Rare	Negligible	Low	MBH05AA753 only open on start up and shutdown	
Other then - impurities / contamination										Inlet filter house therefore clean air	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High	Cooling fan motor fault	Loss of cooling	UnLikely	Minor	Low	Automatic Runback	Rare	Minor	Low	VSD Drive and bypass contactor. Details not apparent for HAZOP	
Volts / Amps Low	MCC fault	Loss of cooling	UnLikely	Minor	Low	Automatic Runback	Rare	Minor	Low		
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 29 - Lube Oil - Tank, pumps, prv Dwg A-21021 - Lube oil system 1 of 4											
Pressure High										Centrifugal pumps cannot deadhead. Can run both pumps together. No PRV back to tank only control valve MBV01AA702	
Pressure Low	Loss AC supply and the DC pump fail - Unrealistic	Double jeopardy	Rare	Major	Medium	2oo3 Lube oil pressure Lo Lo trip	Rare	Major	Medium	Accumulator for AC pump fail over, shock absorption and DC pump fail over	40. DC Lube oil pump to be tested prior or after each start to prove functionality. Replacing MBV01CP304 DC lube oil pressure gauge with a transmitter would facilitate fast auto test sequence. Requirements to be confirmed by SHL
Pressure No or not	Too many transmitters and switches to be realistic									Lube oil pressure selected as MHI consider these work much faster than transmitters	
Pressure Vacuum	BPCS - loss of pump	Bearing fire								Refer to extraction fan node	
Temperature High	BPCS - Loss of cooling	Bearing damage	UnLikely	Major	Medium	2oo3 Lube oil temperature Hi Hi trip	Rare	Major	Medium		
	BPCS - Tank heater stuck on		UnLikely	Minor	Low		UnLikely	Minor	Low	Oil tank heater is too small to create over temp scenario	
Temperature Low	Standby operation for a long time, resulting in cold oil tank	Loss of production - pump fail to start	UnLikely	Minor	Low		UnLikely	Minor	Low	Oil tank heater maintains 15 C on, 20 C off	
Temperature – No or not										Oil tank heater is too small to create over temp scenario. Manifold 2oo3	
Flow / Level – High	Pipe / gland leak	Potential pool fire, low oil pressure								Oil pressure greater than cooler water supply, wont leak into tank	
Flow / Level – Low	Blocked filter and MBV01CP501 not working	Potential bearing damage	Rare	Major	Medium		Rare	Major	Medium	Normal oil level 1.634mm from bottom of tank. Low level 148mm lower. Low level results in low pressure trip	
Flow / Level – No or not										MBV01AA702 stuck closed is protected by the bypass orifice MBV01BP102 which is sized to maintain minimum supply	
Flow / Level – Reverse										Check valves on all pumps	
Vibration – High Low or not											
As well as - concentration / two phase										Managed by standard maintenance procedures and oil analysis. Base load station may change over every 5 or so years. Peaking plant may last a very long time.	
Other then - impurities / contamination											
Timing / Sequence - Early / Late						2oo3 Lube oil pressure Lo Lo trip					
Timing / Sequence - Fast / Slow						2oo3 Lube oil pressure Lo Lo trip					
Utility failure - instr. air / oil / power										Would need to lose both AC and DC supply and not shutdown. Not realistic	
Volts / Amps High										MCC is monitored. No realistic to lose both AC and DC supplies	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 30 - Lube Oil - GT bearings Dwg A-21022 - Lube oil system 2 of 4											
Pressure High	BPCS - loss of AC pumps	Bearing fire	UnLikely	Major	Medium	1oo1 MBV10CP101 Loss of vacuum Normal Stop	Rare	Major	Medium	Also Refer to extraction fan node	
Pressure Low						2oo3 Lube oil pressure Lo Lo trip				Refer node above	
Pressure No or not										Bearing pressure transmitter fault alarm only. Used for monitoring only. Loss of vacuum transmitter alarm only	
Pressure Vacuum										refer pressure high above	
Temperature High	Bearing faults, debris or rub	Bearing damage	UnLikely	Major	Medium		UnLikely	Major	Medium	Bearing > 107 C and lube oil return temp hi alarm > 85 C. Supply oil > 60 alarm, > 65 trip	41. SHL to review high temperature alarm shutdown requirements for Hunter. Remote operator may not react in time.
Temperature Low										Refer node above	
Temperature – No or not										Alarm only at this time, subject to action item 41	
Flow / Level – High										Loss of vacuum refer high pressure above	
Flow / Level – Low										No experience of lube oil drain or seal lines blocking flow	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not	Imbalance, bearing faults, debris or rub	Machine damage - blades	Rare	Major	Medium	Shaft vibration Hi Hi trip	Rare	Major	Medium	Refer dwg 21088	
As well as - concentration / two phase	Hydrogen in Lube Oil, refer generator node									Generator bearing seal oil A-13C870	
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High										Loss of motor starter but still have air	42. SHL may request additional oil sampling point downstream of the bearings (generator and turbine). MHI to review installation requirements and advise accordingly
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 31 - Lube Oil - Temp control Dwg A-21023 - Lube oil system 3 of 4											
Pressure High											
Pressure Low	Blocked exchanger	Potential bearing damage	Rare	Major	Medium	2oo3 Lube oil pressure Lo Lo trip	Rare	Major	Medium	Also have alarm and dP across filter, dual exchangers. Change over should be done off line or very very slowly online. Also fill line with bypass valve, MBV01AA103. Standard operating procedure required	
Pressure No or not											
Pressure Vacuum											
Temperature High	BPCS - Loss of cooling	Bearing damage	UnLikely	Major	Medium	2oo3 Lube oil temperature Hi Hi trip	Rare	Major	Medium		
Temperature Low										Heated tank	
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low	Blocked exchanger or bypass stuck closed, continuous bypass	Bearing damage	UnLikely	Major	Medium	2oo3 Lube oil temperature Hi Hi trip	Rare	Major	Medium		
Flow / Level – No or not											
Flow / Level – Reverse										All manual ball valves to be lockable	
Vibration – High Low or not											
As well as - concentration / two phase										Cooling water to be circulated on cold days	
Other then - impurities / contamination	Unit on standby (98% likely) and heater exchanger plate leak (1/50 years) and water recirculating on cold days (1/yr), potential CW ingress to oil system	Slug of oily water to bearings	Rare	Negligible	Low		Rare	Negligible	Low	Not realistic if continuous barring. Exchanger is 'plate in frame' design which are less likely to leak compared to tube type.	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow	Operator switches changeover valve too quickly	Loss of Production - false trip	Certain	Negligible	Low	2oo3 Lube oil pressure Lo Lo trip	Certain	Negligible	Low		
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 32 - Lube Oil - Mist extraction fans Dwg A-21024 - Lube oil system 4 of 4											
Pressure High											
Pressure Low											
Pressure No or not										Loss of PT MBV10CP101 is an alarm only, the unit will keep running. Is it a start permissive? No but both extraction fans have MCC monitoring	
Pressure Vacuum	Blocked filter or loss of fans	Bearing fire	UnLikely	Major	Medium	1oo1 MBV10CP101 Loss of vacuum Normal Stop	Rare	Major	Medium	Duty Standby fans, single PT on oil tank	
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low	Blocked filter or loss of fans	Bearing fire	UnLikely	Major	Medium	1oo1 MBV10CP101 Loss of vacuum Normal Stop	Rare	Major	Medium		
Flow / Level – No or not										same as low flow	
Flow / Level – Reverse											
Vibration – High Low or not										AECOM will construct solid platform for elevated vent stack, discharge to oily water pit or oil drop receiver	
As well as - concentration / two phase										air and oil mist	
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power										Same as low flow	
Volts / Amps High										Both fans have overload protection and are monitored in the MCC	
Volts / Amps Low											
Volts / Amps - No or Not										Both fans have overload protection and are monitored in the MCC	

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 33 - Lube Oil - Generator bearing seal oil Dwg A-13C870 -											
Pressure High										This drawing covered by the Generator nodes	
Pressure Low											
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low											
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination											
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 34 - Control Oil - Tank, pumps, temp control Dwg A-21031 - Control oil system 1 of 3											
Pressure High	Cooler blockage leads to high return line drain pressure	Loss of control oil return and - potential valve position error / slow response trip	Rare	Major	Medium	PRV MBX01AA114	Rare	Major	Medium	Piston pumps have internal pressure relief and the control oil lines have PRVs. Control oil filters are also monitored. The system is not designed to run both pumps at the same time but it is possible to force this event which is protected by the PRV back to the tank	
						Valve out of position shutdown				Note the trip circuit dumps directly to the tank, therefore high return pressure has no impact on tripping capability	
Pressure Low	Loss AC supply	Loss of production trip, potential surge of compressor on rundown if IGV fails last position	UnLikely	Negligible	Low	2oo3 Control oil pressure Lo Lo trip	UnLikely	Negligible	Low	Passing PRV covered by standby pump	
Pressure No or not										Faulty transmitter will start backup pump	
Pressure Vacuum										Not possible tank fitted with breather	
Temperature High	BPCS - Tank heater stuck on		UnLikely	Minor	Low					Oil tank heater is too small to create over temp scenario	
Temperature High	Cooler fault	Loss of oil properties, potential low oil pressure false trip	UnLikely	Negligible	Low	1oo1 MBX01CT001 control oil tank temp alarm	Rare	Negligible	Low	Oil tank heater is too small to create over temp scenario. Heater stops at 20 C	
Temperature Low	Heater fault and not operating	Potential for pump damage due to high viscosity oil	UnLikely	Negligible	Low	1oo1 MBX01CT001 control oil tank temp alarm	Rare	Negligible	Low	Pump cannot be stopped by Operator. Normally just keeps running	
Temperature – No or not										Alarm only	
Flow / Level – High	Unit shutdown and exchanger leak and cooling water pumps running - Not realistic									Not realistic if continuous barring. Exchanger is 'plate in frame' design which are less likely to leak compared to tube type. Oil pressure greater than cooler water supply, wont leak into tank	
Flow / Level – Low	Pipe / gland leak	Potential pool fire, low oil pressure trip	Rare	Major	Medium	Fire detection and suppression systems	Rare	Major	Medium		
Flow / Level – Low										MBX01CL201 tank level low is an alarm only. Not a start permissive	43. There is a wall in the oil tank which may create different tank levels, design to be confirmed by MHI
Flow / Level – No or not	Blocked filters	Loss of production - trip				2oo3 Control oil pressure Lo Lo trip				Filter hi dP alarm	
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase										Oil piping dead lag leading to oil waxing discussed but MHI have not experienced that.	
Other then - impurities / contamination	Metal fragments or varnish from oil	Potential of slow valve response of stuck	Rare	Negligible	Low		Rare	Negligible	Low	Tank fitted with cleaning system, that runs continuously when oil pumps are running, MBX11SS101. Magnet in tank but is not accessible without draining the tank	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power	Loss AC supply	Loss of production trip, potential surge of compressor on rundown if IGV fails last position	UnLikely	Negligible	Low	2oo3 Control oil pressure Lo Lo trip	UnLikely	Negligible	Low		
Volts / Amps High										Both pumps have overload protection and are monitored in the MCC	
Volts / Amps Low										CO pumps and cooling water systems run continuously and must be manually switched off.	
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 35 - Control Oil - Fuel valve position control Dwg A-21032 - Control oil system 2 of 3											
Pressure High											
Pressure Low	Slow valve response					2oo3 Control oil pressure Lo Lo trip	Rare	Negligible	Low		
Pressure No or not											
Pressure Vacuum											
Temperature High										Valves are close to turbine but in an enclosure (radiant heat shield). No history of problems	
Temperature Low											
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low										Low flow valve position error and flame out covered in the burner and fuel system nodes	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination										refer previous node. Slow response will lead to valve position error trip covered in the burner fuel system nodes	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											44. Fuel gas and Fuel Oil control oil dump valves are single point of failure and common cause fraction is high. Is this allowed per the standard. Valves should failsafe and individually actuated?? PVD to review in detail as part of AS3814 compliance
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 36 - Control Oil - Fuel valve trip solenoids & Inlet Guide Vanes Dwg A-21033 - Control oil system 3 of 3											
Pressure High										refer previous node	
Pressure Low						2oo3 Control oil pressure Lo Lo trip	Rare	Negligible	Low	refer previous node	
Pressure No or not										refer previous node	
Pressure Vacuum										refer previous node	
Temperature High											
Temperature Low	Heater fault and not operating									refer oil tank nodes. Very cold viscous oil may reduce control valve & solenoid flow response time but discussed at length and not expected to effect time critical trips such as overspeed.	
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low	Failed solenoid									Refer action item 45 below	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination										refer filters in previous node	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow	Notes on viscosity above										
Utility failure - instr. air / oil / power										Fuel control valves, refer P&ID notes. Fail open de-energize to trip. This drawing shows operating state of gas operation, therefore fuel oil is shown tripped. 1oo1 solenoid to trip fuel, common cause factor and hardware fault tolerance for SIL rating to be confirmed. Single point of failure Overspeed trip, Fail open de-energize to trip. Solenoids shown in normal operating state (not de-energized state). 2oo4 to trip	45. Control oil dump circuits to be reviewed against SIL requirements and AS3814 compliance
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 37 - Package Enclosure Ventilation Dwg A-21088 - Protection system P&ID											
Pressure High	Loss of AC supply - no ventilation	Potential over-temperature in enclosure, potential gas cloud accumulation	UnLikely	Major	Medium	Loss of ventilation trip	Rare	Major	Medium	Fans normally operate continuously	
Pressure Low											
Pressure No or not										Loss of fan flow transmitter starts standby fan. All 3 fans can run at the same time	
Pressure Vacuum											
Temperature High	Fire in the enclosure	Major equipment damage	Rare	Major	Medium	Fire detection and suppression systems	Rare	Major	Medium	MHI has not experienced fires with this package yet	
Temperature Low											
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low											
Flow / Level – No or not											
Flow / Level – Reverse										Fans have discharge check valves	
Vibration – High Low or not										Shaft vibration shown in this node but covered in the air compressor node. Overspeed shown in this node but covered in the burners section node	
As well as - concentration / two phase	Gas leak, potential oil mist from high pressure control oil leak, CO2 from fire system, H2 and N2 unlikely but from generator package	Fire / explosion	UnLikely	Major	Medium	Combustible gas detection trip	Rare	Major	Medium	Operator must isolate CO2 before entering package. There is a CO2 lockout next to the door. CO2 isolation alarms but does not interlock the door	46. Note AECOM responsible for Fire protection of the Balance of Plant equipment such as lube oil package, fuel oil pump / valve systems and how that system is interlock or integrated into the plant DCS or MHI GT controls. AECOM is design stage now. Fire safety study is well advanced MHI fire and gas detection limited to GT enclosure and Fuel Gas valve systems. SHL to review final design proposal
Other then - impurities / contamination										Clean air from filter hoods used for package ventilation. Louvre dampers at bottom of package close on fire detection, refer comments on P&ID	47. Door tracking isolating the CO2 if someone enters the GT is to be confirmed by vendor and reviewed by SHL
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power						Loss of ventilation trip					
Volts / Amps High										Overload protection and monitoring contactor status	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 38 - Air & Flue Gas - Inlet filter Dwg A-21084 - Protection system P&ID											
Pressure High											
Pressure Low											
Pressure No or not										Loss of signal alarm only	
Pressure Vacuum	Filter blockage	Potential filter media ingress and compressor damage	Rare	Major	Medium	2oo3 Inlet filter dP Hi Hi trip	Rare	Major	Medium	Final consequence likelihood limited by SHL risk matrix. Not modified to be conservative	
Temperature High											
Temperature Low	Potential filter freezing	Potential filter media ingress and compressor damage	Possible	Major	High	2oo3 Inlet filter dP Hi Hi trip	Rare	Major	Medium	Adjust this row after MHI action item 48 resolved	48. Ambient conditions -5 C to +45 C. Anti-icing system was considered in the tender specification but MHI advised at that time it is not required. MHI to revisit the study and reconfirm anti-icing is not required.
Temperature – No or not										Loss of ambient temp sensor will alarm and inhibit evap permissive	
Flow / Level – High											
Flow / Level – Low										same as pressure vacuum	
Flow / Level – No or not											
Flow / Level – Reverse	Compressor surge									No history of filter house impact	
Vibration – High Low or not											
As well as - concentration / two phase	Icy water, snow, dust storm, fly ash bushfire	Potential filter media ingress and compressor damage	Possible	Major	High	2oo3 Inlet filter dP Hi Hi trip	Rare	Major	Medium		
Other then - impurities / contamination											
Timing / Sequence - Early / Late										Filter cleaning pulse system not part of the scope for this site	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High										Evap motors have overload protection breaker is monitored and alarmed	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 39 - Gas Turbine - Casing cooling Dwg A-21090 - GT Casing cooling system											
Pressure High										High pressure coming back to fan, rated at 1 Bar is not realistic with double block fail closed valves	
Pressure Low	BPCS - valve failed closed or fan not operating	Loss of production - Loss of start permissive	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Operator can manually start spin turning to even up temperature. Although lack of cooling may result in a rub there is spin cooling back manual operation. Only operates after shutdown and turning/barring speed is reached 3 rpm, to prevent hogging, rub due to unequal casing rotor expansion. Back up is high speed turning 'spin cooling' at 600 rpm If the difference of the two (2) thermocouples located on the upper and the lower half of the same casing section exceeds the reference setting, an alarm will be generated. This alarm does not allow GTC to initiate the normal starting sequence. Rub for any reason would need inspection (borescope)	
Pressure No or not											
Pressure Vacuum										Inlet damper not tight shutoff. Excessive vacuum not possible	
Temperature High										Adjacent unit exhaust quite far from this unit, so no ambient temperature rise expected	
Temperature Low											
Temperature – No or not	BPCS - Signal fault	Loss of production - Loss of start permissive	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Alarm	
Flow / Level – High											
Flow / Level – Low	Blocked filter	Loss of production - Loss of start permissive	UnLikely	Negligible	Low	QEF13CP501 Inlet filler dP alarm	Rare	Negligible	Low	Filter media ingress not considered likely with dP alarm in service	
	BPCS - Flow control	Loss of production - Loss of start permissive	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Manual valves to be locked in position	
Flow / Level – No or not											
Flow / Level – Reverse										High pressure coming back to fan, rated at 1 Bar is not realistic with double block fail closed valves. Leak test point request to MHI to be considered based on cost and schedule impact	
Vibration – High Low or not										Pump has flexible coupling	
As well as - concentration / two phase										Self draining lines, condensation not a problem	
Other then - impurities / contamination										Inlet filter therefore clean air	
Timing / Sequence - Early / Late	BPCS - commissioning error	Potential hot gas reverse flow	UnLikely	Negligible	Low	Operator alarm response	UnLikely	Negligible	Low	Position limit switch alarm and restriction orifice plates at casing to reduce the impact	
Timing / Sequence - Fast / Slow										Same as low flow	
Utility failure - instr. air / oil / power										Same as low flow	
Volts / Amps High										MCC is monitored.	
Volts / Amps Low											
Volts / Amps - No or Not										Same as low flow	

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 40 - Gas Turbine - Blade washing device Dwg A-21086 - GTW Washing and drain system 1 of 2											
Pressure High	Operator error - Overfilling tank	Soapy water on floor, potential burst line Operator exposed to high pressure water jet, fragment debris	Possible	Moderate	Medium	PRV 90SSD01AA904	Possible	Negligible	Low	Moveable device dwg first	
Pressure Low										Process just takes longer to empty the tank	
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High	Operator error - Overfilling tank	Soapy water on floor, potential burst line Operator exposed to high pressure water jet, fragment debris	Possible	Moderate	Medium	PRV 90SSD01AA904	Possible	Negligible	Low		
Flow / Level – Low										150 lpm for 2 minutes. Needle valve adjusted during commissioning, 90SDD01AA108	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination										Demin water and detergent liquid. All clean service. 304 Stainless steel. Service air clean and last catch strainer before tank	
Timing / Sequence - Early / Late	Operator error - Select Off-line or On-line valve	No major difference, less optimal cleaning	Possible	Negligible	Low		Possible	Negligible	Low		
Timing / Sequence - Fast / Slow		No major difference, less optimal cleaning									
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 41 - Gas Turbine - Blade washing and drain system Dwg A-21087 - GTW Washing and drain system 2 of 2											
Pressure High											
Pressure Low											
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High	Operator error - leave drain valve open	Potential hot pipework, loss of capacity (less combustion air), air venting at drain pit	Rare	Negligible	Low		Rare	Negligible	Low	Double hand valves to prevent leakage	33. Water wash procedure has many manual valves which could potentially lead to false start by flooded combustion chamber and subsequently detergent flow into the oil water pit. SHL to develop a water wash procedure with 2 operators to cross check. Water washing drain header could also have small amounts of diesel residue from liquid fuel false start.
Flow / Level – Low											
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase										Same as previous node, Clean demin, air and soap. Water rinse does not need to be analysed / visual checked	
Other then - impurities / contamination										Carbon drain valves corrosion?	
Timing / Sequence - Early / Late	Operator error	Potential for water corrosion if left in machine wheel space for a long time or potential vibration on run up with excessive water in casing	Rare	Negligible	Low		Rare	Negligible	Low	Potential for water corrosion if left in machine wheel space for a long time or potential vibration on run up with excessive water in casing. MHI to check if opening the offline valve when online creates any hazard	33. Water wash procedure has many manual valves which could potentially lead to false start by flooded combustion chamber and subsequently detergent flow into the oil water pit. SHL to develop a water wash procedure with 2 operators to cross check. Water washing drain header could also have small amounts of diesel residue from liquid fuel false start.
Timing / Sequence - Fast / Slow	Operator error	Water accumulates in inlet filter casing								Designed for on-line and off-line water wash. Casing drain valve should be open for water wash, MBA01AA915	
Utility failure - instr. air / oil / power										Off-line performed at spin cycle, 600 rpm	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 42 - Evaporative Cooler - pump and tank unit Dwg C-50011 - Evaporative cooler system											
Pressure High	BPCS - Valve out of position	Loss of efficiency	UnLikely	Negligible	Low	Operator alarm response	Rare	Negligible	Low		
Pressure Low	BPCS - power fault	Loss of efficiency	UnLikely	Negligible	Low	Operator alarm response	Rare	Negligible	Low	MCC is monitored.	
	Empty tank or blocked strainer	Loss of efficiency, potential pump damage	UnLikely	Negligible	Low	Operator alarm response	Rare	Negligible	Low	Pump suction pressure switch is monitored	49. Valve numbers and instrument numbers and line sizes are not shown on the drawing. Return valve is shown as control valve but is actually a manual lockable isolation valve
Pressure No or not											
Pressure Vacuum										Same as low pressure	
Temperature High										Refer impurities bacteria	
Temperature Low										Low ambient temp not a concern as evap is not enable below 15 Celsius	
Temperature – No or not											
Flow / Level – High	BPCS - Level control failure	Water to drain	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Excessive water flow just returns to the tank. There is also a mist eliminator to catch water droplets. Even then unlikely to do anything to the compressor.	50. Evap tank water is potable water. Should overflow or draining be discharged to Trade Waste or Storm Water. AECOM to review and design accordingly
Flow / Level – Low	BPCS - Level control failure	Loss of efficiency	UnLikely	Negligible	Low	Operator alarm response	Rare	Negligible	Low		
Flow / Level – No or not						Operator alarm response					
Flow / Level – Reverse										Not possible tank fitted with breather and overflow	
Vibration – High Low or not											
As well as - concentration / two phase											
Other then - impurities / contamination										Where is the conductivity meter? Not in MHI scope of supply. System continuously blows down to refresh water in tank. Legionella microbe growth in tank? Has happened in Colongra. Snowy to monitor	51. Evap tank has no sample point. MHI to review option to supply
Timing / Sequence - Early / Late										Potential for very heavy media damage discussed but not considered likely by MHI. Has happened at Laverton	
Timing / Sequence - Fast / Slow										8 to 10 minutes to fully saturate the media. 9 minutes to achieve 90% power boost	
Utility failure - instr. air / oil / power		Loss of efficiency	UnLikely	Negligible	Low	Operator alarm response	Rare	Negligible	Low		
Volts / Amps High										MCC is monitored.	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 43 - Burner nozzle purge air supply and control Dwg A-21100 & A-21042B - Purge air system											
Pressure High	BPCS - Valve out of position	Potential loss of containment, pump damage	UnLikely	Moderate	Medium	PRV QEE02AA903	Rare	Moderate	Low		
Pressure Low	BPCS - Compressor problem, control loop	Loss of production - fuel oil nozzle carburised	Rare	Negligible	Low		Rare	Negligible	Low	Duty standby pump and low pressure air when shutdown from LP service air. LP air to be on for 960 minutes after shutdown. Potential nozzle carburising / coking potential failed to reach maximum fuel flow due to restriction. Top off outage to remove fouling. AECOM already have action item on the minimum length of time lower pressure purge air is required. Sizing to be confirmed	
Pressure No or not										2oo3 Flow Transmitter and 1oo2 Pressure Transmitter, redundant flow control valves	
Pressure Vacuum	Blocked filter									Detail design not available at this time	
Temperature High											
Temperature Low										Potential auto drain trap freezing but that would be a short term issue, 4 hours. Will not create a process water carry over. The receiver is 13m3, big enough for days of water collection	
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low	BPCS - Valve out of position	Loss of production - fuel oil nozzle carburised	UnLikely	Minor	Low	Operator alarm response	Rare	Minor	Low	Primary fuel will be gas. It is considered unlikely that one coking event will contribute more than 10% capacity loss. Suggest seek industry operational experience to better quantify this coking scenario. Can annular burners accessible from outside.	
Flow / Level – No or not										Not likely 2oo3 FT	
Flow / Level – Reverse										Check valves and fail close double block valves	
Vibration – High Low or not											
As well as - concentration / two phase										Water carry over from receiver was discussed at length and not considered plausible. Water is mixed with air and would vaporise before the burners. Quenching not likely. Faulty drain trap covered by routine operator procedure to check receiver drain function.	
Other then - impurities / contamination										Possible scenarios are compressor oil, water humidity and dust but system has adequate filters. There may be construction earth works dust present	
Timing / Sequence - Early / Late										Sequencing controlled by speed interlock and when fuel oil firing stops (change over or shutdown). HP purge air on when firing gas and service when 3 rpm turning. MHI will provide sequence timing charts later to explain how the sequencing works	
Timing / Sequence - Fast / Slow										Potentially increased risk of minor coking. Reverse oil flow not considered a realistic event as there are many block valves and check valves between the receiver and the burner nozzles	
Utility failure - instr. air / oil / power										Is possible if the site black outs, loss of low pressure service air. All valves fail closed	
Volts / Amps High										MCC is monitored.	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 44 - Generator cooling water Dwg A13C868 - Cooling water P&ID											
Pressure High	Heat exchanger tube leak, resulting in water entering the Hydrogen system	Generator damage - Imbalance rotor washing, insulation failure, flash over	UnLikely	Major	Medium	dual Hi Hi level Generator water detectors	Rare	Major	Medium	H2 5 Bar Cooling water 6 - 7.5 Bar	52. MELCO interface details required for AECOM water services. Water pressure recently increased to 7.5 Bar. AECOM to advise MELCO final supply pressure. MELCO cooler to be designed accordingly
Pressure Low	Loss of AC or pump or valve would result in low water pressure. Potential exposure to Hydrogen entering water if there was a tube leak	Double jeopardy	Rare							Water cooling system HAZOP required on loss of CW pressure	
Pressure No or not											
Pressure Vacuum											
Temperature High	Loss of efficiency, loss of AC, or valve out position	Loss of cooling would have long term effect on stator winding insulation	UnLikely	Major	Medium	Stator winding temp Hi auto stop	Rare	Major	Medium	Design max cooling water delivery is 51 Celsius. Name plate rating 456 MVA with 23 Deg C cooling water. High temperature would raise H2 pressure a little but not catastrophically. There is also a high pressure alarm at 5.35 Bar	53. MELCO to provide full list of generator protection settings, trips complete with alarms, auto shutdown and run backs
Temperature Low										Water running continuously, freezing of water not considered realistic. Fin fan coolers weakest point for freezing but recirculation prevents freezing	
Temperature – No or not											
Flow / Level – High										No flow control	
Flow / Level – Low	Operator error - valve out of position	Loss of cooling would have long term effect on stator winding insulation	UnLikely	Major	Medium	Stator winding temp Hi auto stop	Rare	Major	Medium		
Flow / Level – No or not											
Flow / Level – Reverse										Tube failure covered in pressure	
Vibration – High Low or not											
As well as - concentration / two phase										Potential for ice, refer above temp low	
Other then - impurities / contamination										Demin water, clean service. Manual top and sample point for water quality checks	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 45 - Generator CO2 gas supply	Dwg AS29623 - Generator H2 & CO2 gas supply diagram for GT										
Pressure High	BPCS Regulator failure	Loss of containment	UnLikely	Major	Medium	PRV RV-2 CO2 release	Rare	Major	Medium	45A Pressure regulation is not part of this node	
Pressure Low	Insufficient purge flow. Need 1.5 volumes for maintenance and 2.0 times for emergency	Potential explosion / flammable mixture under maintenance								Pressure regulation is not part of this node and there is a gauge on the skid. May need pressure switch monitoring for auto purge system. Currently manual operating procedure. Risk assessed in the regulator node	55. CO2 site capacity to be assessed against minimum volume required for a successful purge times a safety factor. Potential bottle leak reduces capacity. Is adequate monitoring installed, flow pressure bottle weight
Pressure No or not	Operator error - valve out of position	Potential explosion / flammable mixture under maintenance	UnLikely	Major	Medium	Dual operator procedure	Rare	Major	Medium	Multiple gauges. Standard procedure to check vent gas for H2 content	54. Manual purging requires strict procedure with 2 people to cross check to confirm successful purge
Pressure Vacuum											
Temperature High											
Temperature Low										Lines freezing considered in AECOM HAZOP. Heat tracing not required	
Temperature – No or not											
Flow / Level – High										CO2 leak from pipework has good ventilation, not an enclosed space	
Flow / Level – Low	BPCS - Seal oil system failure	Loss of containment - Potential explosive mixture in or around the generator resulting in fire explosion machine damage, refer Callide incident	UnLikely	Severe	High	Automatic H2 vent and CO2 purge	Rare	Severe	Medium	There is a manually actuated (remote controlled) vent valve but it is not automated in the event of a seal failure. Reasons for emergency auto vent is Seal oil failure, generator enclosure fire, major leak very low pressure requires vessel to be purged? MHI have never automated H2 purge system. Not every seal failure would lead to explosion / fire but there are quite a few sites in Australia with automated vent and purge systems so it is best practice.	56. Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. MHI incorporate in design, logic to action valve.
Flow / Level – No or not	BPCS - CO2 supply failure	Loss of purge - H2 left in generator potential maintenance staff exposure to fire / explosion	UnLikely	Severe	High	Automatic H2 vent and CO2 purge	Rare	Severe	Medium		57. Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. AECOM to incorporate automate CO2 supply to the units
Flow / Level – Reverse											
Vibration – High Low or not										Vent stack designed for high flow thrust	
As well as - concentration / two phase										CO2 and H2 or CO2 and Dry instrument air in later nodes	
Other then - impurities / contamination										Clean CO2	
Timing / Sequence - Early / Late										To be reviewed after automated system design is completed	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power										To be reviewed after automated system design is completed - suggest fail safe closed	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 46 - Generator H2 gas supply Dwg AS29623 - Generator H2 & CO2 gas supply diagram for GT											
Pressure High	BPCS - regulator fails open	Loss of Production - Continuous venting of H2 until supply exhausted	UnLikely	Negligible	Low	Operator alarm response	Rare	Negligible	Low	Node 45B AECOM have H2 manifold pressure monitoring with Hi and Lo alarms	58. Unit H2 flow meter can be used for make up flow monitoring, leak and PRV lifting detection. SHL to review
Pressure Low	BPCS - regulator fails closed or leak	Loss of cooling would have long term effect on stator winding insulation	UnLikely	Major	Medium	Stator winding temp Hi auto stop	Rare	Major	Medium		
Pressure No or not											
Pressure Vacuum											
Temperature High										90% above ground next to gas line. Ambient temperature only. 17 m3/day make up	
Temperature Low											
Temperature – No or not											
Flow / Level – High										Same as pressure high	
Flow / Level – Low		Blocked filter	UnLikely	Negligible	Low	Operator alarm response	Rare	Negligible	Low	Same as pressure low	
Flow / Level – No or not										Same as pressure low	
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase										100% H2	
Other then - impurities / contamination										Due consideration is given to piping materials. Mostly carbon steel suitable for low pressure H2 applications but MELCO supply all 304 stainless steel (SUS)	59. AECOM to review H2 pipework for dissimilar metals. MELCO supply all 304 stainless. Potential corrosion and Haz area issue
Timing / Sequence - Early / Late										To be reviewed after automated system design is completed - suggest fail safe closed	
Timing / Sequence - Fast / Slow										H2 is contained with seal oil even when the unit is completely shutdown and not rotating	
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 47 - Generator CO2 Dwg A13C869 - H2 and CO2 for P&ID for GT											
Pressure High										CO2 Pressure regulation previous node. Automation to be considered	
Pressure Low										Refer previous node	
Pressure No or not											
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High	Operator - sets valve open	Lift prv, environment but small issue if attended	Possible	Negligible	Low		Possible	Negligible	Low	Needle valve on CO2 sets the supply flow rate. Operator looks at PI3 to set flow rate. Would need regulator for automated system	
Flow / Level – Low	Operator error - valve out of position	Potential explosion / flammable mixture under maintenance	UnLikely	Major	Medium	Dual operator procedure	Rare	Major	Medium	Multiple gauges. Standard procedure to check vent gas for H2 content	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase										CO2 and H2 or CO2 and Dry instrument air in later nodes	
Other then - impurities / contamination										Clean CO2. no filter on drawings. H2 has 2 filters. CO2 pipework rarely used could cause fouling issue	60. CO2 line has no filter or strainer. It is rarely used which could create fouling issues. MELCO to consider and quote option
Timing / Sequence - Early / Late										Review after automated vent and purge design is completed	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 48 - Generator H2 Dwg A13C869 - H2 and CO2 for P&ID for GT											
Pressure High	BPCS Regulator failure	No real concern				PRV RV-1 H2 release				CV-1 failure would raise pressure to 7 bar RV-1 set to 7 bar	
Pressure Low	BPCS Regulator failure	Loss of cooling would have long term effect on stator winding insulation	UnLikely	Major	Medium	Stator winding temp Hi auto stop	Rare	Major	Medium	H2 make up valve is manual at this time.	61. MELCO to review automating the Hydrogen make up valve as the site is normally not manned.
Pressure No or not										PT1 - H2 pressure in generator. Single sensor to interlock for HiHi and LoLo pressure	62. Hydrogen pressure transmitter PT1 is potentially a single point of failure for an unmanned site. MHI to confirm signal failure response
Pressure Vacuum											
Temperature High	BPCS Regulator failure	Loss of cooling would have long term effect on stator winding insulation	UnLikely	Major	Medium	Stator winding temp Hi auto stop	Rare	Major	Medium	Stainless steel piping. Mounting suitable for expansion. Carbon steel within generator designed to maximum Hydrogen temperature on loss of cooling	
Temperature Low	Ambient temperature	Loss of production and instrument failure	Certain	Negligible	Low		Certain	Negligible	Low	-5 Celsius, analyser doesn't have a heater but is suitably rated. Located under the generator near the pedestal on an open gear plate	66. Site wide review of field mounted instrumentation junction boxes and field panels required. These are normally fitted with heaters to prevent condensation 67. MHI to supply instrumentation datasheets for action item 66. To confirm field instrumentation ratings, i.e. +5 - +45 non-condensing??
Temperature – No or not											
Flow / Level – High	Leak	Potential explosive atmosphere	UnLikely	Minor	Low		UnLikely	Minor	Low	Open access area classified as Hazardous Area well ventilated area, fatality unlikely	68. AECOM to study hydrogen detection requirements for this open area plant area and that location is under exciter which probably has cooling fans that could draw H2 into enclosure
	Heat exchanger tube leak, resulting in water entering the Hydrogen system	Generator damage - Imbalance rotor washing, insulation failure, flash over	UnLikely	Major	Medium	dual Hi Hi level Generator water detectors	Rare	Major	Medium	H2 5 Bar Cooling water 6 - 7.5 Bar	
Flow / Level – Low											64. Melco to confirm what happens to the purity meter if CV-1 fails and flow is too low or no flow or needle valve set incorrectly. Hydrogen purity is important for purging requirements
Flow / Level – No or not										No flow transmitters only indicators	
Flow / Level – Reverse	CO2 manual isolation valve out of position or passing	H2 leaking back into CO2 supply system up the check valve	UnLikely	Negligible	Low		UnLikely	Negligible	Low		69. MELCO to add check valve before CO2 manual isolation valve
Vibration – High Low or not										Fit for purpose mounting and fixing. Can be rechecked on site.	
As well as - concentration / two phase	Dew point from tube leak, refer cooling water node									Loss of purity analyser signal will alarm. It is possible to determine purity (density) from DPI1 but only at rated speed. Danger for purity is < 35%. As long as seal oil system is operating, it is not possible to accumulate moisture but there is a hydrogen dryer. Cooling exchanger water leak is most likely	63. Dew point monitoring is currently not part of the scope. SHL to request a quotation from MDI to add dew point monitoring
Other then - impurities / contamination										Loss of purity analyser signal will alarm	
Timing / Sequence - Early / Late	All manual valves	Low hydrogen pressure, loss of cooling, stator winding damage	UnLikely	Major	Medium	Stator winding temp Hi auto stop	Rare	Major	Medium	Manual H2 topping has time to respond, say 2 days from the time of alarm under normal circumstances	
Timing / Sequence - Fast / Slow	All manual valve operation. Insufficient purge flow. Need 1.5 volumes for maintenance and 2.0 times for emergency	Loss of purge - H2 left in generator potential maintenance staff exposure to fire / explosion	UnLikely	Severe	High	Dual operator procedure	Rare	Severe	Medium	Purge complete based on flow timing and analyser	65. SHL to develop written procedure for sampling purity with portable analyser to confirm main analyser reading is correct. Drain sampling and valve switching is manual to select top or bottom of the generator sampling. Note sampling drain point is within hazardous area
Utility failure - instr. air / oil / power										All valves fail closed	
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not	Loss of analyser.	Purge delays									

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 49 - Generator H2 drying system Dwg A13C869 - H2 and CO2 for P&ID for GT											
Pressure High										Very low pressure blower	
Pressure Low	Leak or enclosure seals passing	Hydrogen leak, potential for fire / explosion	Rare	Minor	Low		Rare	Minor	Low	Manufactured to Australian pressure vessel standards	
Pressure No or not											
Pressure Vacuum											
Temperature High										Auto ignition temperature of H2 is 585 C well above 1.6 KW heater design 200 (170 + ambient). Temp switch cut out is 50 C above expected normal operating temp. Not a control circuit only protection. Vessel is lagged to protect Operator hot contact	
Temperature Low	BPCS - Heater failure	Potential long term humidity winding damage	UnLikely	Moderate	Medium	Dew point monitoring	Rare	Moderate	Low	Dew point alarms excess moisture	71. MELCO to quote additional double block and vent isolation valves for on-line maintenance of heater system, to eliminate H2 purge of complete system. Snowy standard maintenance requirement
Temperature – No or not	Loss of heater over-temperature circuit									Heater sized to prevent excessively high auto ignition temperature and only operates during regeneration	
Flow / Level – High	Operator error valve out of position	Vent H2, potential flammable explosive cloud at fan intake								Refer action item 70 below	
Flow / Level – Low	Operator error valve out of position	Desiccator out of service, humidity build up, long term insulation damage	UnLikely	Minor	Low	Dew point monitoring	Rare	Minor	Low		
Flow / Level – No or not										Flow is not measured	
Flow / Level – Reverse	Operator error valve out of position	Vent H2, potential flammable explosive cloud at fan intake	UnLikely	Severe	High	Dual operator procedure	Rare	Severe	Medium		70. Hydrogen dryer blower intake is open to atmosphere and in close proximity to the Operator swinging the 3-ways valves. Incorrect procedure (monthly) or Operator error would vent Hydrogen out of air intake. Operator exposure to fire / explosion (static). Design review required. Air intake pipe to safe area to seal system or automated double block and bleed per combustion standard
Vibration – High Low or not											
As well as - concentration / two phase										Regen is required to eliminate moisture which long term can degrade winding insulation	
Other then - impurities / contamination											
Timing / Sequence - Early / Late										Operator error same as above Reverse flow	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power										Loss of regeneration, monthly process	71. MELCO to quote additional double block and vent isolation valves for on-line maintenance of heater system, to eliminate H2 purge of complete system. Snowy standard maintenance requirement
Volts / Amps High										MCC is monitored.	
Volts / Amps Low										MCC is monitored	
Volts / Amps - No or Not										If generator in service, monthly regeneration. With generator in standby with seal oil system in service may not require as frequent regen.	

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 50 - Generator - Lube oil system Dwg A13C870 - Generator seal oil diagram for GT											
Pressure High											73. MELCO design is heavily reliant on Operator alarm response and on site Operator rounds. This is not how Snowy normally operate. Additional instrumentation would be likely be installed on future upgrades. MELCO design to be reviewed for potential instrumentation upgrades
Pressure Low	Loss AC and DC power or blockage or major pipe failure	Bearing damage	Rare	Severe	Medium	2oo3 Lube oil pressure Lo Lo trip	Rare	Severe	Medium		
Pressure No or not										No pressure measurements in this section	
Pressure Vacuum	Loss of fan power or damper out of position	No real concern								Loss of vacuum fan / H2 eliminator (not for oil mist) is not a concern for oil flow oil temp and has spring loaded non return valve as back up. Loss of oil vacuum has no impact on the seal oil vacuum and vice versa	
Temperature High	Bearing faults, debris or rub	Bearing damage	UnLikely	Major	Medium	Operator alarm response	Rare	Major	Medium	Bearing > 107 C and lube oil return temp hi alarm > 85 C. Supply oil > 60 alarm, > 65 trip	41. SHL to review high temperature alarm shutdown requirements for Hunter. Remote operator may not react in time.
Temperature Low	Standby operation for a long time, resulting in cold oil tank	Loss of production - pump fail to start	UnLikely	Minor	Low		UnLikely	Minor	Low	Oil tank heater maintains 15 C on, 20 C off	
Temperature – No or not	BPCS Sensor fault									TC 1,2,3 alarm only, so loss of signal is alarm. There will be an alarm priority / call out response strategy implemented for the site	
Flow / Level – High	LOOP tank									Very large size pipework, unrealistic to block up. Leaving commissioning strainer in or spade would be detected by seal oil level high alarms on LS3 and LS1,2. Potential to pump oil out of vent discussed but not realistic scenario	
Flow / Level – Low										Normally the seal oil system flows into the LOOP tank to maintain tank level. Loss of oil level is really only possible during commissioning by leaving spade or block strainers. Discussed at length but would be detected by GTC system somehow	72. There is a discrepancy between MELCO pipe sizes and MHI drawing A-21022 page 2of 4. MHI to review and correct
Flow / Level – No or not										Level is not measured	
Flow / Level – Reverse										Possible when the DC pump runs. Designed accordingly. Also possible if seal oil vacuum pump is not running but not an issue	
Vibration – High Low or not	Bearing faults, debris or rub	Potential bearing damage	Rare	Major	Medium	Shaft vibration Hi Hi trip	Rare	Major	Medium		
As well as - concentration / two phase										Designed for hydrogen and lube oil	
Other then - impurities / contamination										Oil system is filtered and dP monitored	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High										mcc is monitored	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 51 - Generator - Seal oil vacuum pump and tank Dwg A13C870 - Generator seal oil diagram for GT											
Pressure High	Loss of vacuum pump	Slow loss of Hydrogen purity	Rare	Negligible	Low	Operator alarm response	Rare	Negligible	Low	Node 47B start - Seal oil vacuum pump	
Pressure Low	Solenoid failure	Vacuum pump failure	Rare	Negligible	Low		Rare	Negligible	Low	MCC is monitored but the seals would already be damaged. There is no instrumentation on the pump, local pressure gauge	
Pressure No or not										No instrumentation on the vacuum system, refer action item 73	
Pressure Vacuum											
Temperature High											
Temperature Low											
Temperature – No or not											
Flow / Level – High	Oil leak	Environmental - Oil / water to ground	Possible	Negligible	Low		Possible	Negligible	Low	Sight glass to be checked every day. Oily water drain to keep vent line clear	75. Seal oil system drip tray or bunded area should be remotely monitored for large leaks and potentially auto draining function of sight glass. Similar to fuel oil / lube oil bunds
Flow / Level – High	BPCS - Seal oil vacuum tank fill valve stuck open	Environmental - Oil pumped up to vent stack	Rare	Moderate	Low		Rare	Moderate	Low	Tank fill float valve likely to fail every 50 years? Remote operator / unmanned site, no time to respond. LS-5 stops vacuum pump but that doesn't stop the lube oil filling	76. Seal oil vacuum tank fill valve is a single point of failure which can lead to lube oil overfilling the tank and lube oil discharging via the vent stack, potential large quantities due to unmanned site. Alarm response cannot prevent this consequence and would happen quite quickly. Design review required
Flow / Level – Low	BPCS - Seal oil vacuum tank fill valve stuck closed	Potential loss of H2 seal	Rare	Negligible	Low	PS-1 seal oil pressure c/w DC back up pump	Rare	Negligible	Low	No credit for LS-6 low tank level alarm, remote Operator response too slow. Battery charger would keep DC system running plus 3 hours battery time	
Flow / Level – Low	BPCS - Seal oil vacuum tank fill valve stuck closed	Potential loss of H2 seal	Rare	Negligible	Low	DPS-1 seal oil diff pressure c/w DC back up pump	Rare	Negligible	Low	No credit for LS-6 low tank level alarm, remote Operator response too slow	
Flow / Level – No or not										Flow is not measured	
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase										Clean lube oil system with some moisture in H2	
Other then - impurities / contamination										clean filtered system	
Timing / Sequence - Early / Late										Solenoid and fill valve covered above	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High										mcc is monitored	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 52 - Generator - AC seal oil system Dwg A13C870 - Generator seal oil diagram for GT											
Pressure High	Differential pressure regulator valve not controlling well	Oil flows into generator level detection circuit. Diagnostic alarm for seal or pressure system	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Confirm strainer on AC pump inlet is not required - Karl	
Pressure Low	Differential pressure regulator valve not controlling well	Loss of cooling - Hydrogen would flow into lube oil collection area and vent via the LOOP tank system	UnLikely	Negligible	Low	DPS-1 seal oil diff pressure c/w DC back up pump	Rare	Negligible	Low	Monthly function test of DC pump recommended by Melco	
Pressure No or not										PS1 stuck fails over to DC pump and also via DPS-1	
Pressure Vacuum	Manual valve closed or blocked filter	Pump damage	Rare	Negligible	Low	PS-1 seal oil pressure c/w DC back up pump	Rare	Negligible	Low	All manual ball valves to be lockable	
Temperature High	Loss of cooling	Low discharge pressure	Rare	Negligible	Low		Rare	Negligible	Low	Oil temperature controlled by main lube oil system. Not realistic for this node but would result in low discharge pressure	
Temperature Low										Oil tank heaters	
Temperature – No or not											
Flow / Level – High											
Flow / Level – Low	Blocked filter or loss of AC or valve position					Operator alarm response				refer above low pressure. Redundant filter set with on-line change over capability	
Flow / Level – No or not										Flow is not measured	
Flow / Level – Reverse											
Vibration – High Low or not										Flexible coupling on AC pump inlet more for thermal expansion compensation	
As well as - concentration / two phase										Clean oil H2 service	
Other then - impurities / contamination	Metal fragments or varnish from oil	Blocked filter				Operator alarm response				refer above low pressure. Redundant filter set with on-line change over capability	
Timing / Sequence - Early / Late										AC DC pump failover timing, 0.2 sec on change over and no delay on low pressure PS1. No accumulators in the system. H2 escape time on complete loss of oil pressure a few seconds only.	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power	Loss of AC supply	Low discharge pressure, potential loss of containment	Rare	Negligible	Low	PS-1 seal oil pressure c/w DC back up pump	Rare	Negligible	Low	MCC contactor also monitored refer timing above. Potential scenarios include loss of control power per Callide incident	77. MELCO to review design to define the potential consequences of an unmanaged seal oil system failure and loss of hydrogen containment. Snowy will use this information to risk assess the installation per HAZOP guidelines
Volts / Amps High										mcc is monitored	
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 53 - Generator - DC seal oil system Dwg A13C870 - Generator seal oil diagram for GT											
Pressure High	Differential pressure regulator valve not controlling well	Oil flows into generator level detection circuit. Diagnostic alarm for seal or pressure system	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Generator casing vacuum test normally used for water cooled generators not required for H2 cooled systems. MELCO do positive pressure decay test on the casing	
Pressure Low	Differential pressure regulator valve not controlling well	Loss of cooling - Hydrogen would flow into lube oil collection area and vent via the LOOP tank system	UnLikely	Negligible	Low	DPS-1 seal oil diff pressure c/w DC back up pump	Rare	Negligible	Low		
Pressure Low	DC Pump fault	Loss of H2 containment	UnLikely	Severe	High		UnLikely	Severe	High	There is no safeguard for DC pump failure. No DC pump discharge pressure sensor. Pump is tested monthly. Proof test procedure with pressure limits and response time to be confirmed on site. No method for automatic H2 venting system.	78. Change DC pressure PI-5 to pressure transmitter for DC pump test run and linking to H2 automatic venting system. MELCO team suggest change is technically possible but may cause delays. Snowy to review schedule impact and instruct MELCO accordingly
Pressure Low	Oversized DC pressure relief valve RV-2 passing	Loss of H2 containment	UnLikely	Severe	High		UnLikely	Severe	High	Note monthly testing regime	79. MELCO team to confirm DC pump recirc line size. The large size valve passing may result in very low DC seal oil pressure
Pressure No or not										Currently no sensor but we plan to install one. Failure would be alarm only.	81. DC pump inlet (suction side) check valve stuck closed resulting in no oil pressure in a demand scenario. Why do we need this valve and is it normally open or closed. Confirm also design of this valve, i.e. spring, lockable, power cylinder??
Pressure Vacuum	DC pump inlet (suction side) check valve stuck closed resulting in no oil pressure in a demand scenario	Loss of H2 containment	Rare	Severe	Medium		Rare	Severe	Medium	Powered (spring or cylinder or lockable) check valve design to be confirmed	80. AC and DC suction pressure indicators not shown on drawing but will be provided. MELCO to update drawing
Temperature High	Loss of oil cooling	Low discharge pressure AND AC system is not running AND temperature so high that oil pressure is completely lost = not realistic								Oil temperature controlled by main lube oil system. Not realistic for this node but would result in low discharge pressure. DC pump pressure greater than AC pump, so continuous recirc not possible.	
Temperature High	DC pump running for long time or gland seal problem leading to high temp resulting in low oil pressure	Loss of H2 containment potential explosion equipment damage, fatality	Rare	Severe	Medium		Rare	Severe	Medium	Operator opens valve (1) to blend lube oil with seal oil to reduce the temperature when the DC pump is running or seal gland problems? MELCO thinks this will never be required, as normally batteries would run out and Operator would manually vent H2. Standard procedure is to vent hydrogen as soon as the DC pump starts running. The check valve (2) prevents lube oil overfilling LOOP tank	56. Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. MHI incorporate in design, logic to action valve.
Temperature Low										Oil tank heaters. DC circuit is normally not running but the valves are suitably rated	
Temperature – No or not											
Flow / Level – High										Both AC and DC pumps running but has no consequence	
Flow / Level – Low	Blocked filter or loss of DC or valve position					Operator alarm response				refer above low pressure. Redundant filter set with on-line change over capability	
Flow / Level – No or not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
Flow / Level – Reverse										Operator opens valve (1) to blend lube oil with seal oil to reduce the temperature when the DC pump is running or seal gland problems? MELCO thinks this will never be required, as normally batteries would run out and Operator would manually vent H2. Standard procedure is to vent hydrogen as soon as the DC pump starts running. The check valve (2) prevents lube oil overfilling LOOP tank	
Vibration – High Low or not											
As well as - concentration / two phase										Clean oil H2 service	
Other then - impurities / contamination	Metal fragments or varnish from oil	Blocked filter				Operator alarm response				refer above low pressure. Redundant filter set with on-line change over capability	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow	DC pump starter takes a few seconds to build pressure subject to oil temperature	Momentary dip in seal oil pressure								No problem for MELCO design. Accumulator not required to maintain pressure	
Utility failure - instr. air / oil / power										Redundant DC battery banks. Pump supply fails over (Locky to confirm)	
Volts / Amps High										MCC is monitored. Single AC pump. Why is the design not as robust as the lube oil system 2 x AC + 1 x DC? MELCO delivery per tender specification. Snowy correspondence notes based on auto hydrogen dump on loss of AC pump	82. Snowy to review redundant AC seal oil pump configuration requirement and work with MELCO on solution
Volts / Amps Low											
Volts / Amps - No or Not											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 54 - Generator - Gland seal oil system Dwg A13C870 - Generator seal oil diagram for GT											
Pressure High	Blocked filter	Used to match up the oil and hydrogen pressure. No real consequence, potentially high vibration on start up if rings are well positioned around the shaft	UnLikely	Moderate	Medium	Rotor vibration hi hi trip	Rare	Moderate	Low	Gland seal is needed to centre the seal rings around the shaft. Shaft moves within the bearing casing (low position at no speed and moves progressively up and to the right with speed). If the seal rings are touching the shaft it will lead to high vibration. If gland seal is left on too long it can lead to ring destabilising and that again leads to high vibration. Ring shaft clearances vary from site to site and it is not clear if gland seal is needed every start up but in any case it is currently a manual Operator procedure for a remote operated site. It is best practice to enable the gland seal on hydrogen fill and at full speed for a short time on high vibration.	83. Gland seal system if currently a manually operated procedure that is required during hydrogen fill and 'potentially' at full speed to centre the seal rings to reduce shaft vibration. Remotely operated solenoid would be the ideal solution. MELCO to confirm the design requirements and schedule impact to be confirmed
Pressure Low	Blocked filter	Poor seal hydrogen consumption through seal into LOOP seal oil tank	UnLikely	Negligible	Low	Operator alarm response	UnLikely	Negligible	Low		
Pressure No or not										Indicator gauges only. Loss of filter dP alarm	
Pressure Vacuum											
Temperature High										Only used on start up with AC pump	
Temperature Low											
Temperature – No or not	Sensor failure	Alarm only									
Flow / Level – High	Needle valve not set correctly	Used to match up the oil and hydrogen pressure. No real consequence, potentially high vibration on start up if rings are well positioned around the shaft	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Operator procedure with pressure indicator PI-9	
Flow / Level – High	Check valve left open after initial start up	Hydrogen seal ring damage after a long time	Rare	Negligible	Low		Rare	Negligible	Low	Dual Operator procedure with lockable valve	
Flow / Level – Low	Needle valve not set correctly	Poor seal hydrogen consumption through seal into LOOP seal oil tank	UnLikely	Negligible	Low	Operator alarm response	UnLikely	Negligible	Low		
Flow / Level – No or not											
Flow / Level – Reverse	Only possible if DC pump running and NC check valve is open on start up.	Poor seal hydrogen consumption through seal into LOOP seal oil tank	Rare	Negligible	Low		Rare	Negligible	Low	Start up and hydrogen fill would be aborted if DC pump started	
Vibration – High Low or not											
As well as - concentration / two phase										Clean oil H2 service	
Other then - impurities / contamination	Metal fragments or varnish from oil	Blocked filter				Operator alarm response				refer above low pressure. Redundant filter set with on-line change over capability	
Timing / Sequence - Early / Late	Operator error	Used to match up the oil and hydrogen pressure. No real consequence, potentially high vibration on start up if rings are well positioned around the shaft	UnLikely	Moderate	Medium	Rotor vibration hi hi trip	Rare	Moderate	Low	Dual Operator procedure with lockable valve. If Operator forgets to turn on gland seal oil before hydrogen fill then worst case poor hydrogen seal would flow hydrogen to LOOP seal oil tank and then to vent, potential loss of containment is considered NOT possible because seal oil system is running	
Timing / Sequence - Fast / Slow	Operator error - early	Poor seal hydrogen consumption through seal into LOOP seal oil tank	UnLikely	Negligible	Low	Operator alarm response	UnLikely	Negligible	Low	Dual Operator procedure with lockable valve	
Timing / Sequence - Fast / Slow	Operator error - late	Used to match up the oil and hydrogen pressure. No real consequence, potentially high vibration on start up if rings are well positioned around the shaft	UnLikely	Moderate	Medium	Rotor vibration hi hi trip	Rare	Moderate	Low	Dual Operator procedure with lockable valve	

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											

Appendix 3: SnowyHydro Risk Matrix

When business risk is considered in the risk assessment, instrumented functions that are classified as machine interlocks may be re-classified as Safety Instrumented Functions (SIF) and will then require a Safety Integrity Level (SIL) assignment and SIF architecture verification study.

Likelihood frequencies were taken from the SnowyHydro corporate risk matrix, where

Certain	> 1 event / year
Likely	1 to 2 years / event
Possible	2 to 10 years / event (basic process control failure (machine life)
Unlikely	10 to 50 years / event (machine life, has happened in industry)
Rare	> 50 years /event (remote but theoretically possible event)

Note that a basic process control system (BPCS) failure rate is typically 1 event per 10 years and therefore study records tend to be limited to Unlikely or Rare. A BPCS failure includes the sensors, the logic solver, the final elements (valves, contactors, etc) and where applicable the wiring and power supplies

Likelidood								
Certain	Low	Medium	High	Extreme	Extreme	Extreme	> 0.9	1 yr /event
Likely	Low	Medium	High	High	Extreme	Extreme	0.5 - 1	1 - 2 yrs / event
Possible	Low	Medium	Medium	High	High	Extreme	0.1 - 0.5	2 - 10 yrs /event
UnLikely	Low	Low	Medium	Medium	High	High	0.02 - 0.1	10 - 50 yrs / event
Rare	Low	Low	Low	Medium	Medium	High	< 0.02	> 50 yrs /event
	Negligible	Minor	Moderate	Major	Severe	Catastrophic		

Consquence Level

Likelidood						
Certain	1	2	3	4	4	4
Likely	1	2	3	3	4	4
Possible	1	2	2	3	3	4
UnLikely	1	1	2	2	3	3
Rare	1	1	1	2	2	3
	Negligible	Minor	Moderate	Major	Severe	Catastrophic

Risk Rating Matrix

RISK RATING MATRIX	LIKELIHOOD				
CONSEQUENCE	Rare	Unlikely	Possible	Likely	Almost Certain
Catastrophic	High	High	Extreme	Extreme	Extreme
Severe	Med	High	High	Extreme	Extreme
Major	Med	Med	High	High	Extreme
Moderate	Low	Med	Med*	High	High
Minor	Low	Low	Med	Med	Med
Negligible	Low	Low	Low	Low	Low

* For example, a risk with a likelihood of "Possible" and a consequence

Likelihood Criteria

RATING	LIKELIHOOD	PROBABILITY
Almost Certain	The event is very likely to occur	>90%
Likely	The event will probably occur	50% to 90%
Possible	The event might occur	10% to 50%
Unlikely	The event probably won't occur	2% to 10%
Rare	The event is very unlikely to occur	<2%

In determining the appropriate likelihood rating for your risk, consider the timeframe within which you are delivering your objective and select a rating that indicates the likelihood of the risk event occurring over that period. The timeframe could be, for example, the life of an asset (years) or an individual payroll run (hours).

Consequence Criteria

RATING	FINANCIAL	SAFETY	ENVIRONMENT	COMPLIANCE	AVAILABILITY	REPUTATION
Catastrophic	Cost variation or financial loss greater than $300M.	Multiple fatalities involving employees, contractors or members of the public.	Permanent impact on populations of significant (eg threatened) flora or fauna. Permanent unconfined impact on previously undisturbed ecosystem.	Snowy Hydro loses a licence to operate (eg AFSL, Snowy Park Lease, Retail licence).	Approximately 1500MW of generating plant unavailable to the market for more than 6 months.	Court, regulator or Government inquiry concludes improper, corrupt or grossly negligent conduct by Snowy Hydro.
Severe	Cost variation or financial loss between $20M and $300M. (The current consequence criteria simply has a threshold of $20 million).	Single fatality or permanent significant disability, long term impairment or illness significantly affecting the quality of life for an employee, contractor or member of the public.	Long term (>10 year) impact on populations of significant (eg threatened) flora or fauna. Long term impacts on soil, air or water quality. *Or* Potential for long term off-site impacts. Loss of numerous significant heritage items.	Claim or action (other than by a Regulator) involving an amount greater than $20M (including court/defence/compliance costs and loss of revenue); or Regulator action that results in: 1. A penalty greater than $5M; and/or 2. Imposition of requirements that would cost more than $20M (including court/defence/compliance costs and loss of revenue)	Approximately 1500MW between generating plant unavailable to the market for between 1 week and 6 months.	Incident or issue causes prolonged, negative national media coverage. Court, regulator or Government inquiry alleges improper, corrupt or grossly negligent conduct by Snowy Hydro. Other action by Snowy Hydro results in shareholders dismissing one or more directors.
Major	Cost variation or financial loss between $5M and $20M.	Long term or permanent disability, impairment or illness not significantly affecting the quality of life for an employee, contractor or member of the public.	Medium term (3-10 year) impact on populations of native flora or fauna. Medium term impacts on soil, air, water quality or habitat. Potential for medium term off-site impacts.	Claim or action (other than by a Regulator) involving an amount between $5M and $20M (including court/defence/compliance costs and loss of revenue); or Regulator action that results in: 1. A penalty between $1M and $5M; and/or 2. Imposition of requirements that would cost between $5M and $20M (including court/defence/compliance costs and loss of revenue)	Approximately 1500MW of generating plant unavailable to the market for between 1 day and 1 week; or 600MW of plant unavailable for at least 1 week; or 300MW of generating plant unavailable for a month or more.	Incident or issue causes negative state wide media attention and regulatory intervention. Government inquiry into Snowy Hydro's actions or operations in regard to conduct, pricing etc. Action by Snowy Hydro results in one or more Executives or senior managers being terminated.
Moderate	Cost variation or financial loss between $1M and $5M.	Hospitalisation with medical intervention of an employee, contractor or member of the public.	Short term (1-3 year) impact on flora or fauna. Short term impact on soil, air, water quality or habitat. Impact mostly confined to work area but potential short term off-site impacts. Loss of a significant (eg Category A and B) heritage item. Visual, noise or airborne dust impacts with potential for regulator response.	Claim or action (other than by a Regulator) involving an amount between $1M and $5M (including court/defence/compliance costs and loss of revenue); or Regulator action that results in: 1. A penalty between $100K and $1M; and/or 2. Imposition of requirements that would cost between $1M and $5M (including court defence/compliance costs and loss of revenue)	Approximately 1500MW of generating plant unavailable to the market for between 1 hour and 1 day; or 600MW generating plant unavailable for between 1 day and 1 week; or 150MW of generating plant unavailable for a month or more.	Incident or issue causes local outrage with potential for escalation to state media and/or to generate regulator interest. State or Federal regulator conducts formal inquiry into broader industry issues which encompass Snowy Hydro's operations. Major changes to Snowy Hydro operations have significant local community impacts.
Minor	Cost variation or financial loss between $100K and $1M.	Injury or illness requiring medical treatment of an employee, contractor or member of the public.	Adverse impact to significant (eg Category A and B) heritage item. Visual, noise or airborne dust impacts with potential for credible stakeholder/ public complaint.	Claim or action (other than by a Regulator) involving an amount between $100K and 1M (including court/ defence/compliance costs and loss of revenue); or Regulator action that results in: 1. A penalty between $10K and $100K; and/or 2. Imposition of requirements that would cost between $100K and $1M (including court defence/compliance costs and loss of revenue)	Approximately 600MW of generating plant unavailable to the market for up to 1 day; or up to 300MW of generating plant unavailable for up to 1 week; or up to 100MW of generating plant unavailable for a month or more.	Incident or issue causes local outrage with no potential for escalation. Short term negative regional media attention around a minor, localised issue. Minor damage to reputation with a regulator.
Negligible	Cost variation or financial loss less than $100K.	Nil to first aid injury, low level short term inconvenience or symptoms for an employee, contractor or member of the public.	Promptly reversible/trivial impact on air, water, soil, flora, fauna, habitat or heritage..	Claim or action (other than by a Regulator) involving an amount up to $100K (including court/defence/ compliance costs and loss of revenue); or Notification to a Regulator is required (but with no other consequence); or Regulator action that results in: 1. A warning notice; 2. A penalty up to $10K; and/or 3. Imposition of requirements that would cost up to $100K (including court/defence/compliance costs and loss of revenue)	Loss of a single generating unit for up to a day.	Incident or issue causes local inconvenience. Negative comment about Snowy Hydro at regional level. Formal complaint made to Snowy Hydro by the public.

330	mw	Capacity loss
300	$/mw	Unit loss
24	hrs out	Outage time
$ 2,376,000		Event impact

Appendix 4: HAZOP action items

Note that this section collates all the workshop action items into one list for quick reference. The reader will need to refer to the Study Records in Appendix 2 for the background and references (node, dwg, descriptions, etc) of each action.

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
1	1. Confirm forwarding pump deadhead pressure and prv	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022	SHL to coordinate		Open
2	2. Review bunding requirements around FO pumps	sara.roder@snowyhydro.com.au	1. Prior to Construction	25.2.2022	SHL AECOM to coordinate		Open
3	3. Confirm $ cost per unit trip / 1 hr outage	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022			Open
4	4. All ball valves to be lockable	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022	SHL AECOM to coordinate		Open
5	5. SHL to review who supplies instrumentation at MHI interfaces	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022			Open
6	6. AECOM to consider heat tracing for FO dwg 2of 5. Start up temperature should be 11 deg C. Alternative may be an enclosure for the pump and piping	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
7	7. The screw pump has no min flow bypass return line. The HP pump only starts when burners are to be lit. When no burner flow the manifold pressure control valve acts as the min flow control. MHI to confirm forwarding pump flow rate through HP screw pump when shutdown	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
8	8. MHI manual ball valves should all be lockable type, i.e. flow divider drain valves. SHL to discuss requirements with MHI	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
9	9. Pantac to review blade path flameout voting logic. One or multiple burners, adjacent burners, single or duplex t/c. No optical flame detectors	paul.vandyk@pantac.com.au	2. Prior to Commissioning	25.2.2022	in time for coordination meeting		Open
10	10. MHI to advise combustion frequency sensor criticality. Commissioning tool or protection	MHI	2. Prior to Commissioning	25.2.2022	in time for coordination meeting	Extended operation can lead to catastrophic failure. Combustion components and blades	Closed
11	11. SHL investigating additional diesel fuel quality reports	evan.bayliss@snowyhydro.com.au	2. Prior to Commissioning	25.2.2022	in time for coordination meeting		Open
12	12. MHI to confirm if there is a drain tank Hi level start permissive. Unit wont start with high level	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
13	13. SHL to confirm with operations to see if small lines have been problematic with non-return valves failing / passing	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
14	14. AECOM to consider drain pit discharge hi alarm to start pump and hi hi to alarm to remote operations	jason.lawer@aecom.com	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
15	15. AECOM Fuel oil discharge to oily water pit detection to be considered in design	jason.lawer@aecom.com	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
16	16. MHI to confirm at what load level water injection is enabled. Also when water injection is not correct the unit would go to run back load, where water injection is turned off.	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting	WI on at 50% load, Pilot water injection on during start up	Closed
17	17. SHL to confirm action required when water injection is off, i.e. valley will try to restart water injection 3 times and max operating time without water injection is 15 minutes. Automatic shutdown required, tbc and advise to MHI or add into station controls	evan.bayliss@snowyhydro.com.au	2. Prior to Commissioning	25.2.2022	in time for coordination meeting		Open

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
18	18. Oily water pit to be covered with rain shelter	jason.lawer@aecom.com	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
19	19. AECOM to consider valve failure, excessive flow to oily water pit overflow during runback time. Flow balance required. MHI to advise oily water flow rate and volumes expected during normal operating conditions and if one of the drain valves fails open, MBN13AA735,AA736,AA737 based on SHL RFI document	1. SHL then 2. MHI then 3. AECOM to design accordingly	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
20	20. Water injection flow transmitter is a single point of failure which would cause diesel outage, so it is critical for operation. Redundancy for valve control per fuel oil control should be considered. MBU02CP531.	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022			Open
21	21. Single point of failure mode analysis should be completed at a suitable time. SHL internal item	evan.bayliss@snowyhydro.com.au	3. Prior to Handover for Beneficial Operation	25.2.2022			Open
22	22. Outage, run back, emergency trip restart time cost analysis required for Risk Assessment decision around device fault tolerance, i.e. trip or 1 hours outage = 800k (330MW x 2500MW/Hr x 1 hr), additional instrument = 20k installed	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022			Open
23	23. Purge credit details are not well understood by Operations. There is a manual, Operating Procedure(S4-96597), that describes it in more detail. Type B compliance, intermittent or continuous turning and start and re-purge credit are all good questions. Potentially every 8 days the unit needs repurging, which can lead to more blade wear (wobbling in root) and starter problems. This item to be revisited by Operations with MHI detail input.	evan.bayliss@snowyhydro.com.au	3. Prior to Handover for Beneficial Operation	25.2.2022	in time for coordination meeting		Open
24	24. MHI to review if fuel oil from the fuel oil purge credit can go to the tank not the pit as it is clean fuel. Environmental credit	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
25	25. Fuel oil purge credit valves only have a single limit switch, preference for both open and closed indication, all valves (block, drain, N2). AECOM supply these valves	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
26	26. MHI to check logic. Gas vent valve out of position during operation should be a trip. Redundant limit switches may be.		2. Prior to Commissioning	25.2.2022	in time for coordination meeting		Open
27	27. AECOM should review vent valve position failure actions	jason.lawer@aecom.com	2. Prior to Commissioning	25.2.2022			Open
28	28. AECOM to review appliance manual isolation valve per AS3814 requirements within 5m of the appliance. Paul van Dyk to confirm AS3814 clause requirements	paul.vandyk@pantac.com.au	1. Prior to Construction	25.2.2022		5m is considered remote for individual burners but one lockable hand valve for the unit pre-coalescer meets the requirements. AECOM model location is similar to Laverton	Closed

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
29	29. Tapping points for pressure testing / leak testing valves not shown on P&ID. Additional testing points may be required. SHL to review based on length of pipework and valve locations.	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
30	30. MHI to review AS3814 section 2.13 requirement for sufficient test points to verify the integrity of shutoff valve / train.	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
31	31. RFI for the purpose of the HAZOP the main question, is there a single point of failure (DPT) and what would be consequence of a critical time pressure excursion explosion. Is DPT control or protection, refer control description fig 2.9.1	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
32	32. MHI to confirm temperature rating of pipework after MBA01AA704, burner drain valve. Rating drops from 525 to 60 Celsius	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
33	33. Water wash procedure has many manual valves which could potentially lead to false start by flooded combustion chamber and subsequently detergent flow into the oil water pit. SHL to develop a water wash procedure with 2 operators to cross check. Water washing drain header could also have small amounts of diesel residue from liquid fuel false start.	evan.bayliss@snowyhydro.com.au	3. Prior to Handover for Beneficial Operation				Open
34	34. Commissioning spool required for flow meter, that will need to be removed for pipe blow down activities. Mark up P&ID	jason.lawer@aecom.com	2. Prior to Commissioning	25.2.2022			Open
35	35. Add instrument tapping point for Nitrogen entry for valve leak testing, with smaller volume than upstream line	jason.lawer@aecom.com	1. Prior to Construction	25.2.2022			Open
36	36. Calorie meter. 1. Cal gas bottles only have single regulator and no relief valve. Potential single point of failure. Is meter rated for cal gas pressure. 2. If reg fails, is it possible to reverse flow cal gas into the gas line? 3. Why is there a flow meter in the vent line?	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
37	37. All ball valves to be lockable. Evan to confirm who is responsible for providing the pad locking system for all the manual isolation valves and to ensure the valves have lock tabs, refer also action item 4. Also send sample photos to MHI. The requirement is in the tender specification section 2.3	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022	SHL AECOM to coordinate		Open
38	38. MHI to confirm failure mode of IGV, i.e. fail last position, fail ramp closed on loss of control oil or power?	MHI	2. Prior to Commissioning	25.2.2022	in time for coordination meeting		Open
39	39. 2oo3 trip voting degradation to be reviewed on a trip by trip basis by SHL, 2oo3, 1oo2 or 2oo2 and 1oo1 = trip or run?	evan.bayliss@snowyhydro.com.au	2. Prior to Commissioning	25.2.2022			Open
40	40. DC Lube oil pump to be tested prior or after each start to prove functionality. Replacing MBV01CP304 DC lube oil pressure gauge with a transmitter would facilitate fast auto test sequence. Requirements to be confirmed by SHL	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	25.2.2022			Open
41	41. SHL to review high temperature alarm shutdown requirements for Hunter. Remote operator may not react in time.	evan.bayliss@snowyhydro.com.au	2. Prior to Commissioning	25.2.2022			Open

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
42	42. SHL may request additional oil sampling point downstream of the bearings (generator and turbine). MHI to review installation requirements and advise accordingly	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
43	43. There is a wall in the oil tank which may create different tank levels, design to be confirmed by MHI	MHI	1. Prior to Construction	25.2.2022	in time for coordination meeting		Open
44	44. Fuel gas and Fuel Oil control oil dump valves are single point of failure and common cause fraction is high. Is this allowed per the standard. Valves should failsafe and individually actuated?? PVD to review in detail as part of AS3814 compliance	paul.vandyk@pantac.com.au	1. Prior to Construction	1.4.2022			Open
45	45. Control oil dump circuits to be reviewed against SIL requirements and AS3814 compliance	paul.vandyk@pantac.com.au	1. Prior to Construction	1.4.2022			Open
46	46. Note AECOM responsible for Fire protection of the Balance of Plant equipment such as lube oil package, fuel oil pump / valve systems and how that system is interlock or integrated into the plant DCS or MHI GT controls. AECOM is design stage now. Fire safety study is well advanced MHI fire and gas detection limited to GT enclosure and Fuel Gas valve systems. SHL to review final design proposal	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	15.03.2022			Open
47	47. Door tracking isolating the CO2 if someone enters the GT is to be confirmed by vendor and reviewed by SHL	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	15.03.2022			Open
48	48. Ambient conditions -5 C to +45 C. Anti-icing system was considered in the tender specification but MHI advised at that time it is not required. MHI to revisit the study and reconfirm anti-icing is not required.	MHI	1. Prior to Construction	1.04.2022	in time for coordination meeting		Open
49	49. Valve numbers and instrument numbers and line sizes are not shown on the drawing. Return valve is shown as control valve but is actually a manual lockable isolation valve	MHI	3. Prior to Handover for Beneficial Operation	15.3.2022	in time for coordination meeting		Open
50	50. Evap tank water is potable water. Should overflow or draining be discharged to Trade Waste or Storm Water. AECOM to review and design accordingly	AECOM	1. Prior to Construction	1.06.2022			Open
51	51. Evap tank has no sample point. MHI to review option to supply	MHI	1. Prior to Construction	1.04.2022	in time for coordination meeting		Open
52	52. MELCO interface details required for AECOM water services. Water pressure recently increased to 7.5 Bar. AECOM to advise MELCO final supply pressure. MELCO cooler to be designed accordingly	blair murray AECOM	1. Prior to Construction	1.04.2022	in time for coordination meeting		Open
53	53. MELCO to provide full list of generator protection settings, trips complete with alarms, auto shutdown and run backs	Melco - Kohei Miura - H2 seal oil system	2. Prior to Commissioning	1.04.2022	in time for coordination meeting		Open
54	54. Manual purging requires strict procedure with 2 people to cross check to confirm successful purge	evan.bayliss@snowyhydro.com.au	2. Prior to Commissioning	15.03.2022			Open
55	55. CO2 site capacity to be assessed against minimum volume required for a successful purge times a safety factor. Potential bottle leak reduces capacity. Is adequate monitoring installed, flow pressure bottle weight	AECOM	1. Prior to Construction	1.06.2022			Open

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
56	56. Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. MHI incorporate in design, logic to action valve.	MHI	1. Prior to Construction	1.04.2022	in time for coordination meeting		Open
57	57. Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. AECOM to incorporate automate CO2 supply to the units	AECOM	1. Prior to Construction	1.06.2022			Open
58	58. Unit H2 flow meter can be used for make up flow monitoring, leak and PRV lifting detection. SHL to review	evan.bayliss@snowyhydro.com.au	2. Prior to Commissioning	1.04.2022			Open
59	59. AECOM to review H2 pipework for dissimilar metals. MELCO supply all 304 stainless. Potential corrosion and Haz area issue	AECOM	1. Prior to Construction	1.04.2022			Open
60	60. CO2 line has no filter or strainer. It is rarely used which could create fouling issues. MELCO to consider and quote option	Melco - Kohei Miura - H2 seal oil system	1. Prior to Construction	1.04.2022			Open
61	61. MELCO to review automating the Hydrogen make up valve as the site is normally not manned.	Melco - Kohei Miura - H2 seal oil system	1. Prior to Construction	1.04.2022			Open
62	62. Hydrogen pressure transmitter PT1 is potentially a single point of failure for an unmanned site. MHI to confirm signal failure response	MHI	2. Prior to Commissioning	1.04.2022	in time for coordination meeting		Open
63	63. Dew point monitoring is currently not part of the scope. SHL to request a quotation from MDI to add dew point monitoring	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	1.04.2022			Open
64	64. Melco to confirm what happens to the purity meter if CV-1 fails and flow is too low or no flow or needle valve set incorrectly. Hydrogen purity is important for purging requirements	MHI	2. Prior to Commissioning	1.04.2022	in time for coordination meeting		Open
65	65. SHL to develop written procedure for sampling purity with portable analyser to confirm main analyser reading is correct. Drain sampling and valve switching is manual to select top or bottom of the generator sampling. Note sampling drain point is within hazardous area	evan.bayliss@snowyhydro.com.au	2. Prior to Commissioning	1.09.2022			Open
66	66. Site wide review of field mounted instrumentation junction boxes and field panels required. These are normally fitted with heaters to prevent condensation	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	1.04.2022			Open
67	67. MHI to supply instrumentation datasheets for action item 66. To confirm field instrumentation ratings, i.e. +5 - +45 non-condensing??	MHI	1. Prior to Construction	1.04.2022	in time for coordination meeting		Open
68	68. AECOM to study hydrogen detection requirements for this open area plant area and that location is under exciter which probably has cooling fans that could draw H2 into enclosure	AECOM	1. Prior to Construction	1.04.2022			Open
69	69. MELCO to add check valve before CO2 manual isolation valve	Melco - Kohei Miura - H2 seal oil system	1. Prior to Construction	1.04.2022			Open

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
70	70. Hydrogen dryer blower intake is open to atmosphere and in close proximity to the Operator swinging the 3-ways valves. Incorrect procedure (monthly) or Operator error would vent Hydrogen out of air intake. Operator exposure to fire / explosion (static). Design review required. Air intake pipe to safe area to seal system or automated double block and bleed per combustion standard	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	1.04.2022			Open
71	71. MELCO to quote additional double block and vent isolation valves for on-line maintenance of heater system, to eliminate H2 purge of complete system. Snowy standard maintenance requirement	Melco - Kohei Miura - H2 seal oil system	1. Prior to Construction	1.04.2022			Open
72	72. There is a discrepancy between MELCO pipe sizes and MHI drawing A-21022 page 2of 4. MHI to review and correct	MHI	1. Prior to Construction	1.04.2022	in time for coordination meeting		Open
73	73. MELCO design is heavily reliant on Operator alarm response and on site Operator rounds. This is not how Snowy normally operate. Additional instrumentation would be likely be installed on future upgrades. MELCO design to be reviewed for potential instrumentation upgrades	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	1.04.2022			Open
74	74. AECOM to incorporate seal oil system drip / leak tray overflow to oily water system in their design	AECOM	2. Prior to Commissioning	1.04.2022			Open
75	75. Seal oil system drip tray or bunded area should be remotely monitored for large leaks and potentially auto draining function of sight glass. Similar to fuel oil / lube oil bunds	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	1.04.2022			Open
76	76. Seal oil vacuum tank fill valve is a single point of failure which can lead to lube oil overfilling the tank and lube oil discharging via the vent stack, potential large quantities due to unmanned site. Alarm response cannot prevent this consequence and would happen quite quickly. Design review required	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	1.04.2022			Open
77	77. MELCO to review design to define the potential consequences of an unmanaged seal oil system failure and loss of hydrogen containment. Snowy will use this information to risk assess the installation per HAZOP guidelines	Melco - Kohei Miura - H2 seal oil system	1. Prior to Construction	1.04.2022		Potential explosion	Closed
78	78. Change DC pressure PI-5 to pressure transmitter for DC pump test run and linking to H2 automatic venting system. MELCO team suggest change is technically possible but may cause delays. Snowy to review schedule impact and instruct MELCO accordingly	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	1.04.2022			Open
79	79. MELCO team to confirm DC pump recirc line size. The large size valve passing may result in very low DC seal oil pressure	Melco - Kohei Miura - H2 seal oil system	1. Prior to Construction	1.04.2022			Open
80	80. AC and DC suction pressure indicators not shown on drawing but will be provided. MELCO to update drawing	Melco - Kohei Miura - H2 seal oil system	2. Prior to Commissioning	1.04.2022			Open

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
81	81. DC pump inlet (suction side) check valve stuck closed resulting in no oil pressure in a demand scenario. Why do we need this valve and is it normally open or closed. Confirm also design of this valve, i.e. spring, lockable, power cylinder??	Melco - Kohei Miura - H2 seal oil system	1. Prior to Construction	1.04.2022	Normally open valve		Open
82	82. Snowy to review redundant AC seal oil pump configuration requirement and work with MELCO on solution	evan.bayliss@snowyhydro.com.au	1. Prior to Construction	1.04.2022			Open
83	83. Gland seal system if currently a manually operated procedure that is required during hydrogen fill and 'potentially' at full speed to centre the seal rings to reduce shaft vibration. Remotely operated solenoid would be the ideal solution. MELCO to confirm the design requirements and schedule impact to be confirmed	Melco - Kohei Miura - H2 seal oil system	1. Prior to Construction	1.04.2022			Open

Appendix 5: Safeguards

No	Safeguards - Description	Instances	Notes
1	PRV MBN12AA126	0	0 instance means it is not referenced in the study records
2	PS MBN12CP211	2	
3	PT MBN12CP118, MBN12CP119	2	
4	PDIT MBN12CP521 MBN12CP522	2	
5	Blade path temperature	30	High instance count for flame out and combustion trouble detection
6	Limit switch alarm	2	
7	Overspeed protection	3	
8	Combustion pressure monitoring trip	5	
9	2oo3 High pressure trip and 5 block valves in series	1	
10	2oo3 Low pressure trip and 5 block valves in series	1	
11	2oo3 High temperature trip and 5 block valves in series	2	
12	Vent valve position trip	2	
13	Gas control valve position trip	1	
14	2oo3 High gas temperature trip	1	
15	Exhaust gas pressure Hi Hi trip	1	
16	Rotor vibration hi hi trip	4	Generator rotor vibration
17	Fuel transfer limited to part load	1	
18	Sweep air block valve out of position auto shutdown	1	
19	Filter dP alarm	1	
20	Valve out of position shutdown	5	
21	Start permissive	3	
22	IGV out of position trip	4	
23	Shaft vibration Hi Hi trip	5	Turbine shaft vibration
24	2oo3 Exhaust pressure Hi Hi trip	2	
25	NooM Exhaust temp Hi Hi trip	3	
26	DCS general electrical monitoring	2	
27	Automatic Runback	6	
28	2oo3 Lube oil pressure Lo Lo trip	7	
29	2oo3 Lube oil temperature Hi Hi trip	3	
30	Bearing temp Hi Hi trip - does not exist	0	0 instance means it is not referenced in the study records
31	1oo1 MBV10CP101 Loss of vacuum Normal Stop	3	
32	PRV MBX01AA114	1	

33	2oo3 Control oil pressure Lo Lo trip	5	
34	1oo1 MBX01CT001 control oil tank temp alarm	2	
35	Fire detection and suppression systems	2	
36	Loss of ventilation trip	2	
37	Combustible gas detection trip	1	
38	2oo3 Inlet filter dp Hi Hi trip	3	
39	QEF13CP501 Inlet filler dp alarm	1	
40	Operator alarm response	20	High instance count but an administrative control is not actually a reliable Protection Layer
41	PRV 90SSD01AA904	2	
42	PRV QEE02AA903	1	
43	dual Hi Hi level Generator water detectors	2	
44	Stator winding temp Hi auto stop	6	
45	PRV RV-2 CO2 release	1	
46	Dual operator procedure	4	
47	Automatic H2 vent and CO2 purge	2	
48	PRV RV-1 H2 release	1	
49	Dew point monitoring	2	
50	LS-5 seal oil vacuum tank level hi	0	Does not prevent consequence
51	PS-1 seal oil pressure c/w DC back up pump	3	
52	DPS-1 seal oil diff pressure c/w DC back up pump	3	

Appendix 6: Participants

		Attendance											
No	Email	day 1 7 Feb	day 2 10 Feb	day 3 14 Feb	day 4 16 Feb	day 5 21 Feb	day 6 24 Feb	day 7 9 Mar	day 8 10 Mar	day 9 16 Mar	day 10 18 Mar	day 11 25 Mar	Discipline
1	ben.teh@snowyhydro.com.au	am	n	y	n	n	n	n	n	n	n	n	Project engineer
2	Blair.Murray@aecom.com	n	y	y	y	y	y	y	y	y	y	y	Project Engineer - Mechanical
3	damian.cooper@snowyhydro.com.au	y	n	y	n	y	n	y	n	y	y	y	Operations
4	david.bedding@snowyhydro.com.au	x	n	n	n	n	y	n	n	n	n	n	Operations
5	desk@pooletranslation.com.au	y	y	y	y	y	y	y	y	y	y	y	Translation services
6	Donny Richmond - Jacobs	y	y	n	n	n	n	n	n	n	n	n	Combustion engineer
7	emily 9CPT)@pooletranslation.com.au	n	y	n	n	y	y	n	n	n	n	n	Translation QC
8	Errol.Lannin@snowyhydro.com.au	am	n	n	n	n	n	n	n	n	n	n	Operations - Plant manager LPS
9	evan.bayliss@snowyhydro.com.au	am	y	n	n	n	n	n	n	n	n	n	Design and Quality lead engineer
10	frank.safi@wsp.com	y	y	y	y	n	n	n	n	n	y	y	Gas turbine combustion specialist
11	jason.lawer@aecom.com	y	n	n	n	n	n	n	n	n	n	n	Project technical director
12	Karl.Ivanusic@jacobs.com	y	y	y	y	y	y	y	y	y	y	y	Project Engineer - Mechanical
13	Kerri Wells AECOM	n	n	1 hr	n	n	n	n	n	n	n	n	Project Engineer - Mechanical
14	lachlan.smith@snowyhydro.com.au	y	y	y	y	y	y	n	y	y	y	y	Project Egnineer - Mechatronics
15	maria.iseya@	n	y	n	n	y	y	n	n	n	n	n	Translation services
16	MHI - hirofumi.moriguchi.3h@mhi.com	n	y	y	y	y	y	y	y	y	y	y	Project manager
17	MHI - eiki.anzawa.c7@mhi.com	y	y	y	n	y	y	y	y	n	n	n	Control system engineer
18	MHI - daisuke.shibita.37@mhi.com	y	y	y	y	y	y	y	y	n	n	n	Control system engineer
19	MHI - yoji.oshino.mr@mhi.com	n	y	y	y	y	y	y	y	n	n	n	Plant Engineer
20	MHI - masaaki.yamasaki.4e@mhi.com	n	n	n	n	n	y	y	y	n	n	n	Plant Engineer
21	MHI action item												
22	olivia.panjkov@snowyhydro.com.au	n	am	n	n	n	n	n	n	n	n	n	
23	Patrick.Scholtes@snowyhydro.com.au	n	n	y	n	y	y	n	n	n	n	y	Mechanical gas assetts
24	paul.hill@snowyhydro.com.au	n	y	n	n	n	n	n	n	n	n	n	Operations
25	paul.vandyk@pantac.com.au	y	y	y	y	y	y	y	y	y	y	y	Facilitator - Functional Safety Engineer
26	rebecca.johnson@snowyhydro.com.au	y	n	n	n	n	n	n	n	n	n	n	Mech eng 1st year
27	sara.roder@snowyhydro.com.au	y	y	y	y	y	y	y	y	y	y	y	Mech eng 1st year
28	francois.vallette@snowyhydro.com.au	n	n	n	n	y	y	y	y	y	n	n	Mechanical
29	Melco - Kohei Miura - H2 seal oil system	n	n	n	n	n	y	n	y	y	y	y	Project Engineer - Mechanical
30	Melco - Eura - H2 seal oil system	n	n	n	n	n	n	n	n	n	y	y	Project Engineer - Mechanical
31	Tony Slinko - Jacob	n	n	n	n	n	n	n	n	n	y	n	Electrical Engineer

Appendix 7: Acronyms

ACRONYMS

The following acronyms may be used throughout this course and reference documents:

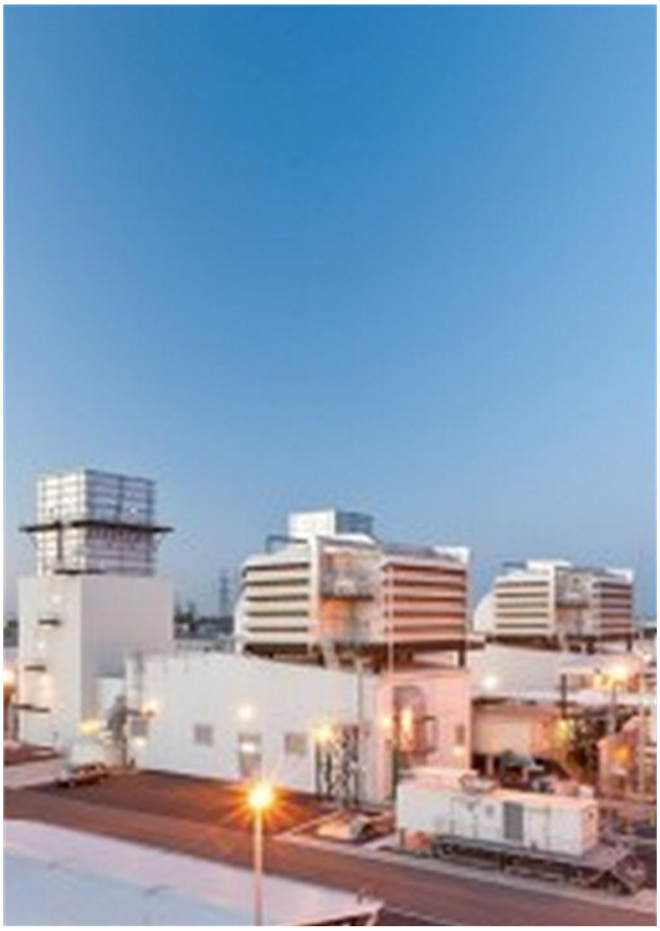
AIChE	American Institute of Chemical Engineers
AC/DC	Alternating current/direct current
ALARP	As low as reasonably practicable
ANSI	American National Standards Institute
ANSI/ISA	American National Standards Institute/ Instrumentation, Systems and Automation
API	American Petroleum Institute
ANSI / API 611	American Petroleum Institute: General purpose steam turbines
ANSI / API 612	Australian Standard: Special purpose steam turbines
ANSI/ISA-84.01	Application of Safety Instrumented Systems for the Process Industries.
AS	Australian Standard
ASME	American Society of Mechanical Engineers
AS 1375	Australian Standard: Industrial fuel fired appliances
AS 3814	Australian Standard: Industrial and commercial gas-fired app.
AS 4629	Australian Standard: Automatic shut off and vent valves.
AS / IEC 61508	Australian Standard: Functional safety of electrical /electronic/programmable electronic safety-related systems - Set
AS / IEC 61511 process	Australian Standard: Functional safety - Safety instrumented systems for the industry sector
BI	Business Interruption
BLEVE	Boiling Liquid Expanding Vapor Explosion
B.P.	Boiling Point
BPCS	Basic Process Control System
C	Consequence factor, related to magnitude of severity
CCF	Common Cause Failure
CCF	Common Cause Factor
CCPS	Center for Chemical Process Safety, American Institute of Chemical Engineers
CEI	Dow Chemical Exposure Index
CHAZOP	Controls Hazard & Operability Study
CMS	Consequence Mitigation System
CPQRA	Chemical Process Quantitative Risk Assessment
CW	Cooling Water
DC	Diagnostic coverage
D	Number of times a component or system is challenged (hr–1 or year–1)
DCS	Distributed Control System
DIERS	Design Institute for Emergency Relief Systems, American Institute of Chemical Eng.
DOT	Department of Transportation
EBV	Emergency Block Valve
E/E/PE	Electrical/electronic/programmable electronic
E/E/PES	Electrical/electronic/programmable electronic system
EMC	Electro-magnetic compatibility
ERPG	Emergency Response Planning Guideline
EuReData	European Reliability Data (series of conferences)FAT Factory acceptance testing
F	Failure Rate (hr-1 or year-1)
f	Frequency (hr-1 or year-1)
F&EI	Dow Fire and Explosion Index
F/N	Fatality Frequency versus Cumulative Number
FCE	Final Control Element

FMEA	Failure Modes and Effect Analysis
FMECA	Failure Mode Effect and Criticality Analysis
FPL	Fixed program language
FTA	Fault Tree Analysis
FVL	Full variability language
HAZOP	Hazard and Operability Study
HE	Hazard Evaluation
HFT	Hardware fault tolerance
HMI	Human machine interface
HRA	Human Reliability Analysis H&RA Hazard and risk assessment
H/W	Hardware
IEC	International Electro technical Committee
IEEE	Institute of Electrical and Electronic Engineers
IEV	International Electrotechnical Vocabulary
I/O	Input or Output
IPL	Independent Protection Layer
ISA	The Instrumentation, Systems, and Automation Society
ISO	International Organization for Standardization
ISO 10437	Special purpose steam turbines
LAH	Level Alarm—High
LI	Level Indicator
LIC	Level Indicator—Control
LFL	Lower Flammability Limit
LNG	Liquefied Natural Gas
LOP	Layer of Protection
LOPA	Layer of Protection Analysis
LOTO	Lock-Out Tag-Out
LT	Level Transmitter
LVL	Limited variability language
MAWP	Maximum Allowable Working Pressure
MOC	Management of Change
MOC	Management of Change
MooN	“M” out of “N”
MTBF	Mean Time Between Failures
MTTF	Mean Time To Failure
NFPA	National Fire Protection Authority
NFPA 85	NFPA Standard: Boiler and Combustion Systems Hazards Code
NFPA 86	NFPA Standard: Ovens and Furnaces
NP	Non-programmable
N2	Nitrogen
OSBL	Outside Battery Limits
OREDA	The Offshore Reliability Data project
OSHA	Occupational Safety and Health Administration (U.S.)
P fatality	Probability of Fatality
P ignition	Probability of Ignition
P person present	Probability of Person Present
P	Probability
PCS	Premier Consulting Service
PE	Programmable electronics
PES	Programmable electronic system
PFD	Probability of Failure on Demand

PFDavg	Average probability of failure on demand
PHA	Process Hazard Analysis
PI	Pressure Indicator
PL	Protection Layer
PLC	Programmable logic controller
P&ID	Piping and Instrumentation Diagram
PLC	Programmable Logic Controller
PM	Preventive Maintenance
PSM	Process Safety Management
PSV	Pressure Safety Valve (Relief Valve)
PSAT	Pre-Startup Acceptance Test
QRA	Quantitative Risk Assessment
R	Risk
RV	Relief Valve
RTD	Resistance Temperature Detector
SAT	Site acceptance test
SCE	Safety Critical Equipment
SFF	Safe failure fraction
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SOP	Standard Operating Procedures
SOV	Solenoid Valve
SRS	Safety Requirement Specification
S/W	Software
T	Test Interval for the Component or System (hours or years)
T/C or TE	Thermocouple
TMR	Triple Modular Redundant
UPS	Uninterruptible Power Supply
VCE	Vapor Cloud Explosion
VLE	Vapor Liquid Equilibrium
WDT	Watch Dog Timer
XV	Remote Activated/Controlled Valve
1oo1	One-out-of-One Voting
2oo2	Two-out-of-Two Voting
3oo3	Three-out-of-Three Voting

Appendix C

Power Island Closed Cooling Water System HAZOP Study Report



0.

HAZOP STUDY

SnowyHydro – Hunter Power Station
Mitsubishi Heavy Industries
M701G Gas turbine generators
SHL Work Order No. 314502

PANTAC SYSTEM CONTROL

ABSTRACT

Hazard and Operability (HAZOP) Study of the Hunter Power Station closed cooling water system process design

Pantac System Control

Risk Assessment Doc No 21081700-002-R0

Contents

Revision History

Date	Rev	Description
5 May 2022	0	Draft – Issued for comments

Revision	Prepared By	Reviewed by	Approved By
0	Paul van Dyk	Reinier van Dyk	Paul van Dyk

1. Executive Summary

This report covers the findings of the HAZOP study workshop for the SnowyHydro Hunter Power Station closed cooling water system process design. Due to COVID travel restrictions, the workshop was performed remotely via google meet with client, vendor, translation services and specialist representation. The scope and focus of the study are limited to the closed cooling water system Process and Instrumentation Design (P&IDs) systems.

The workshop was performed according to the agreed scope as outlined in Section 4, using the methodology described in Section 6. It is considered that the stated objectives listed in Section 5 were satisfactorily met, subject to implementation of the recommendations generated.

The workshop generated:

28 recommendations tabled in appendix 4 and identified

11 Safeguards tabled in appendix 5

It is worth noting the following:

- The system design relies on a cooling water system discharge pressure that is greater than the generator hydrogen pressure to prevent any hydrogen accumulation in the water system in the event of an exchanger leak.

  The system design is not 100% complete and action item 23 relates specifically to the cooling water system discharge pressure control.

- The high-pressure air compressors interlocks and protection is not well understood at this time and action items 20 and 21 are with MHI to confirm with their 3rd party vendor.

  This section of the plant will need to be reviewed again on completion of design and suitable interlock and protection information becomes available

- The P&IDs in appendix 1 Nodes and Drawings, includes commented additions as advised before the HAZOP (known omissions) and as mark ups (design modifications and details appended during the workshop i.e., not all drawing comments are re-designs.

2. Background

This new gas turbine peaking plant will be commissioned on liquid fuel in 2023 to provide power to the New South Wales electricity spot market. Natural gas firing will follow 6 to 12 months after that.

The plant will be owned and operated by SnowyHydro Ltd.

Hydrogen blending with natural gas for combustion is not included at the time of this study.

3. Process description

Hunter Power Station will be a dual fuel (high speed diesel and natural gas fired), Open Cycle Gas Turbine Power Station with a rated output of approximately 2 x 330 MW. The plant consists of two dual fuel, MHI M701G series gas turbines with water injection for fuel oil low NOx control, two hydrogen cooled generators, associated lube and seal oil and gas systems, electrical equipment and I&C, emergency diesel generator, power/distribution transformers, closed circuit cooling system, firefighting and detection systems and HVAC. The GT intakes are equipped with an evaporative cooling system to increase output performance.

The station is designed for peak load operation with fast start-up and loading (approximately 5 minutes to synchronising and 15 MW/min normal load rate {TBC}) but has a predicted operating regime of only 48 fired hours per year {TBC} with 25 starts {TBC}.

The plant may be dispatched and operated remotely for much of the time. Site staffing will be minimal.

4. Scope

The scope of the HAZOP workshop was limited to the closed cooling water system Process and Instrumentation Design systems and any associated control requirements to maintain system protection and minimise environmental excursions in accordance with the targets defined in the SnowyHydro corporate Risk Matrix, refer appendix 3.

5. Objectives

The objective of the HAZOP workshop is to

- Review the proposed design
- Generate action items for any areas of concern brought to the meeting
- Identify potential hazards and operability problems, to examine safeguards and to make recommendations to address identified problems

- Ensure that all applicable recommendations related to the hierarchical controls are recorded

6. Methodology

The HAZOP examination procedure systematically questions every part of a process or operation to discover qualitatively how deviations from normal operation can occur and whether further protective measures, altered operating procedures or design changes are required.

The examination procedure uses a full description of the process which will, almost invariably, include a P&ID or equivalent, and systematically questions every part of it to discover how deviations from the intention of the design can occur and determine whether these deviations can give rise to hazards.

The questioning is sequentially focused on guide words which are derived from method study techniques. The guide words ensure that the questions posed to test the integrity of each part of the design will explore ways in which operation could deviate from the design intention.

Some of the causes may be so unlikely or trivial, that they need not be considered further, however there may be some deviations with causes that are conceivable and consequences that are potentially serious. The potential problems are then noted for remedial action.

The immediate solution to a problem may not be obvious and could need further consideration either by a team member or perhaps a specialist. All decisions taken are recorded.

The main advantage of this technique is its systematic thoroughness in failure case identification. The method may be used at the design stage, when plant alterations or extensions are to be made, or applied to an existing facility.

6.1 Guide words and Deviations

The following deviations were applied to each study node

No	Deviation	Notes
1	Pressure High	
2	Pressure Low	
3	Pressure No or not	
4	Pressure Vacuum	
5	Temperature High	Include Fire
6	Temperature Low	
7	Temperature – No or not	
8	Flow / Level – High	
9	Flow / Level – Low	

10	Flow / Level – No or not	
11	Flow / Level – Reverse	
12	Vibration – High Low or not	
13	As well as - concentration / two phase	
14	Other then - impurities / contamination	
15	Timing / Sequence - Early / Late	Start up, shutdown, Auto / manual valves
16	Timing / Sequence - Fast / Slow	
17	Utility failure - instr. air / oil / power	Fail safe?
18	Volts / Amps High	
19	Volts / Amps Low	
20	Volts / Amps - No or Not	
21	Maintenance	Access, discharge points and storm water

7. Participants

Study attendance is normally recorded and listed here in the body of the document but to be consistent with the gas turbine controls HAZOP report, the participants are listed in Appendix 6

Appendix 1: HAZOP Nodes and drawings

The nodes and drawings should be read in conjunction with the system descriptions listed below

20220426_ Cooling Water Loop - Basis of Design excerpt.docx
20220426_Cooling Water Loop - Control Philosophy excerpt.docx

	Node	Dwg	Dwg Title	Day
1	Fin fans	HPP-AEC-MEC-SW-GEN-DRG-1160-A	HPS P&ID Power island closed cooling water system, Sht 1 of 4	1
2	Helper cooler and booster pump	HPP-AEC-MEC-SW-GEN-DRG-1160-A	HPS P&ID Power island closed cooling water system, Sht 1 of 4	1
3	Expansion tank	HPP-AEC-MEC-SW-GEN-DRG-1161-A	HPS P&ID Power island closed cooling water system, Sht 2 of 4	2
4	Cooling water pumps	HPP-AEC-MEC-SW-GEN-DRG-1161-A	HPS P&ID Power island closed cooling water system, Sht 2 of 4	2
5	GT HP Purge air coolers	HPP-AEC-MEC-SW-GEN-DRG-1162-A	HPS P&ID Power island closed cooling water system, Sht 3 of 4	1
6	GTG H2 air coolers	HPP-AEC-MEC-SW-GEN-DRG-1162-A	HPS P&ID Power island closed cooling water system, Sht 3 of 4	1
7	GT Control oil coolers	HPP-AEC-MEC-SW-GEN-DRG-1163-A	HPS P&ID Power island closed cooling water system, Sht 4 of 4	1
8	GT Lube oil coolers	HPP-AEC-MEC-SW-GEN-DRG-1163-A	HPS P&ID Power island closed cooling water system, Sht 4 of 4	1

HOLDS:

1. THE KKS NUMBERING SYSTEM SHOWN IS INDICATIVE ONLY AND SUBJECT TO CHANGE.

NOTES:

1. THIS P&ID GIVES COOLING WATER SYSTEM FOR ONE SET OF GT. THE TWO SETS ARE IDENTICAL.
2. FIN FAN COOLER MOTOR IS SUITABLE FOR VSD OPERATION.
3. BLADDER TYPE EXPANSION TANK FOR CLOSE COOLING WATER SYSTEM.
4. GOULDS PUMP IS CONSIDERED FOR HOT WATER.
5. SMALL CIRCULATING PUMP FOR WINTERIZATION OPERATION.
6. CHEMICAL DOSING FOR IMPROVING WATER QUALITY.
7. REFER TO MITSUBISHI DRAWINGS FOR DETAILS OF COOLERS FOR LUBE OIL, CONTROL OIL, GENERATOR HYDROGEN AND PURGE AIR COMPRESSOR.
8. REFER TO VENDOR DRAWING FOR DETAIL OF FIN FAN & HELPER COOLERS.

PRELIMINARY

REV	NAME	DATE	DESCRIPTION
A	AECOM	21.02.2022	ISSUE FOR INFORMATION

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-SW-GEN-DRG-1160
REV: A

DRAWN EDP 21.02.2022	DRAWING CHECKED BW 21.02.2022		
DESIGNED NS 21.02.2022	DESIGN CHECKED KW 21.02.2022		
SCALE	APPROVED CDT 21.02.2022		
WORK ORDER No			
SECTION No/KKS PGG	A1 SHEET SIZE		

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
POWER ISLAND CLOSED COOLING WATER SYSTEM

A SH 1 OF 4

HOLDS:

1. THE KKS NUMBERING SYSTEM SHOWN IS INDICATIVE ONLY AND SUBJECT TO CHANGE.

NOTES:

1. THIS P&ID GIVES COOLING WATER SYSTEM FOR ONE SET OF GT. THE TWO SETS ARE IDENTICAL.
2. FIN FAN COOLER MOTOR IS SUITABLE FOR VSD OPERATION.
3. BLADDER TYPE EXPANSION TANK FOR CLOSE COOLING WATER SYSTEM.
4. GOULDS PUMP IS CONSIDERED FOR HOT WATER.
5. SMALL CIRCULATING PUMP FOR WINTERIZATION OPERATION.
6. CHEMICAL DOSING FOR IMPROVING WATER QUALITY.
7. REFER TO MITSUBISHI DRAWINGS FOR DETAILS OF COOLERS FOR LUBE OIL, CONTROL OIL, GENERATOR HYDROGEN AND PURGE AIR COMPRESSOR.
8. REFER TO VENDOR DRAWING FOR DETAIL OF FIN FAN & HELPER COOLERS.

PRELIMINARY

REV	NAME	DATE	DESCRIPTION
A	AECOM	21.02.2022	ISSUE FOR INFORMATION

THIS DRG SUPPLIED BY
AECOM
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-SW-GEN-DRG-1161
REV: A

DRAWN: EDP 21.02.2022	DRAWING CHECKED: BW 21.02.2022	
DESIGNED: NS 21.02.2022	DESIGN CHECKED: KW 21.02.2022	
SCALE	APPROVED: CDT 21.02.2022	
WORK ORDER No		
SECTION No/KKS: PGG	SIZE: A1	SHEET

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
POWER ISLAND CLOSED COOLING
WATER SYSTEM

A | REV | SH 2 OF 4

HOLDS:

1. THE KKS NUMBERING SYSTEM SHOWN IS INDICATIVE ONLY AND SUBJECT TO CHANGE.

NOTES:

1. SAMPLE POINT.

PRELIMINARY

REV	NAME	DATE	DESCRIPTION
A	AECOM	21.02.2022	ISSUE FOR INFORMATION

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-SW-GEN-DRG-1162
REV: A

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SCALE	APPROVED CDT 21.02.2022		
WORK ORDER No			
SECTION No/KKS PGG	A1 SHEET SIZE		

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
POWER ISLAND CLOSED COOLING
WATER SYSTEM

A REV SH 3 OF 4

HOLDS:

1. THE KKS NUMBERING SYSTEM SHOWN IS INDICATIVE ONLY AND SUBJECT TO CHANGE.

NOTES:

1. SAMPLE POINT.

PRELIMINARY

REV	NAME	DATE	DESCRIPTION
A	AECOM	21.02.2022	ISSUE FOR INFORMATION

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-SW-GEN-DRG-1163
REV: A

DRAWN EDP 21.02.2022	DRAWING CHECKED BW 21.02.2022	DESIGNED NS 21.02.2022	DESIGN CHECKED KW 21.02.2022
SCALE	WORK ORDER No	APPROVED CDT 21.02.2022	
SECTION No/KKS PGG	A1 SHEET SIZE		

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
POWER ISLAND CLOSED COOLING WATER SYSTEM

A SH 4 OF 4

FLOW STREAM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
PIPE SIZE (DN)	350	350	80	350	250	250	250	50	50	250	250	250	350	80	80	350	50	25	25	25	25
PIPE SCHEDULE	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
FLOWRATE (M^3/H)	720	720	13.20	706.80	319.00	387.80	5.50	382.30	382.30	5.50	387.80	319	706.80	13.20	13.20	720	–	–	–	0.5	0.5
VELOCITY (M/S)	2.25	2.25	0.77	2.21	1.74	2.12	0.71	2.04	2.04	0.71	2.12	1.74	2.21	0.77	0.77	2.25	3	3	8	1.5	1.5
PRESSURE (KPA)	289	607	579	564	564	556	556	556	436	436	430	430	417	569	417	404	750	650	–	750	3000
TEMPERATURE (°C)	51	51	51	51	51	51	51	51	55.70	54.70	55.70	61.20	58.20	40	44.10	58.20	30	30	30	30	30

NOTES:

1. SEPARATE IDENTICAL CLOSED COOLING WATER SYSTEM IS REQUIRED FOR EACH OF THE GAS TURBINES GENERATOR (TWO IN TOTAL)
2. FIN FAN COOLERS AND HELPER COOLERS ARE SUPPLIED BY OTHERS AS A COMPLETE PACKAGE.
3. POWER ISLAND COOLERS ARE SUPPLIED BY MITSUBISHI AND CONNECTED AT FLANGES.
4. THE MAXIMUM DESIGN TEMPERATURES 51°C AND 40°C ON THE SUPPLY LINES DOWNSTREAM OF THE FIN FAN COOLERS, AND THE MAXIMUM AMBIENT AIR TEMPERATURE 46°C ARE BASED ON MHI UTILITY LIST S4-96585, REV.1

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	07.04.2022	PROGRESS ISSUE
A	AECOM	30.11.2021	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM, AECOM Australia Pty Ltd	DRAWN CAR 30.11.2021	DRAWING CHECKED BVA 30.11.2021	snowy hydro LIMITED
	DESIGNED NS 30.11.2021	DESIGN CHECKED DBM 30.11.2021	HUNTER POWER STATION PROCESS FLOW DIAGRAM UNIT XX – FIN FAN COOLER
DRAWING No. HPP-AEC-MEC-CL-GEN-DRG-1007	SCALE WORK ORDER No	APPROVED CDT 30.11.2021	
REV: B	SECTION No/KKS	A1 SHEET SIZE	B REV SH 1 OF 1

Appendix 2: Study records

Notes on study records

Column 4 ‘Likelihood’ and column 5 ‘Severity’ represent the possibility and consequence of a hazard without taken credit for the safety protection layer (SPL).

Column 8 ‘Likelihood with SPL’ and column 9 ‘Severity with SPL’ represent the possibility and consequence of a hazard taken credit for the correct operation of the SPL. The consequence remains the same, only the frequency is modified.

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 1 - Fin fans Dwg HPP-AEC-MEC-SW-GEN-DRG-1160-A - HPS P&ID Power island closed cooling water system, Sht 1 of 4											
Pressure High										Designed for 2 pumps running	1. Add drain points and vibration sensors to P&ID Sht 1 of 4
Pressure Low										Its possible but should be set up correctly during commissioning. Many process alarms would show insufficient cooling	2. Piping ratings on drawings need to be corrected
Pressure No or not										Alarm monitoring only	3. Pumps have not been specified yet. System pressure with 2 pumps running to be checked against MHI supplied heat exchangers and the fin fan cooler design pressure
Pressure Vacuum											4. Delete upstream individual header pressure indicators and change the downstream individual header pressure indicators to temperature sensors to assist with flow balancing
Temperature High										Ambient temp change and both isolation valves without draining the system could lead to deadhead but this is a maintenance task. High process temperature managed by downstream nodes	5. Add fin fan overall dP sensor
Temperature Low	Ambient temperature									Freezing mitigated by running system at temperatures below 5 Celsius. System would normally be operating all the time	6. Add helper cooler discharge pressure and temperature transmitter to P&ID
Temperature – No or not	BPCS failure - sensor fault	Loss of production - Potential process problems	UnLikely	Negligible	Low	Redundant sensor fail over	Rare	Negligible	Low	Fail over to the header temperature sensor, sht 1162. Loss of both sensors starts all fans. Operator can also manually stop start fin fans	7. Review system design for thermal expansion to assess if a flexible connection is required
Flow / Level – High											8. Review which sensor is better to control the fin fans, CT102 or CT103
Flow / Level – Low											9. Review sensor failure on loss of signal for fin fans, CT102 and CT103
Flow / Level – No or not											10. Temperature sensors should be dual elements, even if only 1 is used. Consistent with MHI design
Flow / Level – Reverse											11. Flow balancing valves should be set and forget. Not move with water vibration. Valve selection to consider locking or rigid stem packing to hold commissioned position
Vibration – High Low or not	Fin fan imbalance	Loss of production - Throw a blade	UnLikely	Negligible	Low	Fin fan vibration Hi Hi	Rare	Negligible	Low	Blades are guarded	
As well as - concentration / two phase											
Other then - impurities / contamination										Carbon steel and corrosion covered by routine maintenance	
Timing / Sequence - Early / Late											
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power										MCC are monitored. Individual motor = loss of performance. Total AC outage would mean unit out	
Volts / Amps High										MCC are monitored	
Volts / Amps Low											
Volts / Amps - No or Not											
Maintenance										Motors are underslung but would need scaffold. Grease points also accessible underneath. Access typically 3 to 6 mth intervals. Need scissor lift. SHL to cover this in Operability study	12. Grease points access needs a lift. SHL to review site requirements hire or buy a scissor lift

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 2 - Helper cooler and booster pump Dwg HPP-AEC-MEC-SW-GEN-DRG-1160-A - HPS P&ID Power island closed cooling water system, Sht 1 of 4											
Pressure High										Designed for 2 pumps running. Manual valves locked open	13. Add duty standby pumps to drawing
Pressure Low											14. Confirm piping pressure rated for two pumps running
Pressure No or not	BPCS failure - sensor fault									Alarm only. Used to monitor pump	
Pressure Vacuum	Demin forwarding pumps not running	Potential cavitation - pump damage	Possible	Negligible	Low	Forwarding pumps running interlock	Rare	Negligible	Low	Small but high pressure pumps	
Temperature High											
Temperature Low	Ambient temperature									Low ambient temp does not need helper pump running. -5 C for only a few hours. Freezing low risk and low impact	15. Review instrument impulse lines for low ambient temp. Threaded socket direct to pipe is probably the best approach.
Temperature – No or not										TT used for pump control. Alarm only. Only required on very high ambient temp days 46 C	7. Review system design for thermal expansion to assess if a flexible connection is required
Flow / Level – High											
Flow / Level – Low										Isolation valves locked open	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not	Fin fan imbalance	Loss of production - Throw a blade	UnLikely	Negligible	Low	Fin fan vibration Hi Hi	Rare	Negligible	Low	Blades are guarded	
As well as - concentration / two phase											
Other then - impurities / contamination										Nozzle blocking over time would be alarmed in process temp	
Timing / Sequence - Early / Late											16. Potential forwarding pressure is sufficient to continuously leak out of helper spray nozzles. Review booster pump or spray bar isolation requirements
Timing / Sequence - Fast / Slow										Pumps are fixed speed	
Utility failure - instr. air / oil / power										Potential loss of performance. Negligible	
Volts / Amps High										MCC are monitored	
Volts / Amps Low											
Volts / Amps - No or Not											
Maintenance										Same as above. Rain water flows to trade waste	17. Helper Cooler spray water is demin that needs to flow (if any) to Trade waste. System is not covered so rain water catchment would also flow to trade waste. To be considered in the design.

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 3 - Expansion tank Dwg HPP-AEC-MEC-SW-GEN-DRG-1161-A - HPS P&ID Power island closed cooling water system, Sht 2 of 4											
Pressure High	Regulator failure	Loss of production - Heat exchanger damage	UnLikely	Major	Medium	PRV	Rare	Major	Medium	1. High suction would result in high discharge from pumps potentially greater than system design causing equipment failure. Long lead time no spare. Water system is common to both exchangers. 2. System designed for both pumps running but normal operation is 1 pump duty / standby configuration	19. Add PRVs to instrument air and forwarding demin supplies to prevent overpressure, Press Reg, Sight glass, manifold suction pressure transmitter and level switch to P&ID and suitably rated
Pressure Low	Leak or normal operation consumption	Loss of production - Generator load limited	UnLikely	Negligible	Low	Procedural - Operator alarm response	Rare	Negligible	Low	This row discharge pressure low Refer notes in H2 coolers, Node 6	
Pressure Low	Leak or normal operation consumption	Loss of production - Generator load limited	UnLikely	Negligible	Low	Expansion tank level Lo Lo Inlet manifold pressure Lo Lo	Rare	Negligible	Low	This row suction pressure low	
Pressure No or not										Alarm only	
Pressure Vacuum										Manual isolation valves will be lockable type	
Temperature High										Designed for max water temp of 60 C and ambient 46 C	
Temperature Low										Ambient to -5 C for a couple of hours	
Temperature – No or not										No instrument here for temp	
Flow / Level – High	Air leak	Loss of production - Generator load limited	UnLikely	Negligible	Low	Procedural - Operator alarm response	Rare	Negligible	Low	System pressure would become low	
Flow / Level – Low	Leak or normal operation consumption	Loss of production - Generator load limited	UnLikely	Negligible	Low	Expansion tank level Lo Lo	Rare	Negligible	Low		18. Water consumption of pump gland seals and leakage to be estimated to evaluate automating tank filling and pump discharge pressure stability. More than 1 x per mth suggest automation required.
Flow / Level – No or not										Alarm only	
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase	Bladder leak	Aerated water, potential pump cavitation	UnLikely	Negligible	Low	Discharge manifold pressure Lo	Rare	Negligible	Low		26. Expansion tank bladder inspection and repair access and maintenance requirements to be specified
Other then - impurities / contamination										Clean demin system	
Timing / Sequence - Early / Late										Add water first then air to balance tank level	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											
Maintenance											26. Expansion tank bladder inspection and repair access and maintenance requirements to be specified

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 4 - Cooling water pumps Dwg HPP-AEC-MEC-SW-GEN-DRG-1161-A - HPS P&ID Power island closed cooling water system, Sht 2 of 4											
Pressure High										System designed for both pumps running but normal operation is 1 pump duty / standby configuration. High pressure refer expansion tank node 3	27. Pump discharge manifold PRV to discharge to trade waste system. All (all nodes) CW system drain points need to go to trade waste
Pressure Low	Motor starter fault	Loss of production - Potential process problems	UnLikely	Negligible	Low	Pump discharge flow Lo Lo	Rare	Negligible	Low	Refer expansion tank node 3. Pump flow switch start check incorporated in design	
Pressure No or not										Alarm only. Constant speed pumps	
Pressure Vacuum										Manual isolation valves will be lockable type. Blocked strainer on clean demin system unlikely and slow to build so would be detected by low discharge pressure. Potential pump damage cost is < 100K negligible	
Temperature High											
Temperature Low											
Temperature – No or not										No instrument here for temp	
Flow / Level – High										Refer high pressure above	
Flow / Level – Low										Refer expansion tank and strainer comments above	
Flow / Level – No or not										Option to auto transfer to standby pump	
Flow / Level – Reverse											
Vibration – High Low or not										Manual spot checking suggested	
As well as - concentration / two phase										Air same as above, corrosion inhibitor manual dosing. Water leaks into the oil systems	
Other then - impurities / contamination										After commissioning it is clean demin system with dosing only.	
Timing / Sequence - Early / Late										Late picked up by process. Early no problem	
Timing / Sequence - Fast / Slow										Constant speed pumps	
Utility failure - instr. air / oil / power										Black stop capability? MCC are monitored	28. On loss of AC supply, does the closed cooling water system (fans and / or pumps) need to be operational for any specified period time after a black stop. MHI to confirm any run down time requirements
Volts / Amps High										MCC are monitored	
Volts / Amps Low											
Volts / Amps - No or Not											
Maintenance										Pumps are accessible and isolatable	27. Pump discharge manifold PRV to discharge to trade waste system. All (all nodes) CW system drain points need to go to trade waste

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 5 - GT HP Purge air coolers Dwg HPP-AEC-MEC-SW-GEN-DRG-1162-A - HPS P&ID Power island closed cooling water system, Sht 3 of 4											
Pressure High										Refer flow AA020 back pressure	
Pressure Low										Manual isolation valves will be lockable type	
Pressure No or not											
Pressure Vacuum											
Temperature High	BPCS failure - sensor fault	Loss of production - Compressor damage	UnLikely	Minor	Low		UnLikely	Minor	Low	CW spec is 40 C max. Only used when running on diesel	20. MHI to review HP compressor protection requirements. What are the consequences if the closed cooling water temperature increases above 40 C. Do we need to shutdown the compressors to protect them from damage?
Temperature Low										CW temp range 23 to 40 C in design spec. There is no flow temperature control on the exchanger flow. Too warm managed by helper coil but too cold? HP compressor is within an enclosure and would generate heat when running. MHI don't think low temp is a major concern based on 20 C cooling water temp. HP compressors only used at barring so turbine would also generate heat low	
Temperature – No or not											
Flow / Level – High										Set during commissioning. Loss of performance consequence if set incorrectly.	
Flow / Level – Low										Same as high flow	
Flow / Level – No or not											
Flow / Level – Reverse											
Vibration – High Low or not											
As well as - concentration / two phase	Exchanger leak	Loss of production - Compressor bearing damage	UnLikely	Minor	Low		UnLikely	Minor	Low	CW 5.5 Bar, Oil tbc Bar	21. MHI to confirm HP compressor oil pressure and if there is an exchanger leak, will the water flow into the compressor and cause damage? How is this detected?
Other then - impurities / contamination										Clean demin system	
Timing / Sequence - Early / Late										All manual valves	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											
Maintenance											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 6 - GTG H2 air coolers Dwg HPP-AEC-MEC-SW-GEN-DRG-1162-A - HPS P&ID Power island closed cooling water system, Sht 3 of 4											
Pressure High										H2 press 5 Bar and CW press 5.5 Bar	22. P&ID line 100mm to be updated to 125mm
Pressure Low	BPCS failure - pressure regulation	Potential H2 accumulation in water	UnLikely	Negligible	Low	Procedural - Operator alarm response	Rare	Negligible	Low	CW pressure low and tube leak could potentially leak H2 into water system, which would accumulate at the fin fan vent pipe. Automation for double jeopardy discussed and will be further reviewed by AECOM	23. Pressure regulation wont work as shown. AECOM to review water pressure balancing system. It is important to maintain 5.5 Bar cooling water at exchangers to inhibit H2 leak
Pressure No or not										PI only used for commissioning to set balance	
Pressure Vacuum											
Temperature High	BPCS failure - pressure regulation	Loss of production - Generator load limited	UnLikely	Negligible	Low	Procedural - Operator alarm response	UnLikely	Negligible	Low		
Temperature Low											
Temperature – No or not											
Flow / Level – High										Flows set during commissioning. Worst case loss of production, retuning	
Flow / Level – Low											
Flow / Level – No or not										Loss of performance monitoring	
Flow / Level – Reverse											
Vibration – High Low or not										All AECOM pipework is stress analysed for thermal expansion	
As well as - concentration / two phase	Exchanger leak	Potential water accumulation in generator	UnLikely	Major	Medium	Generator level switches	Rare	Major	Medium	Refer to GTG HAZOP	
Other then - impurities / contamination											
Timing / Sequence - Early / Late										All valves are manual and locked open / closed	
Timing / Sequence - Fast / Slow											
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											
Maintenance											24. AECOM to review and confirm with MHI if any closed cooling water commissioning strainer / removal spool requirements

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 7 - GT Control oil coolers Dwg HPP-AEC-MEC-SW-GEN-DRG-1163-A - HPS P&ID Power island closed cooling water system, Sht 4 of 4											
Pressure High	Exchanger leak	Potential oil accumulation in control oil tank	UnLikely	Negligible	Low	Procedural - Operator alarm response	Rare	Negligible	Low	CO press 80 Bar supply but return 5 Bar return and CW press 5.5 Bar	
Pressure Low	Exchanger leak	Potential oil accumulation in cooling water system	UnLikely	Negligible	Low	Procedural - Operator alarm response	Rare	Negligible	Low	Tube leak and low pressure (double jeopardy) would leak oil into water but before it became an issue for cooling water it would trigger low control oil level	
Pressure No or not										PI only used for commissioning to set balance	
Pressure Vacuum											
Temperature High	BPCS failure - pressure regulation									CW temp max 51 C. MHI advise no real concern.	
Temperature Low	BPCS failure - pressure regulation	Loss of production - Potential process problems	UnLikely	Negligible	Low		UnLikely	Negligible	Low	Valve sticking or poor control if oil too cold. CO temp is monitored in the tank for heater control.	
Temperature – No or not										Alarm, loss of heater control but not in this node	
Flow / Level – High										Potential loss of performance. Negligible	
Flow / Level – Low										Potential loss of performance. Negligible	
Flow / Level – No or not										Loss of performance monitoring	
Flow / Level – Reverse											25. AECOM to review check valve quantity and location. Control oil only has 1 common NRV but other exchangers are individually controlled. Do we need them?
Vibration – High Low or not										All AECOM pipework is stress analysed for thermal expansion	
As well as - concentration / two phase										Refer pressure hi and low above	
Other then - impurities / contamination										Same above	
Timing / Sequence - Early / Late										Same above	
Timing / Sequence - Fast / Slow										Same above	
Utility failure - instr. air / oil / power										Same above	
Volts / Amps High										Same above	
Volts / Amps Low										Same above	
Volts / Amps - No or Not										Same above	
Maintenance											

Deviation	Cause	Consequences	Likeli-hood	Conse-quence	Cost Ranking	Safe Guards	Likeli-hood with SPL	Conse-quence with SPL	Risk Ranking with SPL	Comments	Actions
NODE No. 8 - GT Lube oil coolers Dwg HPP-AEC-MEC-SW-GEN-DRG-1163-A - HPS P&ID Power island closed cooling water system, Sht 4 of 4											
Pressure High	Exchanger leak	Potential oil accumulation in lube oil tank	UnLikely	Negligible	Low	Procedural - Operator alarm response	Rare	Negligible	Low	LO press 5 Bar supply and CW press 5.5 Bar	
Pressure Low	Exchanger leak	Potential oil accumulation in lube oil tank	UnLikely	Negligible	Low	Procedural - Operator alarm response	Rare	Negligible	Low	Tube leak and low pressure (double jeopardy) would leak oil into water but system volume is big enough to raise CW suction pressure and discharge pressure until system is balanced and water would flow into the lube oil tank	
Pressure No or not										PI only used for commissioning to set balance	
Pressure Vacuum											
Temperature High	BPCS failure - pressure regulation	Potential bearing damage	UnLikely	Moderate	Medium	Lube oil temperature Hi Hi	Rare	Moderate	Low	CW temp max 51 C.	
Temperature Low										Turbine running will heat oil and also tank has an oil heater and the exchangers have a bypass control. Less than 15 C could be a problem	
Temperature – No or not											
Flow / Level – High										Potential loss of performance. Negligible	
Flow / Level – Low										Potential loss of performance. Negligible	
Flow / Level – No or not										Loss of performance monitoring	
Flow / Level – Reverse											
Vibration – High Low or not										All AECOM pipework is stress analysed for thermal expansion	
As well as - concentration / two phase										Refer pressure hi and low above	
Other then - impurities / contamination										Same above	
Timing / Sequence - Early / Late										Same above	
Timing / Sequence - Fast / Slow										Same above	
Utility failure - instr. air / oil / power											
Volts / Amps High											
Volts / Amps Low											
Volts / Amps - No or Not											
Maintenance											

Appendix 3: SnowyHydro Risk Matrix

When business risk is considered in the risk assessment, instrumented functions that are classified as machine interlocks may be re-classified as Safety Instrumented Functions (SIF) and will then require a Safety Integrity Level (SIL) assignment and SIF architecture verification study.

Likelihood frequencies were taken from the SnowyHydro corporate risk matrix, where

Certain	> 1 event / year
Likely	1 to 2 years / event
Possible	2 to 10 years / event (basic process control failure (machine life)
Unlikely	10 to 50 years / event (machine life, has happened in industry)
Rare	> 50 years /event (remote but theoretically possible event)

Note that a basic process control system (BPCS) failure rate is typically 1 event per 10 years and therefore study records tend to be limited to Unlikely or Rare. A BPCS failure includes the sensors, the logic solver, the final elements (valves, contactors, etc) and where applicable the wiring and power supplies

Likelidood								
Certain	Low	Medium	High	Extreme	Extreme	Extreme	> 0.9	1 yr /event
Likely	Low	Medium	High	High	Extreme	Extreme	0.5 - 1	1 - 2 yrs / event
Possible	Low	Medium	Medium	High	High	Extreme	0.1 - 0.5	2 - 10 yrs /event
UnLikely	Low	Low	Medium	Medium	High	High	0.02 - 0.1	10 - 50 yrs / event
Rare	Low	Low	Low	Medium	Medium	High	< 0.02	> 50 yrs /event
	Negligible	Minor	Moderate	Major	Severe	Catastrophic		

Consquence Level

Likelidood						
Certain	1	2	3	4	4	4
Likely	1	2	3	3	4	4
Possible	1	2	2	3	3	4
UnLikely	1	1	2	2	3	3
Rare	1	1	1	2	2	3
	Negligible	Minor	Moderate	Major	Severe	Catastrophic

RISK RATING MATRIX	LIKELIHOOD				
CONSEQUENCE	Rare	Unlikely	Possible	Likely	Almost Certain
Catastrophic	High	High	Extreme	Extreme	Extreme
Severe	Med	High	High	Extreme	Extreme
Major	Med	Med	High	High	Extreme
Moderate	Low	Med	Med*	High	High
Minor	Low	Low	Med	Med	Med
Negligible	Low	Low	Low	Low	Low

* For example, a risk with a likelihood of "Possible" and a consequence

Risk Rating Matrix

Likelihood Criteria

RATING	LIKELIHOOD	PROBABILITY
Almost Certain	The event is very likely to occur	>90%
Likely	The event will probably occur	50% to 90%
Possible	The event might occur	10% to 50%
Unlikely	The event probably won't occur	2% to 10%
Rare	The event is very unlikely to occur	<2%

In determining the appropriate likelihood rating for your risk, consider the timeframe within which you are delivering your objective and select a rating that indicates the likelihood of the risk event occurring over that period. The timeframe could be, for example, the life of an asset (years) or an individual payroll run (hours).

Consequence Criteria

RATING	FINANCIAL	SAFETY	ENVIRONMENT	COMPLIANCE	AVAILABILITY	REPUTATION
Catastrophic	Cost variation or financial loss greater than $300M.	Multiple fatalities involving employees, contractors or members of the public.	Permanent impact on populations of significant (eg threatened) flora or fauna. Permanent unconfined impact on previously undisturbed ecosystem.	Snowy Hydro loses a licence to operate (eg AFSL, Snowy Park Lease, Retail licence).	Approximately 1500MW of generating plant unavailable to the market for more than 6 months.	Court, regulator or Government inquiry concludes improper, corrupt or grossly negligent conduct by Snowy Hydro.
Severe	Cost variation or financial loss between $20M and $300M. (The current consequence criteria simply has a threshold of $20 million).	Single fatality or permanent significant disability, long term impairment or illness significantly affecting the quality of life for an employee, contractor or member of the public.	Long term (>10 year) impact on populations of significant (eg threatened) flora or fauna. Long term impacts on soil, air or water quality. *Or* Potential for long term off-site impacts. Loss of numerous significant heritage items.	Claim or action (other than by a Regulator) involving an amount greater than $20M (including court/defence/compliance costs and loss of revenue); or Regulator action that results in: 1. A penalty greater than $5M; and/or 2. Imposition of requirements that would cost more than $20M (including court/defence/compliance costs and loss of revenue)	Approximately 1500MW between generating plant unavailable to the market for between 1 week and 6 months.	Incident or issue causes prolonged, negative national media coverage. Court, regulator or Government inquiry alleges improper, corrupt or grossly negligent conduct by Snowy Hydro. Other action by Snowy Hydro results in shareholders dismissing one or more directors.
Major	Cost variation or financial loss between $5M and $20M.	Long term or permanent disability, impairment or illness not significantly affecting the quality of life for an employee, contractor or member of the public.	Medium term (3-10 year) impact on populations of native flora or fauna. Medium term impacts on soil, air, water quality or habitat. Potential for medium term off-site impacts.	Claim or action (other than by a Regulator) involving an amount between $5M and $20M (including court/defence/compliance costs and loss of revenue); or Regulator action that results in: 1. A penalty between $1M and $5M; and/or 2. Imposition of requirements that would cost between $5M and $20M (including court/defence/compliance costs and loss of revenue)	Approximately 1500MW of generating plant unavailable to the market for between 1 day and 1 week; or 600MW of plant unavailable for at least 1 week; or 300MW of generating plant unavailable for a month or more.	Incident or issue causes negative state wide media attention and regulatory intervention. Government inquiry into Snowy Hydro's actions or operations in regard to conduct, pricing etc. Action by Snowy Hydro results in one or more Executives or senior managers being terminated.
Moderate	Cost variation or financial loss between $1M and $5M.	Hospitalisation with medical intervention of an employee, contractor or member of the public.	Short term (1-3 year) impact on flora or fauna. Short term impact on soil, air, water quality or habitat. Impact mostly confined to work area but potential short term off-site impacts. Loss of a significant (eg Category A and B) heritage item. Visual, noise or airborne dust impacts with potential for regulator response.	Claim or action (other than by a Regulator) involving an amount between $1M and $5M (including court/defence/compliance costs and loss of revenue); or Regulator action that results in: 1. A penalty between $100K and $1M; and/or 2. Imposition of requirements that would cost between $1M and $5M (including court defence/compliance costs and loss of revenue)	Approximately 1500MW of generating plant unavailable to the market for between 1 hour and 1 day; or 600MW generating plant unavailable for between 1 day and 1 week; or 150MW of generating plant unavailable for a month or more.	Incident or issue causes local outrage with potential for escalation to state media and/ or to generate regulator interest. State or Federal regulator conducts formal inquiry into broader industry issues which encompass Snowy Hydro's operations. Major changes to Snowy Hydro operations have significant local community impacts.
Minor	Cost variation or financial loss between $100K and $1M.	Injury or illness requiring medical treatment of an employee, contractor or member of the public.	Adverse impact to significant (eg Category A and B) heritage item. Visual, noise or airborne dust impacts with potential for credible stakeholder/ public complaint.	Claim or action (other than by a Regulator) involving an amount between $100K and 1M (including court/ defence/compliance costs and loss of revenue); or Regulator action that results in: 1. A penalty between $10K and $100K; and/or 2. Imposition of requirements that would cost between $100K and $1M (including court defence/compliance costs and loss of revenue)	Approximately 600MW of generating plant unavailable to the market for up to 1 day; or up to 300MW of generating plant unavailable for up to 1 week; or up to 100MW of generating plant unavailable for a month or more.	Incident or issue causes local outrage with no potential for escalation. Short term negative regional media attention around a minor, localised issue. Minor damage to reputation with a regulator.
Negligible	Cost variation or financial loss less than $100K.	Nil to first aid injury, low level short term inconvenience or symptoms for an employee, contractor or member of the public.	Promptly reversible/trivial impact on air, water, soil, flora, fauna, habitat or heritage..	Claim or action (other than by a Regulator) involving an amount up to $100K (including court/defence/ compliance costs and loss of revenue); or Notification to a Regulator is required (but with no other consequence); or Regulator action that results in: 1. A warning notice; 2. A penalty up to $10K; and/or 3. Imposition of requirements that would cost up to $100K (including court/defence/compliance costs and loss of revenue)	Loss of a single generating unit for up to a day.	Incident or issue causes local inconvenience. Negative comment about Snowy Hydro at regional level. Formal complaint made to Snowy Hydro by the public.

330	mw	Capacity loss
300	$/mw	Unit loss
24	hrs out	Outage time
$ 2,376,000		Event impact

Appendix 4: HAZOP action items

This section collates all the workshop action items into one list for quick reference. The reader will need to refer to the Study Records in Appendix 2 for the background and references (node, dwg, descriptions, etc) of each action.

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
1	1. Add drain points and vibration sensors to P&ID Sht 1 of 4	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
2	2. Piping ratings on drawings need to be corrected	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
3	3. Pumps have not been specified yet. System pressure with 2 pumps running to be checked against MHI supplied heat exchangers and the fin fan cooler design pressure	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
4	4. Delete upstream individual header pressure indicators and change the downstream individual header pressure indicators to temperature sensors to assist with flow balancing	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
5	5. Add fin fan overall dP sensor	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
6	6. Add helper cooler discharge pressure and temperature transmitter to P&ID	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
7	7. Review system design for thermal expansion to assess if a flexible connection is required	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
8	8. Review which sensor is better to control the fin fans, CT102 or CT103	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
9	9. Review sensor failure on loss of signal for fin fans, CT102 and CT103	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
10	10. Temperature sensors should be dual elements, even if only 1 is used. Consistent with MHI design	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
11	11. Flow balancing valves should be set and forget. Not move with water vibration. Valve selection to consider locking or rigid stem packing to hold commissioned position	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
12	12. Grease points access needs a lift. SHL to review site requirements hire or buy a scissor lift	sara.roder@snowyhydro.com.au	3. Prior to Handover for Beneficial Operation	1.6.23			Open
13	13. Add duty standby pumps to drawing	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
14	14. Confirm piping pressure rated for two pumps running	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
15	15. Review instrument impulse lines for low ambient temp. Threaded socket direct to pipe is probably the best approach.	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
16	16. Potential forwarding pressure is sufficient to continuously leak out of helper spray nozzles. Review booster pump or spray bar isolation requirements	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
17	17. Helper Cooler spray water is demin that needs to flow (if any) to Trade waste. System is not covered so rain water catchment would also flow to trade waste. To be considered in the design.	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open

No	Action items	By	Due - Completion Phase	Due - Date	Notes	Answer	Status
18	18. Water consumption of pump gland seals and leakage to be estimated to evaluate automating tank filling and pump discharge pressure stability. More than 1 x per mth suggest automation required.	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
19	19. Add PRVs to instrument air and forwarding demin supplies to prevent overpressure, Press Reg, Sight glass, manifold suction pressure transmitter and level switch to P&ID and suitably rated	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
20	20. MHI to review HP compressor protection requirements. What are the consequences if the closed cooling water temperature increases above 40 C. Do we need to shutdown the compressors to protect them from damage?	MHI - hirofumi.moriguchi.3h@mhi.com	2. Prior to Commissioning	1.6.22			Open
21	21. MHI to confirm HP compressor oil pressure and if there is an exchanger leak, will the water flow into the compressor and cause damage? How is this detected?	MHI - hirofumi.moriguchi.3h@mhi.com	2. Prior to Commissioning	1.6.22			Open
22	22. P&ID line 100mm to be updated to 125mm	Blair.Murray@aecom.com	2. Prior to Commissioning	1.6.22			Open
23	23. Pressure regulation wont work as shown. AECOM to review water pressure balancing system. It is important to maintain 5.5 Bar cooling water at exchangers to inhibit H2 leak	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
24	24. AECOM to review and confirm with MHI if any closed cooling water commissioning strainer / removal spool requirements	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
25	25. AECOM to review check valve quantity and location. Control oil only has 1 common NRV but other exchangers are individually controlled. Do we need them?	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
26	26. Expansion tank bladder inspection and repair access and maintenance requirements to be specified	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
27	27. Pump discharge manifold PRV to discharge to trade waste system. All (all nodes) CW system drain points need to go to trade waste	Blair.Murray@aecom.com	1. Prior to Construction	1.6.22			Open
28	28. On loss of AC supply, does the closed cooling water system (fans and / or pumps) need to be operational for any specified period time after a black stop. MHI to confirm any run down time requirements	MHI - hirofumi.moriguchi.3h@mhi.com	1. Prior to Construction	1.6.22			Open

Appendix 5: Safeguards

No	Safeguards - Description	Instances
1	Redundant sensor fail over	1
2	Fin fan vibration Hi Hi	2
3	Forwarding pumps running interlock	1
4	PRV	1
5	Procedural - Operator alarm response	8
6	Generator level switches	1
7	Lube oil temperature Hi Hi	1
8	Expansion tank level Lo Lo	2
9	Inlet manifold pressure Lo Lo	1
10	Discharge manifold pressure Lo	1
11	Pump discharge flow Lo Lo	1

Appendix 6: Participants

No	Email	Attendance day 1 28 April	Attendance day 2 5 May	Discipline
1	Bridget McArthur@aecom.com	y	n	Process engineer
2	Blair.Murray@aecom.com	y	y	Project Engineer - Mechanical
3	Brooke Mackley1@consultant.aecom.com	y	y	Process mechanical engineer
4	francois.valette@snowyhydro.com.au	y	y	Mechanical Engineer
5	Neil Shen@aecom.com	y	y	Mechanical Engineer
6	desk@pooletranslation.com.au	y	n	Translation services
7	Karl.Ivanusic@jacobs.com	y	y	Project Engineer - Mechanical
8	lachlan.smith@snowyhydro.com.au	y	y	Project Engineer - Mechatronics
9	MHI - hirofumi.moriguchi.3h@mhi.com	y	n	Project manager
10	MHI - yoji.oshino.mr@mhi.com	y	n	Plant Engineer
11	Mitchell Stokes@aecom.com	y	y	Electrical Instrumentation engineer
12	sara.roder@snowyhydro.com.au	y	y	Mechanical Engineer
13	Melco - Kohei Miura - H2 seal oil system	y	n	Project Engineer - Mechanical
14	Patrick Scholtes	n	y	Mechanical - Gas Assets

Appendix 7: Acronyms

ACRONYMS

The following acronyms may be used throughout this course and reference documents:

AIChE	American Institute of Chemical Engineers
AC/DC	Alternating current/direct current
ALARP	As low as reasonably practicable
ANSI	American National Standards Institute
ANSI/ISA	American National Standards Institute/ Instrumentation, Systems and Automation
API	American Petroleum Institute
ANSI / API 611	American Petroleum Institute: General purpose steam turbines
ANSI / API 612	Australian Standard: Special purpose steam turbines
ANSI/ISA-84.01	Application of Safety Instrumented Systems for the Process Industries.
AS	Australian Standard
ASME	American Society of Mechanical Engineers
AS 1375	Australian Standard: Industrial fuel fired appliances
AS 3814	Australian Standard: Industrial and commercial gas-fired app.
AS 4629	Australian Standard: Automatic shut off and vent valves.
AS / IEC 61508	Australian Standard: Functional safety of electrical /electronic/programmable electronic safety-related systems - Set
AS / IEC 61511 process	Australian Standard: Functional safety - Safety instrumented systems for the industry sector
BI	Business Interruption
BLEVE	Boiling Liquid Expanding Vapor Explosion
B.P.	Boiling Point
BPCS	Basic Process Control System
C	Consequence factor, related to magnitude of severity
CCF	Common Cause Failure
CCF	Common Cause Factor
CCPS	Center for Chemical Process Safety, American Institute of Chemical Engineers
CEI	Dow Chemical Exposure Index
CHAZOP	Controls Hazard & Operability Study
CMS	Consequence Mitigation System
CPQRA	Chemical Process Quantitative Risk Assessment
CW	Cooling Water
DC	Diagnostic coverage
D	Number of times a component or system is challenged (hr–1 or year–1)
DCS	Distributed Control System
DIERS	Design Institute for Emergency Relief Systems, American Institute of Chemical Eng.
DOT	Department of Transportation
EBV	Emergency Block Valve
E/E/PE	Electrical/electronic/programmable electronic
E/E/PES	Electrical/electronic/programmable electronic system
EMC	Electro-magnetic compatibility
ERPG	Emergency Response Planning Guideline
EuReData	European Reliability Data (series of conferences)FAT Factory acceptance testing
F	Failure Rate (hr-1 or year-1)
f	Frequency (hr-1 or year-1)
F&EI	Dow Fire and Explosion Index
F/N	Fatality Frequency versus Cumulative Number
FCE	Final Control Element

FMEA	Failure Modes and Effect Analysis
FMECA	Failure Mode Effect and Criticality Analysis
FPL	Fixed program language
FTA	Fault Tree Analysis
FVL	Full variability language
HAZOP	Hazard and Operability Study
HE	Hazard Evaluation
HFT	Hardware fault tolerance
HMI	Human machine interface
HRA	Human Reliability Analysis H&RA Hazard and risk assessment
H/W	Hardware
IEC	International Electro technical Committee
IEEE	Institute of Electrical and Electronic Engineers
IEV	International Electrotechnical Vocabulary
I/O	Input or Output
IPL	Independent Protection Layer
ISA	The Instrumentation, Systems, and Automation Society
ISO	International Organization for Standardization
ISO 10437	Special purpose steam turbines
LAH	Level Alarm—High
LI	Level Indicator
LIC	Level Indicator—Control
LFL	Lower Flammability Limit
LNG	Liquefied Natural Gas
LOP	Layer of Protection
LOPA	Layer of Protection Analysis
LOTO	Lock-Out Tag-Out
LT	Level Transmitter
LVL	Limited variability language
MAWP	Maximum Allowable Working Pressure
MOC	Management of Change
MOC	Management of Change
MooN	"M" out of "N"
MTBF	Mean Time Between Failures
MTTF	Mean Time To Failure
NFPA	National Fire Protection Authority
NFPA 85	NFPA Standard: Boiler and Combustion Systems Hazards Code
NFPA 86	NFPA Standard: Ovens and Furnaces
NP	Non-programmable
N2	Nitrogen
OSBL	Outside Battery Limits
OREDA	The Offshore Reliability Data project
OSHA	Occupational Safety and Health Administration (U.S.)
P fatality	Probability of Fatality
P ignition	Probability of Ignition
P person present	Probability of Person Present
P	Probability
PCS	Premier Consulting Service
PE	Programmable electronics
PES	Programmable electronic system
PFD	Probability of Failure on Demand

PFDavg	Average probability of failure on demand
PHA	Process Hazard Analysis
PI	Pressure Indicator
PL	Protection Layer
PLC	Programmable logic controller
P&ID	Piping and Instrumentation Diagram
PLC	Programmable Logic Controller
PM	Preventive Maintenance
PSM	Process Safety Management
PSV	Pressure Safety Valve (Relief Valve)
PSAT	Pre-Startup Acceptance Test
QRA	Quantitative Risk Assessment
R	Risk
RV	Relief Valve
RTD	Resistance Temperature Detector
SAT	Site acceptance test
SCE	Safety Critical Equipment
SFF	Safe failure fraction
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SOP	Standard Operating Procedures
SOV	Solenoid Valve
SRS	Safety Requirement Specification
S/W	Software
T	Test Interval for the Component or System (hours or years)
T/C or TE	Thermocouple
TMR	Triple Modular Redundant
UPS	Uninterruptible Power Supply
VCE	Vapor Cloud Explosion
VLE	Vapor Liquid Equilibrium
WDT	Watch Dog Timer
XV	Remote Activated/Controlled Valve
1oo1	One-out-of-One Voting
2oo2	Two-out-of-Two Voting
3oo3	Three-out-of-Three Voting

Appendix D
Balance of Plant HAZOP Study Report

Prepared for
Snowy Hydro Limited
ABN: 17 090 574 431

AECOM

HAZOP Study Report

Balance of Plant Scope

15-Jul-2022
Hunter Valley Power Station
Doc No. HPP-AEC-SYS-PT-GEN-REP-0001

aecom.com

Delivering a better world

HAZOP Study Report

Balance of Plant Scope

Client: Snowy Hydro Limited

ABN: 17 090 574 431

Prepared by

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AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 and ISO45001.

Quality Information

Document HAZOP Study Report

Ref 60666845

Date 15-Jul-2022

Prepared by Steven Sylvester

Reviewed by David Lockley/ Kerrie Wells

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	28-Apr-2022	For Internal Review	Jason Lawer Project Manager	
0	14-Jun-2022	For Information	Jason Lawer Project Manager	
1	15-Jul-2022	Required Action Completion Phase added to Detail Records	Jason Lawer Project Manager	

Table of Contents

Executive Summary

Introduction, Objectives and Scope

Snowy Hydro Limited (Snowy Hydro) proposes to construct and operate a Gas Turbine Peaking Power Station in the Hunter Valley, NSW. AECOM has been commissioned to design the services systems for the power station and as part of the power station design, Hazard and Operability studies (HAZOP) were performed to identify any potential hazards and operational issues prior to the plant construction/operation. Snowy Hydro and AECOM commissioned RiskCon Engineering Pty Ltd (RiskCon) to provide an independent HAZOP facilitator for the proposed studies conducted for the power station service systems project.

The objectives of the HAZOP were to identify hazard and operability issued associated with the design and operation of the proposed services areas, identify hazard management & control measures and report on the study findings including HAZOP minutes incorporating action recording functions.

The scope of work for the HAZOP was for the services systems (Balance of Plant) only and does not include the gas turbines and associated power components.

Methodology

The HAZOP study was conducted using a workshop format following the principles of Hazardous Industry Planning Advisory Paper No. 8 (Ref.2), Kletz (Ref.1) and AS/IEC 61882 (Ref.3). To ensure the most effective recording of results was achieved, for the Hunter Power Services Systems, or Balance of Plant, HAZOP study, the following recording format was adopted:

1. For the issues identified in the assessment, where a discussion issue was clearly identified to result in no hazard or operability issue, no entry was made in the HAZOP minutes sheet. This entry approach was followed to minimise the recording requirements of the study.
2. Where a hazard and operability issue may have a potential to occur as a result of the process design or operation, the deviation from normal operations was reviewed and where the safeguards were considered adequate to control the identified hazard/operability issue, a part record was made with “no action required” recorded.
3. Where a discussion point was identified to result in a potential hazard/operations issue, and safeguards were identified to be insufficient to control the hazard/operability issue, a full minute point was recorded, identifying deviation cause, consequence, proposed safeguards and action required to prevent, detect, protect and/or mitigate the operations consequences.

The summary of HAZOP Minutes recorded during the workshop sessions are presented in Appendix A.

HAZOP Study Results

The meeting was able to review the proposed design in a satisfactory manner, including the impact of disturbances from the Kurri Kurri Gas Lateral on the Hunter Power site (design representatives from the Kurri Kurri Gas Lateral Project Team, APA, participated in the relevant session). Adequate information was available, and the HAZOP participants had a sound range of relevant design and production experience.

The HAZOP study did not reveal any significant hazards that would compromise the safety or integrity of the project and that could not be managed. The project can proceed, subject to satisfactory resolution of the HAZOP recommendations.

There were 316-minute points discussed during the HAZOP study, with a number of these requiring no action or follow up item. However, there were a number of issues raised due to the specific requirements of the systems and the proposed operation.

A total of 213-minute points were recorded requiring action, which are listed in the HAZOP minutes at Appendix A.

Many of these were related to the requirement for update of P&IDs, procedures, detailed operation of the isolation function, access requirements, relocation or addition of valves when in use or when isolated and fail-safe valve failure position, etc. The drawings used in the HAZOP are included at Appendix B, showing the nodes applied during the workshop study.

To ensure appropriate follow-up is recorded for each of the minute points requiring action, HAZOP action columns have been included in the HAZOP minutes at Appendix A. These columns can be used by the project management team to input the action taken and date completed as a record of the minute point follow up. Prior to commencement of operations at the plant, all action points relating to design, operating procedures and commissioning should be completed and the action taken recorded to ensure appropriate hazard reduction or increase in operability has been implemented. Where the HAZOP actions are associated with maintenance activities these may not be fully closed out until the relevant experience has been gained when performing maintenance.

Abbreviations

AS	Australian Standard
BOP	Balance of Plant
CO_2	Carbon Dioxide
CPEng.	Chartered Professional Engineer
Demin.	Demineralised Water
EEHA	Electrical Engineering Hazardous Areas
FIE Aust.	Fellow of Engineers Australia
FT	Full Time
GT	Gas Turbine
GTG	Gas Turbine Generator
H_2	Hydrogen
HAZOP	Hazard & Operability Study
ICI	Imperial Chemical Industries
IEC	International Electrotechnical Commission
kg/h	kilograms per hour
km	Kilometres
kPag	kilo Pascals (gauge)
kV	kilo Volts
L/s	Litres per second
m^3	Cubic Metres
m^3/h	Cubic metres per hour
MHI	Mitsubishi Heavy Industries
MPa	Mega Pascals
MW	Mega Watts
N_2	Nitrogen
NER	National Engineering Register
NG	Natural Gas
Nm^3/h	Normal cubic metres per hour
OCGT	Open Cycle Gas Turbine
P&IDs	Piping and Instrumentation Diagrams
P/T	Part time
pH	Measure of acidity/Alkalinity
RPRQ	Registered Professional Engineer in Queensland
SCADA	Supervisory Control and Data Acquisition
SCADA	Supervisory Control and Data Acquisition
SFAIRP	So Far As Is Reasonably Practicable
SMS	Safety Management System

1.0 Introduction

1.1 Background

Snowy Hydro Limited (Snowy Hydro) proposes to construct and operate a Gas Turbine Peaking Power Station in the Hunter Valley, NSW. AECOM has been commissioned to design the services systems for the power station and as part of the power station design, Hazard and Operability studies (HAZOP) were performed to identify any potential hazards and operational issues prior to the plant construction/operation.

Snowy Hydro and AECOM commissioned RiskCon Engineering Pty Ltd (RiskCon) to provide an independent HAZOP facilitator for the proposed studies conducted for the power station service systems project.

This document provides the HAZOP study minutes, action sheets and report for the services systems for the proposed Hunter Power Station, NSW.

1.2 Objectives

The objectives of the HAZOP study of the Hunter Power Project services systems were to:

- identify hazard and operability issues associated with design and operation of the proposed services areas associated with the Hunter Power Project
- identify hazard management & control measures that can be applied to minimize the potential for hazard and operability impacts
- develop HAZOP action sheets to assist AECOM & Snowy Hydro in implementing the HAZOP actions
- report on the findings of the study, including draft and final HAZOP reports.

1.3 Scope of the HAZOP

The scope of the HAZOP was for the services systems associated with the Hunter Power project only. The HAZOP does not include the Gas Turbine (GT) systems or enclosures, the HAZOP for these systems will be prepared under a separate HAZOP assessment.

The following systems were included in the scope of the HAZOP:

- Natural Gas Supply – from the main gas supply provider at the power station boundary to the GT enclosure, including metering systems, knock out drums, filter/coalescers, cartridge filters, condensate tank and associated pipework
- Diesel Fuel Supply – including diesel fuel unloading, diesel storage tanks, forwarding pumps and associated delivery pipework from the tanks to the GT enclosure
- Process Gas – Hydrogen gas systems including gas cylinders (trailers) and delivery pipework to the generator for each GT
- Process Gas – Carbon Dioxide (CO_2) gas systems including cylinders and delivery pipework to the generator for each GT
- Process gas - Nitrogen gas systems including cylinders and delivery pipework to the natural gas supply line to the GT
- Compressed Air and Instrument air systems supplying air services to the site and to the GT equipment
- Water Supply – potable water supply to the service water tank and site users, including service water tank, service water pumps and associated pipework to users
- Water Supply – service water systems including pumps to Reverse Osmosis (RO) plant, RO plant, demineralised (demin.) water tanks, pumps, filters and chemical dosing systems

- Water Supply – fire water and fire services systems, including fire water tanks, pumps and pipework
- Waste-Water Systems – Oily water collection and treatment systems, Demin plant and blade washing waste water systems, chemical dosing systems for the trade waste system and sewer systems.

1.4 Qualifications of the Facilitator

The HAZOP study was facilitated by Steve Sylvester, Technical Director at RiskCon Engineering. Steve is a mechanical engineer (BEng., Mech.Hons) with over 50 years engineering experience, including 20 years in marine and chemical plant operations and over 30 years in engineering consultancy. Steve spent several years with ICI (inventors of HAZOP) in the early 1990's where he was trained as a HAZOP leader. Since this time he has conducted over 100 HAZOP studies, including major projects such as Goro and Koniambo Nickel plants (New Caledonia), Ichthys Project in Darwin and numerous smaller mining, mineral processing and Oil/Gas project HAZOPs. He is an internationally accredited Functional Safety Engineer (FSE TÜV 2203/10), a founding member and Fellow of the Australasian Institute of Dangerous Goods Consultants (www.aidgc.org.au) and has completed the competency training for Electrical Engineering Hazardous Areas (EEHA). He is a Fellow and Chartered Professional Engineer (FIEAust/CPEng.), is listed on the National Engineering Register (NER) and is a Registered of Professional Engineers in Queensland (RPEQ). A full resume can be provided on request.

2.0 Methodology

2.1 HAZOP Study Background

The hazard and operability study (HAZOP) is a workshop-based approach structured particularly for process operations. However, HAZOP studies have been successfully applied to mechanical electrical and computer systems alike.

The HAZOP study methodology was developed in the mid 1970's by Professor Trevor Kletz* for Imperial Chemical Industries (ICI) and has developed into a useful design tool for project managers to take stock of the status of the design and to assess the hazards associated with a project and how the proposed design caters for the safe management of those hazards.

Whilst HAZOP was originally designed to assess new projects, it has (over time) become a useful tool for assessing existing plant and facilities to determine hazard and operability issues that may have been overlooked in original designs that may not have been subject to the HAZOP process. It is also a useful tool for conducting due diligence assessments to determine whether a proposed purchase is a viable option.

* Trevor Kletz – former Professor Emeritus, Loughborough University, UK (Deceased).

2.2 HAZOP Study Approach

The basic approach used for the Hunter Power Project Services HAZOP was that published by the Department of Planning, Industry and Environment (DPIE, Ref.2), Kletz (Ref.1) and Australian Standard AS/IEC 61882 (Ref.3). The process is as follows:

Preliminary work included the identification of nodes used in the HAZOP assessment and determine the guidewords proposed for use in the study. Preliminary work was discussed with Snowy Hydro and AECOM to confirm the appropriate nodes and guideword selection reflected the proposed design and operations.

Prior to the study commencement, piping and instrumentation diagrams (P&IDs) were provided to the study participants to assist in the detailed assessment of the proposed Hunter Power Project Services systems. P&IDs were provided in electronic format for review and comment by the participants.

Owing to the current health orders and individual company meeting restrictions (i.e. Covid meeting restriction numbers) the HAZOP study sessions were conducted on-line using Microsoft Teams. All participants logged into the teams meeting and each participant was requested, by the facilitator, to introduce their role in the HAZOP so that the facilitator was aware of the team's experience and therefore specific questions could be directed to the person responsible for the point under discussion.

Once the team was introduced, an overview of the proposed Hunter Power Station Project was provided by the Snowy Hydro project manager. Once the team were familiar with the overall project proposed design, the services design engineer from AECOM provided a brief overview description of the services systems. During the system description, participants were encouraged to ask questions and clarify any points to ensure they were familiar with the proposed designs. The overall aim of this "step", in the HAZOP process, is to ensure all team members were commencing the HAZOP on a reasonable knowledgeable basis.

Once the project descriptions were completed, the facilitator selected a service system and P&ID and displayed the P&ID on screen so that all participants were able to see the system and nodes selected for the HAZOP assessment. A "Node" was selected and a team member explained the "Node" design and operation in detail and questions were asked at this point for clarification.

Once "Node" design and operation clarifications were completed, the facilitator confirmed the section on the master drawings to ensure all participants were aware of the "Node" under consideration.

The facilitator then selected a guideword (e.g. pressure, flow, level, temperature, etc., for process systems). The team then reviewed the potential for a deviation from normal operating conditions associated with the guideword. Table 2 shows the list of guidewords used in the study.

Where a deviation from normal operating conditions was identified (e.g. high level), a HAZOP minute was recorded, noting the minute number, guideword used, cause of the deviation, consequence of the deviation, proposed safeguards and required action to control the identified deviation. To ensure the minute action is completed and followed up, the minute action was allocated to a member of the team.

The minutes for the project HAZOP study were recorded on a laptop computer by a dedicated minute taker. The deviation assessment process was continued until all guidewords were reviewed for the specific "Node". On completion of the "Node", the HAZOP minutes were displayed on screen and all participants were able to review the minutes and make comments regarding any recording errors. This minimised lengthy review of the minutes on completion of the HAZOP as all team members were able to see the recorded minute on the shared screen prior to issue of the minutes. An example minute sheet is shown at Table 1.

Table 1 HAZOP Study Team

HAZOP STUDY MINUTES						
Plant:		Section/Line:		Drawing No.:		Date:
No.	Guideword	Cause	Consequence	Safeguard	Action	Responsible

On completion of the study a draft set of study minutes were developed and passed to the HAZOP team for review & comment. Updates to the minutes for points of fact were made and a draft report issued for review and comment by the HAZOP team. A final report was then issued incorporating comments on the draft report for points of fact.

Table 2 Guidewords Used in the Hunter Power Project Services HAZOP

Process Systems Guidewords (e.g. Pipework Pumps, Tanks, etc.)	
Flow	Leak, too high, too low, reverse, two phase
Level	Too high, too low
Temperature	Too high, too low
Pressure	Too high, too low, vacuum
Quality	Wrong concentration, impurities, cross contamination, side reactions, inspection and testing, instrument quality and quantity
Control	Response speed, sensor and display location, interlocks, SCADA system security, hardware/ software weak links, system node/ comms failure
Electrical Safety	Hazardous area classification, earthing, lightning protection
Maintenance	Access to plant and equipment, purging of gas, inspection and testing.
Mechanical Systems Guidewords (e.g., Conveyors, robot systems, materials handling, etc.)	
Position	Too High, Low, Far, Near, Misaligned, Wrong Position
Movement	Speed High/Low, No Movement, Reverse Movement, Vibration, Friction, Slip, Obstacles
Size	Too Large, Small, Long, Short, Wide, Narrow
Load	High/Low Load, High/Low Flow, Loss of Containment
Timing	Too Late, Early, Short, Long, Incorrect Sequence
Energy	Low, High, Energy Failure
Contamination	Water, Oil, Dust, Flammables, Corrosives
Process Control	Adequate, Automatic vs Manual, Interlocks, Limits, Trips, Critical variables

Process Systems Guidewords (e.g. Pipework Pumps, Tanks, etc.)	
Electrical Systems	Area Classification, Isolation, Earthing
Maintenance	Isolation, Access, Purging, Inspection and Testing
Overview Guidewords	
Toxicity	Handling procedures, precautions, exposure and monitoring
Physical Damage	Impact, dropped objects, transport collision, vibration, corrosion
Fire/Explosion	Prevention systems, detection systems, fire protection, emergency isolation, emergency procedures
Environmental Impact	Vapour/gas emissions, dust emissions, effluent, noise, ground seepage, waste minimisation
Materials Of Construction	Pipework, valves, fitting, instruments, filters, gaskets, protective systems and coatings
Access	Operation, Maintenance, Emergency Escape
Utilities And Services	Instrument air/gas, compressed air, breathing air, nitrogen, cooling water, process water, steam, fuel gas, electricity, oxygen, lighting
Commissioning	Requirements, sequence, procedures
Start-Up	First time, routine, procedures
Shut Down	Planned, emergency
Safety Equipment	Personnel protection, gas monitoring, breathing apparatus, safety showers, barriers and guards
Natural Hazards	Earthquake, Flooding, Thunderstorm, High Winds
Inspection And Testing	Alarms and trips, emergency isolation, gas/fire detectors, fire protection systems
Procedures	Operations, maintenance, inspection and testing, confined space, emergency, engineering drawings, modification control
Quality Control	Inspection and Testing, Quality Assurance System

2.3 HAZOP Location, Timing and Study Participants

As noted in Section 2.2, the HAZOP was conducted "on-line" using Microsoft Teams. A core team from AECOM, including the services system design engineer, the electrical/instruments design engineer, the study facilitator and minute taker were located in the conference room at the AECOM offices in Warabrook Boulevard, Newcastle, NSW.

The study was conducted over 14 sessions each of around three and a half (3.5) to four (4) hours duration. The sessions were conducted on the following days:

- Thursday 20 January 2022 – Diesel Systems.
- Friday 21 January 2022 – Natural Gas Systems
- Thursday 27 January 2022 – Hydrogen Systems, CO_2 systems, Nitrogen Systems
- Friday 28 January 2022 – Instrument Air Systems, Services Air Systems
- Tuesday 1 February 2022 – Potable Water Systems, Services Water Systems, Demineralised Water Systems, chemical dosing systems
- Wednesday 2 February 2022 – Fire water systems, oily water systems
- Thursday 3 February 2022 - Blade washing systems, trade waste and sewer systems.

The HAZOP team (participants) for each of the HAZOP sessions are listed in Table 3**.**

Table 3 HAZOP Study Team

Name	Organisation	Position	Workshop Date	Full/Part Time
Natural Gas and Diesel Fuel Systems				
Jason Lawer	AECOM	Project Manager	20/01/2022 – 21/01/2022	FT
Chris Treleaven	AECOM	Engineering Manager	20/01/2022 – 21/01/2022	FT
Kerrie Wells	AECOM	Process Lead (BOP)	20/01/2022 – 21/01/2022	FT
Jafar Dashtbani	AECOM	Senior Process Engineer	20/01/2022 – 21/01/2022	FT
Brooke Mackley	AECOM	Process Mechanical Specialist	20/01/2022 – 21/01/2022	FT
Francis Nadaraju	AECOM	Mechanical Lead (BOP)	20/01/2022 – 21/01/2022	FT
Blair Murray	AECOM	Process and Mechanical Team Lead (Power Island)	20/01/2022 – 21/01/2022	FT
Ali Noursadeghi	AECOM	Senior Mechanical Engineer	20/01/2022 – 21/01/2022	FT
Peter Haines	AECOM	Principal Mechanical Engineer	20/01/2022 – 21/01/2022	FT
Mike Allan	AECOM	Electrical and Instrumentation Lead (BOP)	20/01/2022 – 21/01/2022	FT
Steven Sylvester	RiskCon	HAZOP Facilitator (Mech. Eng.)	20/01/2022 – 21/01/2022	FT
Samantha Grabelli	AECOM	Technical Scribe (Process Engineer)	20/01/2022 – 21/01/2022	FT
Evan Bayliss	Snowy Hydro	Design and Quality Lead (Hunter Power Project)	20/01/2022 – 21/01/2022	FT
Dave Bedding	Snowy Hydro	Operator Technician (Maintenance) Colongra	20/01/2022 – 21/01/2022	FT
Sara Roder	Snowy Hydro	Project Mechanical Engineer	20/01/2022 – 21/01/2022	FT
Patrick Scholtes	Snowy Hydro	Mechanical Engineer (operations)	20/01/2022 – 21/01/2022	FT
Karl Ivanusic	Snowy Hydro	Owners Engineer	20/01/2022 – 21/01/2022	FT
Michael Carton	Snowy Hydro	Electrical engineer	20/01/2022 – 21/01/2022	FT
Locky Smith	Snowy Hydro	Instrumentation and Controls Engineer	20/01/2022 – 21/01/2022	FT
Gary Blanch	Snowy Hydro	Area Manager of Snowy Hydro Gas Power stations	20/01/2022 – 21/01/2022	FT
Mukul Bokil	Snowy Hydro	Engineering Construction	20/01/2022 – 21/01/2022	FT
Ciaran McGettigan	APA	Process Lead	20/01/2022 – 21/01/2022	PT
Matthew Walton	APA	Engineering manager	20/01/2022 – 21/01/2022	PT

Name	Organisation	Position	Workshop Date	Full/Part Time
Moriguchi Hirofumi	MHI	Project Manager	20/01/2022 – 21/01/2022	PT
Oshino Yoji	MHI	Senior Manager, Project Engineering	20/01/2022 – 21/01/2022	PT
Yamasaki Masaaki	MHI	Eng. Manager & Design Eng. (Mechanical & Process)	20/01/2022 – 21/01/2022	PT
Tsukuda Yuya	MHI	Design Engineer (Mechanical & Process)	20/01/2022 – 21/01/2022	PT
Process Gas (H_2, CO_2, N_2) and Air Systems (compressed air and instrument air)				
Jason Lawer	AECOM	Project Manager	27/01/2022 – 28/01/2022	FT
Chris Treleaven	AECOM	Engineering Manager	27/01/2022 – 28/01/2022	FT
Kerrie Wells	AECOM	Process Lead (BOP)	27/01/2022 – 28/01/2022	FT
Jafar Dashtbani	AECOM	Senior Process Engineer	27/01/2022 – 28/01/2022	FT
Brooke Mackley	AECOM	Process Mechanical Specialist	27/01/2022 – 28/01/2022	FT
Francis Nadaraju	AECOM	Mechanical Lead (BOP)	27/01/2022 – 28/01/2022	FT
Blair Murray	AECOM	Process and Mechanical Team Lead (Power Island)	27/01/2022 – 28/01/2022	FT
Ali Noursadeghi	AECOM	Senior Mechanical Engineer	27/01/2022 – 28/01/2022	FT
Peter Haines	AECOM	Principal Mechanical Engineer	27/01/2022 – 28/01/2022	FT
Mike Allan	AECOM	Electrical and Instrumentation Lead (BOP)	27/01/2022 – 28/01/2022	FT
Steven Sylvester	RiskCon	HAZOP Facilitator	27/01/2022 – 28/01/2022	FT
Samantha Grabelli	AECOM	Technical Scribe (Process Engineer)	27/01/2022 – 28/01/2022	FT
Barry Tyer	AECOM	Process verifier	27/01/2022 – 28/01/2022	FT
Evan Bayliss	Snowy Hydro	Design and Quality Lead (Hunter Power Project)	27/01/2022 – 28/01/2022	PT
Dave Bedding	Snowy Hydro	Operator Technician (Maintenance) Colongra	27/01/2022 – 28/01/2022	FT
Sara Roder	Snowy Hydro	Project Mechanical Engineer	27/01/2022 – 28/01/2022	FT
Patrick Scholtes	Snowy Hydro	Mechanical Engineer	27/01/2022 – 28/01/2022	FT
Karl Ivanusic	Snowy Hydro	Owners Engineer	27/01/2022 – 28/01/2022	FT
Michael Carton	Snowy Hydro	Electrical engineer	27/01/2022 – 28/01/2022	PT
Locky Smith	Snowy Hydro	Instrumentation and	27/01/2022 –	FT

Name	Organisation	Position	Workshop Date	Full/Part Time
		Controls Engineer	28/01/2022	
Gary Blanch	Snowy Hydro	Area Manager of Snowy Hydro Gas Power stations	27/01/2022 – 28/01/2022	PT
Mukul Bokil	Snowy Hydro	Engineering Construction	27/01/2022 – 28/01/2022	PT
Damien Cooper	Snowy Hydro	Colongra Manager	27/01/2022 – 28/01/2022	PT
Paul Hill	Snowy Hydro	Site superintendent	27/01/2022 – 28/01/2022	PT
Isaac Strachan	Snowy Hydro	Health, Safety and Environmental Lead	27/01/2022 – 28/01/2022	PT
Moriguchi Hirofumi	MHI	Project Manager	27/01/2022 – 28/01/2022	PT
Oshino Yoji	MHI	Senior Manager, Project Engineering	27/01/2022 – 28/01/2022	PT
Yamasaki Masaaki	MHI	Eng. Manager & Design Eng. (Mechanical & Process)	27/01/2022 – 28/01/2022	PT
Tsukuda Yuya	MHI	Design Engineer (Mechanical & Process)	27/01/2022 – 28/01/2022	PT
Water, Waste-Water and Sewage Systems				
Jason Lawer	AECOM	Project Manager	1/02/2022 - 3/02/2022	PT*
Chris Treleaven	AECOM	Engineering Manager	1/02/2022 - 3/02/2022	FT
Kerrie Wells	AECOM	Process Lead (BOP)	1/02/2022 - 3/02/2022	FT
Jafar Dashtbani	AECOM	Senior Process Engineer	1/02/2022 - 3/02/2022	FT
Brooke Mackley	AECOM	Process Mechanical Specialist	1/02/2022 - 3/02/2022	FT
Francis Nadaraju	AECOM	Mechanical Lead (BOP)	1/02/2022 - 3/02/2022	FT
Ali Noursadeghi	AECOM	Senior Mechanical Engineer	1/02/2022 - 3/02/2022	FT
Peter Haines	AECOM	Principal Mechanical Engineer	1/02/2022 - 3/02/2022	FT
Mike Allan	AECOM	Electrical and Instrumentation Lead (BOP)	1/02/2022 - 3/02/2022	FT
Steven Sylvester	RiskCon	HAZOP Facilitator	1/02/2022 - 3/02/2022	FT
Samantha Grabelli	AECOM	Technical Scribe (Process Engineer)	1/02/2022 - 3/02/2022	FT
Marco Van Winden	AECOM	Water Engineer	1/02/2022, 3/02/2022	PT
Deni Estiville-Dredge	AECOM	Civil/Water Engineer	1/02/2022 - 3/02/2022	PT
Neil Shen	AECOM	Mechanical Engineer	1/02/2022 - 3/02/2022	FT

Name	Organisation	Position	Workshop Date	Full/Part Time
Ian Leach	AECOM	Civil Engineer	2/02/2022	FT
Evan Bayliss	Snowy Hydro	Design and Quality Lead (Hunter Power Project)	2/02/2022	PT*
Dave Bedding	Snowy Hydro	Operator Technician (Maintenance) Colongra	1/02/2022 - 2/02/2022	FT
Sara Roder	Snowy Hydro	Project Mechanical Engineer	1/02/2022 - 3/02/2022	FT
Patrick Scholtes	Snowy Hydro	Mechanical Engineer	1/02/2022 - 3/02/2022	FT
Karl Ivanusic	Snowy Hydro	Owners Engineer	2/2/2022 - 3/02/2022	PT*
Michael Carton	Snowy Hydro	Electrical engineer	1/02/2022 - 3/02/2022	PT
Locky Smith	Snowy Hydro	Instrumentation and Controls Engineer	1/02/2022 - 3/02/2022	FT
Gary Blanch	Snowy Hydro	Area Manager of Snowy Hydro Gas Power stations	1/02/2022 - 3/02/2022	PT
Mukul Bokil	Snowy Hydro	Engineering Construction	1/02/2022 - 3/02/2022	PT
Tim Gotts	Snowy Hydro	Project Engineer - Civil	1/02/2022 - 3/02/2022	PT
Mariam Biglari	Snowy Hydro	Process Engineer	1/02/2022 - 3/02/2022	PT
Damien Cooper	Snowy Hydro	Colongra Manager	3/02/2022	PT#
Moriguchi Hirofumi	MHI	Project Manager	1/02/2022 - 3/02/2022	PTØ
Oshino Yoji	MHI	Senior Manager, Project Engineering	1/02/2022 - 3/02/2022	PTØ
Yamasaki Masaaki	MHI	Eng. Manager & Design Eng. (Mechanical & Process)	1/02/2022 - 3/02/2022	PTØ
Tsukuda Yuya	MHI	Design Engineer (Mechanical & Process)	1/02/2022 - 3/02/2022	PTØ

* Did not attend Tuesday 1/2 during Service water and demin nodes.
\# Attended during trade waste and sewer nodes
Ø Did not attend on Wednesday 2/2 during Fire Water and Oily water nodes

As part of the compilation of the HAZOP team, Hazardous Industry Planning Advisory Paper No.8 (Ref.2) was consulted to confirm the HAZOP participants comprised team members with the appropriate experience.

Section 2.5.1 of HIPAP 8 (Ref.2) indicates the following team members should be considered for inclusion as HAZOP participants. Names of the relevant participants have been placed against each of the positions to confirm the appropriate personnel attended and participated in the HAZOP.

- **Chairperson** - Chairperson was Steve Sylvester, ICI HAZOP trained with over 100 HAZOP facilitation studies completed in 30 years risk engineering experience. He has conducted a number of Gas Turbine HAZOP studies including Colongra (NSW) and Ichthys Project (NT).

- **Design Engineer** - Chris Treleavan was AECOM's design Engineering Manager, he attended all sessions of the HAZOP. The owners design representative, Karl Ivanusic attended all HAZOP sessions. Evan Baylis, Snowy Hydro Design and Quality Lead Engineer also attended the HAZOP sessions with the exception of water systems. To ensure disturbances from the Kurri Kurri Gas Lateral were understood, Matthew Walton, APA Engineering Manager attended the Fuel Gas session.
- **Process Engineer** - Kerrie Wells was AECOM's lead process engineer, she attended all sessions of the HAZOP, Jafar Dashtbani, AECOM senior process engineer was in the HAZOP sessions at all times, Mariam Bilgary and Tim Gotts from Snowy Hydro attended the HAZOP sessions on a part time basis, with one of the engineers being present at all of the HAZOP sessions. Karl Ivanusic, owners Process Engineering representative attended all HAZOP sessions. Ciaran McGettigan, APA's Lead Process Engineer, attended the Fuel Gas session.
- **Electrical/Instruments Engineer** - Mike Allen, AECOM instrument/Electrical Engineer attended all HAZOP sessions and Locky Smith, Snowy Hydro's instrument/Electrical Engineer attended all sessions.
- **Plant Operator** - Dave Bedding, Snowy Hydro operations at Colongra GT Power Station attended all sessions.
- **Operations Manager** - Gary Blanch, Snowy Hydro Area Manager Gas Power Stations attended sessions on a part time bases, Damien Cooper, Colongra Operations Manager attended sessions on a part time bases, one of the operations managers was in the HAZOP sessions at all times.
- **Maintenance/Mechanical Engineer** - Patrick Scholtes, Snowy Hydro Mechanical and Maintenance Engineer was in the HAZOP sessions at all times, Francis Nadaraju, AECOM Mechanical Lead Engineer was in the HAZOP sessions at all times, Ali Noursadeghi, AECOM Mechanical Engineer, was in the HAZOP sessions at all times,

Other representatives and participants from Snowy Hydro, AECOM, APA (Kurri Kurri Gas Lateral developers) and Mitsubishi Heavy Industries (GT Manufacturers) attended the HAZOP sessions at various times. These participants and their involvement (full time or part time) are listed in Table 3.

2.4 Drawings Used and Nodes Selected for the HAZOP

A list of P&IDs used in the HAZOP is provided in Table 4. Prior to the commencement of the HAZOP, the facilitator reviewed the P&IDs and developed Nodes for assessment during the HAZOP workshop. The P&IDs showing the Nodes are provided in Appendix C to Appendix J.

Table 4 HAZOP Master Drawings (or Marked up P&IDs)

Drawing Number	Revision	Description
Diesel Systems (drawings provided in Appendix B)		
HPP-AEC-MEC-DS-LLS-DRG-1064	B	Diesel Fuel Unit Loading System
HPP-AEC-MEC-DS-LLS-DRG-1065	B	Diesel Fuel Unit Un-loading System
HPP-AEC-MEC-DS-LLS-DRG-1066	B	Diesel Fuel Unit Storage Tanks
HPP-AEC-MEC-DS-LLS-DRG-1067	B	Diesel Fuel Unit Forwarding Pumps
HPP-AEC-MEC-DS-LLS-DRG-1068	B	Diesel Fuel Unit Polishing & Forwarding Filters

Drawing Number	Revision	Description
HPP-AEC-MEC-DS-LLS-DRG-1069	B	Diesel Fuel Unit Diesel Storage Tanks
Natural Gas Supply (drawings provided in Appendix C)		
HPP-AEC-MEC-GA-KOO-DRG-1090	B	Natural Gas Supply NG Knock Out Drum GT Unit 1
HPP-AEC-MEC-GA-DTV-DRG-1091	B	Natural Gas Supply - NG Filter Coalescer No. 1GT Unit 1
HPP-AEC-MEC-GA-DTV-DRG-1092	B	Natural Gas Supply - NG Filter Coalescer No.2 GT Unit 1
HPP-AEC-MEC-GA-DTV-DRG-1093	B	Natural Gas Supply – NG Metering & Heating GT Unit 1
HPP-AEC-MEC-GA-DTV-DRG-1094	B	Natural Gas Supply - Drip Tanks and Vent GT Unit 1
HPP-AEC-MEC-GA-DTV-DRG-1095	B	Natural Gas Supply – Turbine Supply Unit GT Unit 1
HPP-AEC-MEC-GA-DTV-DRG-1096	B	Natural Gas Supply – Calorie Meter & Battery Limit
HPP-AEC-MEC-GA-DTV-DRG-1097	B	Natural Gas Supply – NG Cartridge Filter & Isolation GT1
Instrument Air (drawings provided in Appendix D)		
HPP-AEC-MEC-CP-IAS-DRG-1060 HPP-AEC-MEC-CP-IAS-DRG-1118	B B	Instrument Air – Air Compressors
HPP-AEC-MEC-CP-IAS-DRG-1061 HPP-AEC-MEC-CP-IAS-DRG-1120	B B	Instrument Air – Air Dryers
HPP-AEC-MEC-CP-IAS-DRG-1062	B	Instrument Air – Air Receivers
HPP-AEC-MEC-CP-IAS-DRG-1063	B	Instrument Air – Air Distribution
Service Air (drawings provided in Appendix E)		
HPP-AEC-MEC-CP-PAS-DRG-1026 HPP-AEC-MEC-CP-PAS-DRG-1110	B B	Service Air Unit – Air Compressors
HPP-AEC-MEC-CP-PAS-DRG-1027 HPP-AEC-MEC-CP-PAS-DRG-1111	B B	Service Air Unit – Air Dryers
HPP-AEC-MEC-CP-PAS-DRG-1112	B	Service Air Unit – Air Receivers
HPP-AEC-MEC-CP-PAS-DRG-1113	B	Service Air Unit – Air Distribution
Hydrogen, N_2 & CO_2 System (drawings provided in Appendix F)		
HPP-AEC-MEC-HY-GEN-DRG-1100	B	Hydrogen Facility – Trailer Cylinder & Backup Bottles (1)

Drawing Number	Revision	Description
HPP-AEC-MEC-HY-GEN-DRG-1102	B	Process Gas Facility – N_2 & CO_2 Press. Regulator Panels
HPP-AEC-MEC-HY-GEN-DRG-1124	B	Hydrogen Facility – Pressure Reduction panels and Vent
Demineralised Water ((drawings provided in Appendix G)		
HPP-AEC-MEC-DW-SFP-DRG-1057	B	Demin Water - Storage Tank
HPP-AEC-MEC-DW-SFP-DRG-1058	B	Demin Water - Forwarding Pumps
HPP-AEC-MEC-DW-SFP-DRG-1055	B	Demin Water - Pre-Treatment System
HPP-AEC-MEC-DW-SFP-DRG-1056	B	Demin Water - Treatment Systems
HPP-AEC-MEC-DW-SFP-DRG-1059	B	Demin Water - Treatment System
Water Systems (drawings provided in Appendix H)		
HPP-AEC-MEC-PW-FPS-DRG-1051	B	Service Water Unit - Forwarding Pumps
HPP-AEC-MEC-PW-SMS-DRG-1050	B	Service Water Unit - Storage and Metering
HPP-AEC-MEC-PW-SMS-DRG-1052	B	Service Water Unit - Storage Tank
Fire Water (drawings provided in Appendix I)		
HPP-AEC-MEC-PW-SMS-DRG-1070	B	Fire Water Unit - Storage Tanks
HPP-AEC-MEC-PW-SMS-DRG-1071	B	Fire Water Unit - Fire Pumps
Effluent Treatment (drawings provided in Appendix J)		
HPP-AEC-MEC-GN-GEN-DRG-1085	C	Effluent Treatment - Storm & Oily Water Treatment
HPP-AEC-MEC-GN-GEN-DRG-1086	C	Effluent Treatment - Sewer Transfer Pit & Pumps
HPP-AEC-MEC-GN-GEN-DRG-1087	C	Effluent Treatment - Neutralisation Pit & Transfer Pumps (1)
HPP-AEC-MEC-GN-GEN-DRG-1123	B	Effluent Treatment - Neutralisation Pit & Transfer Pumps (2)
HPP-AEC-MEC-GN-GEN-DRG-1088	C	Effluent Treatment - pH Adjustment Injection Packages (1)
HPP-AEC-MEC-GN-GEN-DRG-1128	B	Effluent Treatment - pH Adjustment Injection Packages (2)

3.0 Brief Description of the Services Systems

3.1 Hunter Power Project Regional Location

The Hunter Power Project is proposed to be located in a newly created industrial zone on the site of the previous Aluminium Smelter at Kurri Kurri. Figure 1 shows the regional location of the proposed industrial zone.

Figure 1 Regional Location of the Hunter Power Project

3.2 Brief Description of the Services Systems – Hunter Power Project

Snowy Hydro proposes to construct and operate a Gas Turbine Peaking Power Station in the Hunter Valley, NSW. The Hunter Power Station is expected to have a nominal capacity of approximately 660 megawatts (MW) and will be generated via two heavy-duty 'F Class' open cycle gas turbines (OCGT).

The plant includes diesel fuel facilities for unloading/loading of tankers, storage and supply to the gas turbines. Two 1840 m^3 diesel storage tanks located within a bunded area, store sufficient diesel for three (3) consecutive days turbine operation on diesel with a minimum delivery of six diesel tankers per day. There are also two diesel unloading/loading pumps and three diesel forwarding pumps to supply the gas turbine.

Figure 2 shows a layout of the proposed plant on the land.

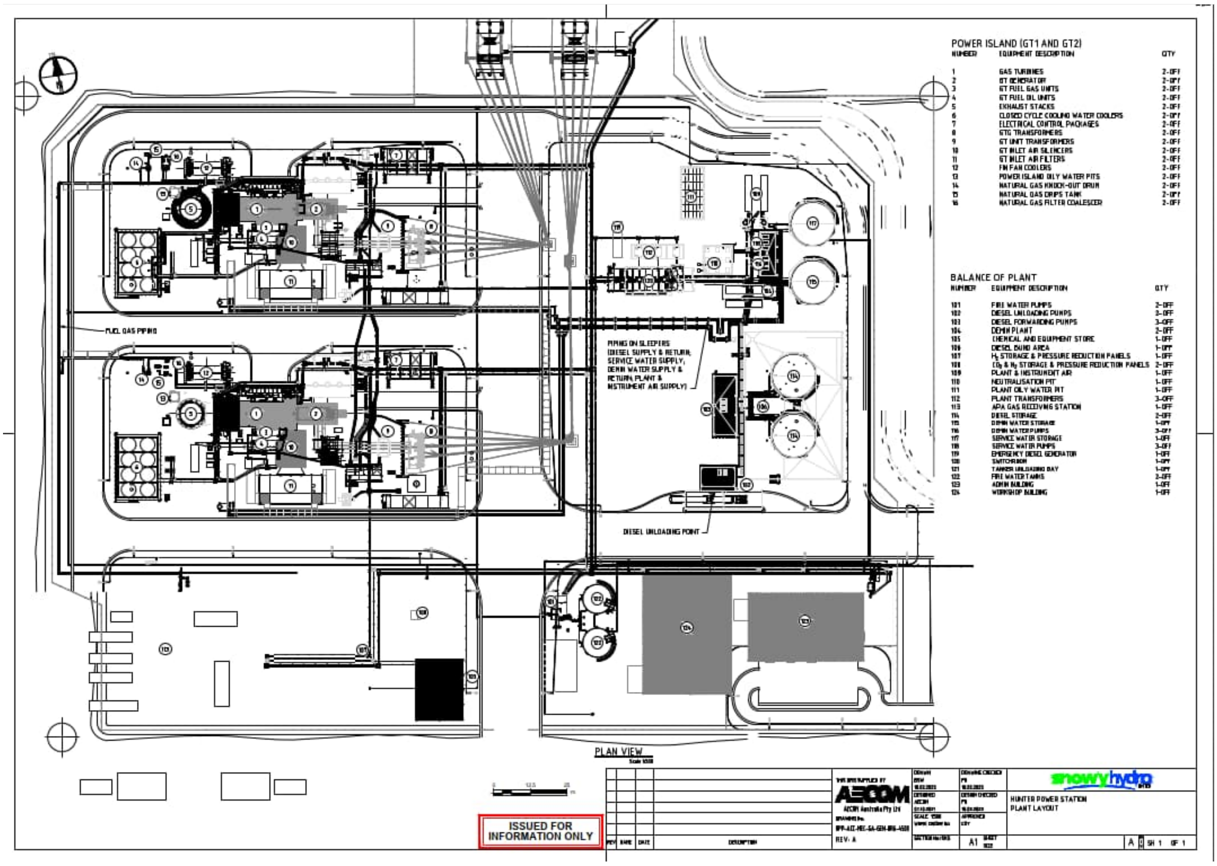


Figure 2 Site Layout Showing Gas Turbine Locations

3.3 Natural Gas Supply System

Gas Pipeline

A new gas lateral is required to service the power station and this will tee-off from the existing Jemena JGN Trunk line pipeline. The new gas lateral will be constructed by APA who is the gas lateral proponent. The gas lateral will also consist of a 'storage bottle' which will provide storage capacity for operation of the power station. The design of the pipeline and storage bottle is expected to include approximately 6-7 hours' worth of gas storage.

The length of pipeline to the site is dependent on the route and is still being developed and could be approximately 15-20km. The pipeline will be buried below ground level within an easement and will be connected to the Gas Receiving Station at the power station.

External gas compression equipment will be required and will be the responsibility of APA. The proposed location currently being assessed for the gas compressor equipment is within the buffer zone on the southern boundary of the power station site.

Natural Gas Supply System

The gas delivery and metering station, designed by APA, takes gas directly from the gas supply line or the “storage bottle” to provide gas to the power station turbines. The equipment includes automated valves, flow meters, heaters and pressure control valves. The details of this equipment will be provided by APA.

The gas pressure delivered to the power station will be from 3,800 to 4,700 kPag, normally 4,400 kPag and the temperature will normally be 30 °C, with a minimum of 5 °C and a maximum of 60 °C.

The flowrate can vary between 3,600 to 73,800 kg/h, depending on the requirements of the gas turbine. The flowrate is specified by Mitsubishi.

The gas line will be isolatable at the power station boundary by a manual isolation valves. There will be line venting and nitrogen purging facilities also located to safely vent the natural gas to an elevated safe location. An MHI supplied pressure reduction unit and natural gas calorie meter downstream of the isolation facilities will measure the heating value of the gas and a monitoring tool.

The common gas supply runs along the western boundary of the plant before splitting on the northern side of Gas turbine (unit 2, southern unit). Each gas turbine will have separate gas isolation valves with downstream facilities for venting to a cold vent and nitrogen purging facilities to allow safe isolation for maintenance work.

A knockout vessel for removal of any condensed liquid in the gas supply line to each turbine is provided downstream of the unit isolation valve. The liquid is drained to a condensate collection tank which is connected to a small vent stack for separation of entrained gases. Downstream of the knockout vessel there are two filter/coalescer vessels arranged as a duty/standby to remove carry over oil and hydrocarbon condensates from the gas compressor and any solid particles carried over from the storage bottle and gas receiving station. Downstream of the filter / coalescers is a MHI supplied flow meter and fuel gas heater with heater bypass valve.

An MHI supplied gas cartridge filter is located downstream of the fuel gas heater to provide “last chance” filtration for the gas. After the cartridge filter, there are three fuel gas purge credit shutoff valves to allow quick purging of the fuel gas line for start-up and shutdown. The gas then enters the gas turbine fuel gas pressure control unit.

3.4 Diesel Fuel System

Diesel Fuel Storage Tanks

Two storage tanks, with nominal capacity of 2120 m^3 and useable capacity of 1845 m^3 each, are designed to storage and supply fuel to both turbines when running on diesel fuel for 10 hours per day for 3 consecutive days including six deliveries of a B- double tanker (50 m3) per day.

Whilst the storage tanks are connected by common inlet and outlet lines, the tanks operate as separate (non-connected) supplying the gas turbine as individual tanks isolated by actuated valves. The tanks are located within a common bunded area which is designed to hold 110% capacity of one .storage tanks.

Diesel Forwarding Pumps and Filters

The diesel forwarding pumps have a design capacity to supply the peak demand flow required for GT main fuel oil pumps as per the MHI Utility list plus 10% margin. Three (3) centrifugal pumps each of 100 m^3/hr capacity are installed with a duty/duty/standby arrangement

Two (2) diesel forwarding filters, with a capacity of 200 m^3/hour, are installed in supply line to the GT to remove any suspended solids and to deliver clean fuel to the turbines. The floating suction arrangement reduces the likelihood of free water being supplied to the gas turbines.

Diesel Polishing System

The diesel polishing system comprises a 200 m^3/hour duty cartridge/coalescer filter unit which allows recirculation of the tank contents to remove sediment and water from diesel periodically, or in the case of having off-spec fuel at the storage tanks, due to stagnant conditions. The polishing package includes a cartridge and coalescing filters. The package capacity is equal to the capacity of two forwarding pumps running simultaneously to minimise the polishing time.

Diesel Loading/Unloading System

There is one unloading station including related equipment, piping, adaptors, instrumentation, and a flowmeter with totaliser. The station is designed to unload and transfer a B-Double tanker with approximately 50 m^3 diesel fuel into the storage tanks. The arrangement comprises two (2) off 75 m^3/h Duty/Standby pumps, 1-off single bottom loading arm package and one set of unloading system with 5 dry break hose connections.

A loading bay with a single bottom loading arm with necessary pipework, valving, instrumentation, and control unit is installed adjacent to the unloading station in order to load diesel from the storage tanks into the road tankers if required. The pumps for unloading and loading are two common positive displacement vane pumps used for both operations.

3.5 Process Gas and Air Systems

A sufficient supply of hydrogen, carbon dioxide and nitrogen will be stored on site to meet the demands of operating the gas turbines.

Hydrogen

The hydrogen cooled generator on each power island requires a continual supply of hydrogen . Hydrogen is used as cooling media for the generators and continually leaks from the system requiring replacement. Hydrogen storage is expected to consist of a least one hydrogen tube trailer (400 kg) and 30 hydrogen gas bottles.

The hydrogen pressure is reduced from the trailer or cylinder storage pressure to 5000 kPag before being supplied to the MHI pressure reduction panel where the pressure is further reduced to around 500 kPag.

Nitrogen

Nitrogen will be used for purging the gas turbine and fuel gas system to remove natural gas and air before maintenance or recommissioning. The nitrogen purging systems will consist of a fixed rack of 15 cylinders manifolded and connected to fixed pressure reduction sets and pipework. The natural gas pipework and vessels will be purged with nitrogen prior to introducing natural gas to eliminate to risk of mixing natural gas and air within the pipework. The expected storage of nitrogen is 8 pallets of 15 bottles (120 bottles in total).

Carbon Dioxide

Carbon dioxide is used as purging gas in order to remove air and safely add and remove the hydrogen to/from the generator. The CO_2 purging system is a fixed rack of 15 cylinders manifolded and connected to fixed pressure reduction panels and pipework connected to each GTG cooling circuit The expected storage of carbon dioxide is 4 pallets of 15 bottles (60 bottles in total).

Instrument Air

The instrument air system consists of two air compressor/dryer packages where each package includes a compressor, filters, a knock-out drum, and air dryers. Downstream of the instrument air dryers will be three air receivers that are sized to hold a 3-minute supply of the instrument air required during operation.

The compressor/dryer skids and the filters within the packages will operate in a duty/standby arrangement to allow for redundancy.

Each instrument air compressor will deliver 360 Nm/h with a controlled supply pressure range between 650 kPag to 800 kPag.

Services Air

The service air system consists of two air compressor/dryer packages where each package includes a compressor, filters, a knock-out drum, and air dryers. Downstream of the service air dryer will be one receiver (one duty) that is sized to hold a 3-minute supply of the instrument air required during operation.

The compressor/dryer skids and the filters within the packages will operate in a duty/standby arrangement to allow for redundancy.

Each service air compressor has a capacity of 1716 Nm^3/h with a controlled supply pressure range between 650 kPag to 800 kPag.

3.6 Potable Water and Service Water Systems

Potable water at a maximum flow of 20 L/s will be supplied to the plant by Hunter Water by a new connection from the potable water network on the eastern boundary. The flow will be metered on the site with the main users being the evaporative cooler for the air intake for the gas turbines, demineralised water plant, supply to the on-site fire water tanks, safety showers and general domestic consumption for the control room and workshop. A 1700 m^3 tank will provide buffer storage for water demand in case of interruptions to the supply network. Three forwarding pumps supply water to the gas turbines and other service water users. Water supply to the other users (amenities), safety showers and fire water tank will be upstream of the service water tank from the main water line into the plant.

Demineralised Water Plant and System

Two demineralised water plants with a capacity of 33m3/h, one 1700 m^3 storage tank and three forwarding pumps will supply demineralised water for injection to the gas turbines for NOx suppression. The demineralised water plant treats potable water to remove salts. The expected demin plant type is reverse osmosis/ electro-deionisation. Demin water will be supplied from the demin plant to the storage tank with facilities to allow recirculation of stored demin water to the demin plant for removal of absorbed carbon dioxide. Wastewater and “Clean in Place” chemicals from the demin plants will be neutralised in an on-site collection pit by pH adjustment with either acid or caustic before being discharged to the Hunter Water trade waste system.

Fire Water Tanks and Pumps

The onsite firefighting protection system consists of two tanks (500 m^3 each), two pumps, deluge systems for the transformers, fire hydrants and catch pits for the Facility. The design and capacity of the fire water reticulation system will also consider the fire protection requirements of the adjacent 132 kV electrical switchyard and Gas Receiving Station and gas compressor house.

Oily Water Collection & Treatment System

A centralised oily water pit and treatment area will collect and separate oil and water for discharge. The drains from a number of areas including, transformer oil bund, tanker unloading, fuel storage tank bund, diesel fire water pump and gas turbine control and lubricating oil areas, will have drain connections to the oily water pit. The oily water separator which is a centrifugal type separator uses centrifugal forces to separate water and oil. The oily water is collected in a tank for disposal by truck and the clean water is directed to stormwater for discharge to the environment.

The oily water separator is a standalone vendor supplied package that is capable of achieving a water discharge quality of less than 5mg light liquids per litre i.e., treated water can be discharged directly into the stormwater drainage system.

3.7 Trade Waste System

The trade wastewater collection system has been designed to collect wastewater generated from the blade washing drain pit and demin plant.

Wastewater will be collected from each power island and discharged to the neutralisation pit at the Balance of Plant Island. It shall be treated at this location prior discharging to the Hunter Water trade waste connection proposed at the eastern side of the site. The neutralisation pit is used to collect and correct the pH of the wastewater so that it meets the requirements provided in Hunter Water Standard Trade Wastewater prior to discharge. The treated wastewater will then be pumped into the Hunter water trade waste system.

3.8 Storm Water System

The stormwater collection system for the site will collect rainwater from clean plant areas and direct to a separator which uses hydrodynamic and gravitational separation to remove suspended solids and entrained hydrocarbons. Clean stormwater is discharged from the north-western boundary into an existing water courses. Any entrained solids or oil are contained in the separator for later disposal by truck.

4.0 HAZOP Study Results

4.1 Introduction

The nature of the HAZOP study results in the discussion of many points that relate to hazard and operational issues associated with the operation of the facility under analysis. The recording of every discussion item, at length, would result in an un-necessarily long workshop, leading to frustration among the HAZOP study participants whilst time was wasted recording minor issues requiring no action.

To ensure the most effective recording of results was achieved, for the Hunter Power Services Systems, or Balance of Plant, HAZOP study, the following recording format was adopted:

1. For the issues identified in the assessment, where a discussion issue was clearly identified to result in no hazard or operability issue, no entry was made in the HAZOP minutes sheet. This entry approach was followed to minimise the recording requirements of the study.
2. Where a hazard and operability issue may have a potential to occur as a result of the process design or operation, the deviation from normal operations was reviewed and where the safeguards were considered adequate to control the identified hazard/operability issue, a part record was made with “no action required” recorded.
3. Where a discussion point was identified to result in a potential hazard/operations issue, and safeguards were identified to be insufficient to control the hazard/operability issue, a full minute point was recorded, identifying deviation cause, consequence, proposed safeguards and action required to prevent, detect, protect and/or mitigate the operations consequences.

The summary of HAZOP Minutes recorded during the workshop sessions are presented in Appendix A.

4.2 Summary of HAZOP Study Results

The meeting was able to review the proposed design in a satisfactory manner, including the impact of disturbances from the Kurri Kurri Gas Lateral on the Hunter Power site (design representatives from the Kurri Kurri Gas Lateral Project Team, APA, participated in the relevant session). Adequate information was available, and the HAZOP participants had a sound range of relevant design and production experience.

The HAZOP study did not reveal any significant hazards that would compromise the safety or integrity of the project and that could not be managed. The project can proceed, subject to satisfactory resolution of the HAZOP recommendations.

There were 316-minute points discussed during the HAZOP study, with a number of these requiring no action or follow up item. However, there were a number of issues raised due to the specific requirements of the systems and the proposed operation.

A total of 213-minute points were recorded requiring action, which are listed in the HAZOP minutes at Appendix A. Many of these were related to the requirement for update of P&IDs, procedures, detailed operation of the isolation function, access requirements, relocation or addition of valves when in use or when isolated and fail-safe valve failure position, etc. The drawings used in the HAZOP are included at Appendix B, showing the nodes applied during the workshop study.

The implementation phase for each of the recorded actions is included in the HAZOP Minutes.

5.0 References

1. Kletz, TA 1999, *Hazop and Hazan: Identifying and Assessing Process Industry Hazards*, Institution of Chemical Engineers, Warwickshire.
2. NSW Government, Department of Planning 2011, *Hazardous Industry Advisory Paper 8 (HAZOP Guidelines)*.
3. Standards Australia 2017, *AS IEC 61882:2017 – Hazard and Operability Studies (HAZOP studies) – Application Guide*.

Appendix A

HAZOP Workshop Minutes Including Action Record & Date Completed

Appendix A HAZOP Workshop Minutes

Notes to Workshop Minutes:

1. "No additional issues" is used in the "Cause" column to reflect that some causes have been identified via another Guide Word (this often occurs between flow and pressure because they are related).
2. "No significant issues" is used in the "Cause" column to reflect that while some deviation is possible the consequence is trivial and managed through Administrative Controls.
3. "No additional action" is used in the "Recommendations" column to reflect that a Recommendation to address an issue identified elsewhere will also address the current issue (the source of the first instance of a Recommendation is cross-referenced).
4. "Design Development" is used in the "Cause" column where an aspect of the Design is still "Preliminary" i.e. incomplete. It may be necessary for the HAZOP Team to reconvene to review those aspects in the Final Design to ensure that no new risks have been introduced.
5. "Nil", as used in the "Existing Safeguards" column, shall be interpreted as the Team being unable to identify obvious Safeguards (often there is a contribution to safeguarding through standard site operational and maintenance practices).

DIESEL SYSTEM

Table 5 Diesel System - Node 1.1

Project / Facility:	**60666845 Hunter Valley Power Station - Diesel Unloading**	**Node #**	**1.1**
Node Boundaries:	Tanker, Unloading arm unloading pump and pipework, Diesel Tanks	**Revision Date:**	20-Jan-22
Design Intent:	Unloading facility for B double tankers, 6 per day	**Material / Chemical:**	Diesel
Design Conditions, Operating Envelope	Discharge Pressure of Unloading Pump: 2.5 Barg. Design assumes ambient conditions	**Drawing:**	HPP-AEC-MEC-DS-LLS-DRG-1065

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.1	Flow - Quantity	Inconsistency between different methods of measurement from truck gauge dip and site flow meter because of different level of accuracy.	The truck dip gauge and site diesel flowmeter may not match	N/A	Requirement to be clear in procedures that quantity delivered is based on tanker dip gauges.	Snowy Hydro		Ph.2			
1.1.2	Flow - High Flow	Both unloading pumps running simultaneously.	Pump damage due to overheating.	LAHH 90EGB01CG901A and 90EGB01CG9041A on Diesel Storage Tanks close inlet actuated valves SDV **EGD01CG929* and 90EGD01CG905A	Refer to action of 1.1.15.	AECOM		Ph.1			
1.1.3	Flow -Low Flow	Pump isolation valves closed (Blocked in pump).	Pump overheats and possible damage to the pump.	Low flow switches FS 90EGB01CG001A and 90EGB02CG001A on pump discharges stop pumps after 20 seconds.	Check with the pump vendor if the selected pump can operate for 20 seconds with low flow.	AECOM		Ph.1			
1.1.4	Flow - No flow	Tanker compartment empty and pump draws air from empty compartment.	Air drawn into pump suction. Possible air lock in piping when pump is restarted next time.	Sight glass on unloading hose.	Review requirement of bleed valve on suction line to the pump.	AECOM	Note, not all compartments in the tanker have the same volume.	Ph.1			
1.1.5	Flow -Reverse flow	Diesel flowing backwards to pump.	Pump damage because of reverse flow.	NRVs 90EGB01AA005 and 90EGB02AA005 in discharge line from pumps.	No action						
1.1.6	Flow -Reverse flow	Diesel directed to wrong tank.	No significant issues if the other tank is filled when supply diesel to the GT.	Inlet valves to tank are automatically opened when tank is selected on control panel. Valves are interlocked with the control system to prevent incorrect valve opening. High level on tank closes inlet valve.	No action						
1.1.7	Pressure - High pressure	Valve on pump outlet closed (Blocked in pump).	High pressure in discharge line - Overpressure causing pipe rupture and loss of containment.	Diesel unloading pumps have internal pressure relief valve and low flow switches (see 1.1.3).	Show internal relief of pumps on P&IDs.	AECOM		Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
				During the design, review will be done to ensure the piping design pressure to be higher than the pump stall head.							
1.1.8	High Temperature	Valve on pump outlet closed.	Pump overheats – possible damage to the pump.	Same as 1.1.7	No action						
1.1.9	Contaminants	Truck may contain other type of fuel than diesel.	Gas Turbine receives incorrect fuel leading to equipment damage.	Operating procedures to order correct fuel and operator checks prior to the tanker unloading.	Operating Procedures to include a check of the diesel quality delivered to site.	Snowy Hydro		Ph.2			
1.1.10	Contaminants	Water ingress from adsorption from air into the storage tanks.	Possible damage to gas turbines.	Water is removed by the polishing filters and circulation of tank through the filters.	Diesel should be regularly tested to ensure the water level is suitable for the Gas turbine. Included regular sampling for quality testing in the operating procedures.	Snowy Hydro		Ph.2			
1.1.11	Contaminants	Foreign material/objects remaining in pipe after construction.	Blockages in pipe, potential for damage to equipment.	Pump strainers, polishing filter, and forwarding filters to be regularly cleaned. Commissioning procedures and piping/equipment cleanliness checks.	Review requirement for commissioning strainers. Construction ITPs to include cleanliness checks.	AECOM Snowy Hydro		Ph.1 Ph.2			
1.1.12	Loss of containment - leak	Diesel spill from flange or hose connection.	Diesel spill from the unloading bund flows to oily water system.	Oily water system (200 m3) is large enough to hold full load of B double tanker (50m3)	Review requirement for valve with position indicator in diesel unloading bund.	AECOM		Ph.1			
1.1.13	Loss of containment - leak	Failure of hose during unloading.	Spill of diesel to bund area.	Local E stop. Local bund directed to oily water pit. Volume in Oily water containment is 200 m3.	Review requirement for bund size as per AS 1940. Consider making bund big enough for all compartments on B double.	AECOM	AS1940 requirement of one compartment volume is for loading tanker (not unloading)	Ph.1			
1.1.14	Loss of containment - leak	Leaking pump.	Spill of diesel at pumps.	Pumps contained inside the bunded area.	Review where pump spill containment is discharged to. Preference is to keep in the pump bund area rather than being discharged into larger road containment bund.	AECOM	Tanker bund does not have valve to oily water pit	Ph.1			
1.1.15	Instrument and control system	Both pumps running at the same time.	System may not be designed for this. High flow in system potentially causing damage to piping/equipment.	Flow indication on discharge line of pumps.	Process interlock to be reviewed/designed to not allow running both pumps at the same time. Include permissive that valve should be opened before running pump.	AECOM		Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.16	Instrument and control system	Pumps running when on/off valves downstream are closed (Blocked in pumps).	Pump overheats leading to possible damage.	Inlet valves to selected tank are automatically opened/closed when tank is selected on control panel. Also see 1.1.3.	Review process interlock that on/off valves to tank inlet are opened prior to starting the pump.	AECOM		Ph.1			
1.1.17	Instrument and control system	Flow meter failure i.e. flow meter not indicating flow.	Operators observing fuel loading unable to see if fuel is going through hose/pipe. Hose could be suctioning from empty tank. Air suction into piping may cause an air lock.	None	Review requirement for sight glass downstream of flexible couplings. See 1.1.4	AECOM		Ph.1			
1.1.18	Maintenance - maintainability	Pump not functioning properly/requires maintenance and needs to be taken offline.	Unable to maintain pumps whilst operating.	Isolation valves for all pump inlets/outlets. Pumps can be isolated from each other.	No action						
1.1.19	Maintenance - accessibility	Inadequate access to equipment .	Unable to maintain pumps.	Access for fork lifts considered.	No action						

Table 6 Diesel System - Node 1.2

Project / Facility:	60666845 Hunter Valley Power Station - Diesel Loading	Node #	1.2
Node Boundaries:	Diesel Tank, Loading pump, Loading connection and tankers	Revision Date:	20-Jan-22
Design Intent:	Loading facility for B double tankers in case of off specification fuel	Material / Chemical:	Diesel
Design Conditions, Operating Envelope	Design assumes ambient conditions	Drawing:	HPP-AEC-MEC-DS-LLS-DRG-1064

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.1	Low Flow	Low flow into tanker being loaded when loading pumps start-up/shutdown.	Unknown, review consequence to tanker loading.	FCV in diesel loading skid to control flow.	Review impacts of ramp up and ramp down of delivery to trucks. Review impacts on PD pumps and whether PSV will lift when FCV closes. Could replace PSV with Pressure Reducing Valve. Review if the FCV in the diesel loading skid is required.	AECOM	Note this is inside of a vendor package and this may change after vendor has been selected.	Ph.1			
1.2.2	High Flow	Both loading pumps running.	Damage to pipes/equipment due to overpressure.	Scully connection on tanker to loading bay controller.	Process interlock to be reviewed/designed to prevent running both pumps at the same time.	AECOM		Ph.1			
1.2.3	High Flow	Worker filling tanks walks away from	Overfilling and spilling of tanks.	Operating procedures: Tanker filling is a	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
		tanker while its being loaded.		supervised operation. Two staff members to supervise unloading operations. Tanks are also filled by selecting volume to be filled into the tankers.							
1.2.4	Instrument and control system	Integration failure between unloading pumps and diesel loading skid.	High, low or no flow to tankers due to pumps and loading package not being integrated properly	None	Integrate the vendor package with the loading pumps E stop required for Load bay controller. Check if control should be independent of DCS e.g. Removal of air will close valves and stop the flow.	AECOM		Ph.1			
1.2.5	Reverse Flow	Flow from tanker flowing back to unloading pumps.	Pump damage because of reverse flow.	There is possibly a check valve included inside the tanker loading point. Check valves installed on the unloading pumps discharge lines.	Check tanker loading connection (dry break connection), valving isolation and check valves. Check if there is a sight glass include in line	Snowy Hydro		Ph.1			
1.2.6	High Pressure	System pressure reaches higher than 5 bar at the coupling (coupling design pressure).	Difficult to open dry break coupling.	Preliminary PSV set pressure on the unloading pumps discharge is 300 kPag.	Review pump head to maintain pressure of the loading arm below 5 barg.	AECOM		Ph.1			
1.2.7	High Pressure	TRV on filling line relieves back to blocked in section.	Overpressure of line when line is closed leading to leaks at flanges.		Review location of discharge of TRV to ensure section that is relieved will not exceed design pressure.	AECOM		Ph.1			
1.2.8	High Pressure	Diesel loading skid valves suddenly shut.	Fluid hammer in system.	A surge checklist has been done. Velocity is low and pump head is low. Pipe lengths are short. Surge is unlikely. Pipework will be adequately supported. Valves are closed slowly 5-8 seconds i.e. will not slam shut.	No action						
1.2.9	High Pressure	Filling tank.	Over pressure in tanker	Preliminary PSV set pressure on the unloading pumps discharge is 300 kPag	Confirm if tanker can be over pressured or has lid open. Ensure tanker vent system is interlocked to avoid over pressure in tanker.	Snowy Hydro		Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.10	Contaminants	Contaminants in fuel	Damage to pumps	Selection of pumps/equipment that will not be affected by contaminants that could be present in off spec fuel	No action						
1.2.11	Contaminants	Strainers blocked	No flow through strainers.	None required. No large pieces of contaminant expected to be in fuel.	No action						
1.2.12	Loss of containment - leak	Unloading arm hit by/damaged by vehicle.	Damage to arm and spilling of diesel being loaded.	Unloading arm inside bunded area to catch spills	Consider bollards in unloading area	AECOM		Ph.1			
1.2.13	Instruments and control systems	Incorrect flow measurement by flow meter.	Charged incorrect amount for fuel removal.	Metering systems. Flow meter installed on diesel loading system.	Consider whether a weigh bridge or other mechanism to measure amount of fuel being loaded	Snowy Hydro		Ph.1			
1.2.14	Maintenance	Inadequate access to equipment.	Unable to maintain valves and equipment.	Plant does not run 24/7 allowing time for maintenance if required.	No action						
1.2.15	Impurities	Tanker being filled on site has residual impurities i.e. unleaded fuel.	Potential creation of hazardous area zone.	None	No action		Not a major issue. This is not required to be controlled as per AS 1940.				

Table 7 Diesel System - Node 1.3

Project / Facility:	60666845 Hunter Valley Power Station - Diesel Storage	Node #	1.3
Node Boundaries:	Diesel Tanks and connected equipment e.g. drainage system, bunding	Revision Date:	20-Jan-22
Design Intent:	Storage and containment of diesel	Material / Chemical:	Diesel
Design Conditions, Operating Envelope	Design assumes ambient conditions	Drawing:	HPP-AEC-MEC-DS-LLS-DRG-1066/69

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.3.1	Impurities	Ignition sources and vapours in tank.	Ignition of vapour in tank.	Tank vents to relieve pressure. Ignition sources in the tank are unlikely.	Add a flame arrestor to diesel storage tanks (as per Colongra site)	AECOM	Flame arrestor not required as per AS 1940. Decision to include is SH preference.	Ph.1			
1.3.2	Instruments and controls	Mixing up of tanks, Fuel goes to/comes from wrong tank.	No significant issue. Batching and testing will not be completed	Tanks control philosophy i.e. tanks selection by the operator from DCS opens selected tank suction valve.	No action						
1.3.3	High flow	Air supply to quick flush pump.	Unregulated supply - unnecessary pump operation	None	Consider needle control valve in air supply to operate the pump.	AECOM		Ph.1			
1.3.4	High level	Tank filled above high high level. Failure of high high level switch	Overfilling of tank. Single shutdown from high level switch	High high level switch LAHH 90EGB01CG904A and 90EGB01CG901A shut down filling pumps. High level alarms LAH 90EGB01CG901A and 90EGB01CG904A.	Use level transmitter as pump shutdown as well as the level switch.	AECOM		Ph.1			
1.3.5	Low Level	Tank falls below low low level. Failure of low low level switch	Tank level too low, pump running dry - damage to the pump. Single shutdown of tank unloading pumps from low level switch	Low low level switch LALL 90EGB01CG903A and 90EGB01CG901A shut down diesel forwarding pumps and closes the tank outlet SDVs.	Use level transmitter as pump shutdown as well as the level switch.	AECOM		Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
				Low level alarms LAL 90EGB01CG901A and 90EGB01CG904A.							
1.3.6	Low Level	Failure of the low low level switch.	No diesel fuel to turbines - Turbine trip or unable to operate.	Unlikely to have level switch failure in both tanks, could operate the other tank.	Review the employer requirements to have one or two transmitters. Review how critical this instrument is to the operation of the GT.	AECOM	Existing operations (at Colongra) are using two transmitters	Ph.1			
1.3.7	High pressure	Overfilling of tank.	Tank damage/failure because of overpressure	Three vents (normal vent, emergency vent and vacuum vent) installed In tanks.	No action						
1.3.8	High temperature	Heating from the sun or other external heat source i.e. fire	As diesel is a C1 DG heating above 60 degC would require the diesel tank area to be a hazardous area. Diesel return from GT is approximately 60 deg C.	Tanks have temperature indicator and transmitter.	Review of AS 1940 to determine if any additional temperature control are required	AECOM		Ph.1			
1.3.9	Low temperature	Cold weather	Potential wax formation of fuel.	Tanks have temperature indicator and transmitter	SH to provide fuel specification (pour point) of selected fuel to determine if wax formation is likely at the minimum expected storage temperature .	Snowy Hydro	Review against Mitsubishi Specification for Liquid fuel requirements	Ph.1			
1.3.10	Contaminants	Solid contaminants in diesel stored.	Damage to GT	Impurities in diesel will drop to the base of the tank.	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
				Tank unloading pumps are not drawing off base of tank (Floating suction)							
1.3.11	Contaminants	Water in the tank	Damage to GT	Drain and quick flush system, Polishing filter will remove water.	No action						
1.3.12	Contaminants	Corrosion of drain lines, vents on tank, and tank.	Lines/vents/tank will have accelerated corrosion.	Material selection	Review drain/vent material selection to minimise corrosion. Review coating of tank.	AECOM		Ph.1			
1.3.13	Composition change	Cold weather	Viscosity/density outside limits for GT specification.	Diesel system winterisation, large inventory in storage tank will not cool down quickly.	Determine if density/viscosity of diesel change significantly with temperature. To be confirmed with fuel supplier.	Snowy Hydro	Review against Mitsubishi Specification for Liquid fuel requirements	Ph.1			
1.3.14	Loss of containment	Tank damage/ overfilling.	Spill of diesel.	Spills contained in bund sized as per requirements in AS 1940 (110% of the tank). See 1.3.4 for overfilling scenario. See 1.3.7 for tank damage because of overpressure. See 1.3.12 for tank damage because of corrosion.	No action						
1.3.15	Electrical - earthing	Nearby lightning strike or tank filling/draining causing static charge on tanks.	No diffusion of static discharge voltage to earth or ground.	Four earthing stakes.	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.3.16	Maintenance	Tank not functioning properly/one of the tanks needs to be taken offline for maintenance	Unable to access tanks because systems still running.	Isolation valves have been provided for all tank inlets/outlets. Tanks can be isolated from each other.	No action						
1.3.17	Maintenance	Rain event	Control systems underwater.	None	Confirm that a potential rain event (i.e. 1 in 100 rainfall event) will not cause instrumentation and control systems to be covered in water. Considering including float switch to alert before control switches are under water.	AECOM	Site will only be unmanned for 3 or 4 days (over public holidays)	Ph.1			
1.3.18	Maintenance	Corrosion of tank internal surface.	More frequent maintenance than preferred.	Bottom plate and up to 1 m height is coated.	Consider the internal surface of diesel tank to be fully coated.	AECOM	SH preference is to coat entire tank. Inspection every 10 years	Ph.1			

Table 8 Diesel System - Node 1.4

Project / Facility:	60666845 Hunter Valley Power Station - Diesel Polishing	Node #	1.4
Node Boundaries:	Diesel tank , Pumps, Polishing filter coalescers return to tank	Revision Date:	20-Jan-22
Design Intent:	Removes sediment and water from the diesel by recirculating the contents of the tank through the filters.	Material / Chemical:	Diesel
Design Conditions, Operating Envelope	Design assumes ambient conditions. Polishing system designed for 200 m3/h	Drawing:	HPP-AEC-MEC-DS-LLS-DRG-1068

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.4.1	High flow	All three pumps running together. The second pump starts if the duty pump fails. Operator selects one or two pumps.	No major foreseeable negative consequences. Potential to increase temperature of fluid.	Pump selection from DCS.	Interlock to prevent 3 pumps running at the same time.	AECOM		Ph.1			
1.4.2	Low flow	Polishing filters blocked	Potential for high pressure however pumps have a minimum flow line with PRV.	PDG across diesel polishing package. However, operator may not be monitoring this continually. Flow measurement FS for Diesel pumps.	Check diesel polishing package has alarm for the differential pressure across filters to alert operators of blocked filters in DCS.	AECOM	Include DP alarm for whole polishing package if needed	Ph.1			
1.4.3	Reverse flow	Higher pressure downstream of pump.	Damage to pumps because of reverse flow.	NRV downstream of pump.	No action						
1.4.4	Misdirected flow	Incorrect tank inlet valves open.	Flow to wrong tank - No safety concern	DCS only allows valve to be opened to tank selected	No action						
1.4.5	High Pressure	Blockage or closed valve	Damage to pipes/equipment because of high pressure.	Pipework designed for dead head of the pumps.	No action						
1.4.6	Contaminants	Contaminants collection in polishing filters	Blocked filters.	Package to automatically switch to clean filter when a filter is dirty or high DP.	No action						
1.4.7	Loss of containment	Leak in system	Diesel spill	Diesel polishing package inside bunded area connected to oily water system. Maintenance ITPs to ensure flange integrity.	No action						
1.4.8	Instruments and control system	Sufficient instrumentation	Pump damage because of running dry or blocked in.	Pump is sufficiently protected by instrumentation	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
				including low flow switch downstream of pumps.							
1.4.9	Instruments and control system	Low flow switch downstream of pumps	Pump damage failure due to blockage of pump kickback line or valves on pump kickback line closed.	Low flow switch downstream of pumps to forwarding filters.	No action						
1.4.10	Maintenance	Inadequate access to equipment	Unable to maintain equipment.	Plant does not run 24/7 allowing time for maintenance if required.	No action						
1.4.11	Maintenance	Running diesel through polishing package could impact GT starting times if need to quickly start the GT on diesel. GT can operate on gas	Requirement to start GT's as quickly as possible. Seconds can have an impact on profitability with spot electricity prices	Polishing of diesel can be scheduled.	Consider an additional separate pump for polishing package. Look at automated prioritised control of forwarding pumps.	SH & AECOM	Reduce start times - anything that reduces start time by 20 seconds is considered to have a big impact by Snowy Hydro. Suction valve on tank (from bottom to floating suction) and auto valves to polisher and auto valve needs to change position quickly.	Ph.1			

Table 9 Diesel System - Node 1.5

Project / Facility:	60666845 Hunter Valley Power Station - Diesel Delivery to Gas Turbines	Node #	1.5
Node Boundaries:	Diesel tank, Pumps, Polishing filter coalescers return to tank	Revision Date:	20-Jan-22
Design Intent:	Delivers diesel from the tanks through filters to suction of main Fuel oil pumps at Gas Turbine Unit 1 and Unit 2	Material / Chemical:	Diesel
Design Conditions, Operating Envelope	Design assumes ambient conditions	Drawing:	HPP-AEC-MEC-DS-LLS-DRG-1067/1068

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.5.1	High Flow	All three pumps running at the same time	Damage to piping/equipment	Inlet return valves from pump discharge to storage tank	- One inlet return valve to each storage tank to be open at all times. Set fail action to fail last. - Oil is returned after GT shutdown. Ensure the inlet line is open for the fuel return to tanks. - Keep at least one inlet valve open for diesel return from GT after shutdown.	AECOM	90EGC01AA001100 or equivalent on tank 1	Ph.1			
1.5.2	Low Flow	The duty pump trips	Insufficient flow to GT's when both GT's running	Standby pump available if pump trips	Redundancy and reliability issues need review. Consider running the standby pump at all times so if a single pump trips no loss of flow or pressure to the GT . Perform a dynamic study to determine if only running two pumps and time required for a third pump to start and compensate for loss of flow of tripped pump. How many pumps need to be running if there is a pump trip. Consider n+1 where n is the number of units.	AECOM		Ph.1			
1.5.3	Reverse flow	Diesel flowing back towards	Pump damage because of reverse flow.	Pumps are protected by NRVs	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
		forwarding pump.									
1.5.4	High Pressure	Valves on filter outlet closed.	Filter damage because of high pressure.	Filters designed for dead head from forwarding pumps. Minimum flow line opens on high pressure in pump discharge.	No action						
1.5.5	Low Pressure	Pump trip/not running properly, blockage in pipe.	Low flow to GT.	Pressure indicators will show low pressure High Flow and low pressure will start second pump if only running one pump.	No action						
1.5.5a	Contaminants	Collection of contaminants in the filter.	Blocked filters.	Filters can be changed over on line when a filter is blocked.	No action						
1.5.6	Loss of containment	Leak in system / damage to equipment.	Diesel spill.	Pumps inside bunded skid with roof. Maintenance ITPs to ensure flange integrity.	Consider installing a small sump and weir in bund to contain smaller leak quantities at pump skid bund.	AECOM		Ph.1			
1.5.7	Instruments and control systems	On - off Valve failure action. Diesel supply valve downstream of filters is currently fail close for fire protection.	Loss of Fuel supply to Gas turbines if valve fails closed. Closure prevents feeding fuel to a fire.	Keep isolation valve to supply diesel to GT as FC to lessen duration of a fire.	No action						
1.5.8	Instruments and control systems	Lack of facilities for remote monitoring.	Inability to identify system deviations remotely when no one is on site. No ability to create alarms for system deviations.	PT should be shown upstream of flowmeters but is incorrectly shown as PI currently	Change PI upstream of flowmeter to be PT	AECOM		Ph.1			
1.5.9	Maintenance - isolation	Inability for system to be isolated for maintenance.	System not able to be maintained.	Can isolate both filters and flow meter is removable.	No action						
1.5.10	Maintenance	Maintenance of flow meter required.	Inability to access the flowmeter due to process streams still running	Flow meter can be isolated and maintained.	No action						

Table 10 Diesel System - Overview

Project / Facility:	60666845 Hunter Valley Power Station - Diesel Delivery to Gas Turbines	Node #	OVERVIEW
Node Boundaries:		Revision Date:	20-Jan-22
Design Intent:		Material / Chemical:	Diesel
Design Conditions, Operating Envelope	Design assumes ambient conditions	Drawing:	HPP-AEC-MEC-DS-LLS-DRG-1067/1068

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.6.1	Materials of construction - Tanks, piping, pumps, valves	Incompatible material used with diesel.	Premature corrosion of materials due to inadequate materials of construction.	Galvanized steel used for structures. Specialised materials are required for diesel.	No action						
1.6.2	Utilities and services	Lighting may be insufficient for the task.	Pedestrians injury, trips/falls.	Adequate lighting supplied i.e. Roadway and loading lighting area. Lighting design as per AS standards. Safety shower with activation alarms provided at both diesel pumps and unloading area.	No action		Yellow lighting is preferred to white to reduce attraction for insects. Insects have blocked drains at other sites.				
1.6.3	Hazardous substances	Hazardous substances stored	Requirement for Hazardous Area classification.	Diesel only. No other hazardous substances.	No action						
1.6.4	Physical damage	Moving unloading hose on trolley skid to loading point.	Damage to equipment	Curb to diesel loading/unloading area to allow trolley access.	Review the interaction of the loading/unloading interaction with curb and lighting.	AECOM		Ph.1			
1.6.5	Fire/explosion	No installed fire detection	A fire could start on site undetected. This is unlikely.	None	Review causes of fire/consequences. A fire could start on site undetected. Review fire protection and remote monitoring of critical areas e.g. use of cameras	SH and AECOM	Fire safety study currently being undertaken.	Ph.1			
1.6.6	Shutdown	Emergency requiring system shutdown.	Plant not able to be safely shutdown in emergency or loss of process control.	Emergency stops provided.	No action						
1.6.7	System testing	Trips and alarms not working.	Overfilling of tanks.	Trips and alarm tests to be performed as part of regular testing.	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.6.8	Environmental impact	Overflow of diesel from vents.	Spilling of diesel into bund area.	All diesel vents going to bund which drains to oily water waste system. High level alarms and trips.	No action						
1.6.9	Environmental impact - waste management	Diesel mixing with stormwater.	Release of diesel into environment.	Oily water separator system will separate oil from stormwater discharge system	No action						
1.6.10	Natural hazards	Bushfires due to large amount of natural bushland in the site area.	Ignition/loss of diesel tanks during bushfire.	Site maintenance and clearance of combustible vegetation close to the process areas.	Review bushfire impacts on the fuel tanks. Assess best materials for fencing etc. to minimise this risk. (NOTE: A fence will not prevent ember attack which comes from an elevated height higher than normal fence height).	AECOM	Vegetation near site to be cleared in the future when site is operable. The EIS Bushfire Risk Assessment. Figure 4-2 estimates the radiant heat flux impacts on the site. It is estimated that the Diesel Tanks could be exposed to between **12kW/m2 and 19kW/m2** primarily from the North-East. The recommended Fire Protection criteria for Bulk Tanks at 8kW/m2 is the ability to deploy cooling water from a mobile appliance should be planned. At 32kW/m2 exposure a tank should be fitted with its own deluge system, which is automatically activated. **Therefore the estimated radiant heat flux indicates cooling should be deployed but can be from a mobile appliance or portable equipment, especially onto the upper unwetted surfaces of the tanks with direct line of sight to the flames.** No predicted flooding even including climate change.	Ph.1			
1.6.11	Natural hazards	Earthquake	Destruction of tanks, equipment	Designed to earthquake standard.	No action						
1.6.12	Procedures - development & documentation	O&M manual for system.	Operation/Maintenance documentation for system.	None	O&Ms to be created by SH	SH		Ph.2			
1.6.13	Quality Control	Systems not designed to specification.	System failure.	Systems within the design to be checked by TQR.	No action						

Natural Gas Systems

Table 11 Natural Gas System - Node 2.1

Project / Facility:	**60666845 Hunter Valley Power Station - Natural Gas supply - Inlet skid and Split Junction to Gas Turbines**	**Node #**	**2.1**
Node Boundaries:	Power station boundary to tee junction at each gas turbine	**Revision Date:**	21-Jan-22
Design Intent:	Deliver NG to each gas turbine, includes Calorie Meter (MHI supplied)	**Material / Chemical:**	Natural gas
Design Conditions, Operating Envelope	Pressure: 4400 kPag, Temperature: 5 to 60 deg C, Flowrate: 150,000 Kg/h	**Drawing:**	HPP-AEC-MEC-GA-DTV-DRG-1096

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.1.1	Low Flow	Loss of supply of gas/leak in pipe. Unlikely event unless valve is closed.	Gas turbine stops on low pressure or will not start.	Procedures for checking flanges tightness after maintenance and pressure test and purge with N2 after maintenance.	No action						
2.1.2	Misdirected flow	Vent or drain valves open	Gas flowing to high point vents. Gas Turbine may not start.	Operating procedures for checking valves are closed after maintenance and pressure test and purge with N2 after maintenance.	No action						
2.1.3	Contaminants	Potential for N2 to be introduced with NG if N2 connections left open.	Flame out and potential damage to Gas Turbine caused by intermittent firing.	Operating procedures for checking valves are closed after purging.	Use temporary flexible connection for N2 purging with hoses and only connected when required for maintenance. Covered under operating procedures for only connecting N2 when purging is required.	Snowy Hydro		Ph.2			
2.1.4	High Pressure	Battery inlet ESD EKG01DF001A closed	Gas line pressurised.	Gas supply line design for 5700 kPag with allowance above maximum operating pressure of gas supply skid (5300 kPag) High high trip pressure of APA equipment is 5500 kPag	• SH have requested to add facilities for a remote operated vent for each pipe section to be opened remotely by operators to reduce pressure in the pipeline over a selected time period e.g. 15 minutes in case of fire. • **Two vents will be required** one for first section between battery limit ESD and SDV upstream of knockout drum and second vent required downstream of gas KO drum ESD for downstream equipment. Consider damage to the packing in the filter coalescer vessel from a high differential pressure across the filter material during venting. • Change valve to ESD (currently SDV). • Vent valve interlocked to not open until ESD is closed to prevent loss of gas. • Review the operation of vent in conjunction with remote operation philosophy i.e., effect of ignition of vent and possibility of air entering the gas line when line depressurised. May effect ability for remote start-up. Vent valve will only close in emergency.	AECOM	APA agreed that vent for gas pipeline can be collocated with cold vent for gas receiving station. AECOM to look at radiation from new vent co-located with cold vent. APA permit system requires all lines connected to vent to be purged and lock on isolation valves. Confirm there is a DBB on vent line to new vent in APA area.	Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.1.5	High Pressure	ESD valve closed in a process upset (trip) or fire scenario.	Transient impacts on pipeline-damage/rupture of piping.	Shut off valves closure time at gas turbine are less than 1 second. APA valves will also need to close quickly. ESD at power station battery limit and knockout drum will close more slowly to prevent sudden pressure increases.	Perform dynamic study of the system based on closure times of the valves. Consider all system shutdown (trip) scenarios.	APA and AECOM	**Note:** A gas system does experience the same pressure surges as a liquid system	Ph.1			
2.1.6	High Pressure	Pipe blocked in	Damage to equipment/piping.	Relief valves, high pressure alarms and trips, shut off valves position indication.	Confirm there is a safety relief valve in pressure reduction units supplied by MHI.	MHI		Ph.1			
2.1.7	High temperature	Heating of gas in pipeline due to high ambient temperature.	Expansion of gas potentially causing damage to piping/equipment	High temperature alarm and a trip set at 60 deg C at APA receiving station to trip outlet gas valve. Relief device sizing overpressure scenarios include checks for gas expansion due to fire.	No action		Design Temperature set at 65 deg C.				
2.1.8	Contaminants	Liquid carryover gas at APA receiving station.	Damage to GT's	Filter/Coalescer in APA receiving station removes particulate and droplet contaminants (up to 10 ppb wt). Off-spec gas composition unlikely.	No action		APA Filter Coalescer specification is 10 ppb weight				
2.1.9	Loss of containment	Large discharge of gas to remote located vent near APA vent due to depressurisation	High flow through a cold vent causing potentially a gas cloud that could ignite	High pressure trips will stop further gas supply. Vent lines have reduced bore valves and a restriction orifice to minimise the maximum flow into the vent.	Review location of vent stack with regard to radiation from ignition of NG. Review potential to co-locate new vents required in APA's vent area	AECOM		Ph.1			
2.1.10	Instrument and control system	Inadequate instrumentation	No indication of pressure in line to identify deviation from process pressure.	Pressure transmitters with a high-pressure alarm provided at Fuel Gas Knockout Pots. Pressure transmitters with high- and low-pressure alarms within the APA gas station. Pressure transmitters within the MHI package.	Include pressure transmitter and local pressure indicator on main line. Provide additional tapping points for gauges if required.	AECOM		Ph.1			
2.1.11	Maintenance	Isolation for maintenance	Unable to maintain valves and equipment.	All equipment can be isolated with double block arrangement. Vents are double block only.	Review whether integral DBB valves can be used instead of separate valves to save cost.	AECOM		Ph.1			
2.1.12	Maintenance	Inadequate access to equipment.	Unable to maintain valves and equipment.	All equipment are located at ground level with easy access.	No action						
2.1.13	Maintenance	Equipment for maintenance.	Calibration gas availability.	Calibration gases for calorie meter does not need to permanently connected.	Update PID to show not permanently connected.	AECOM		Ph.1			

Table 12 Natural Gas System - Node 2.2

Project / Facility:	60666845 Hunter Valley Power Station - Natural Gas supply - Knock Out Drum	Node #	2.2
Node Boundaries:	Gas Turbine inlet supply isolation to Gas Knock Out Drum and liquid drains	Revision Date:	21-Jan-22
Design Intent:	Remove liquid from NG delivery to each Gas Turbine	Material / Chemical:	Natural gas
Design Conditions, Operating Envelope	Pressure: 4400 kPagX, Temperature: 5 to 60 deg C, Flowrate: 75,000 Kg/h	Drawing:	HPP-AEC-MEC-GA-DTV-DRG-1090

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.2.1	High flow	Control valve EKG03AA046 on drain line may remain open (Does not shut on low level).	Gas blow through to condensate tank and vent	SDV EKGDF03001A will close with independent low-level switch. Downstream restriction orifice will limit flow to condensate tank and vent is sized for the maximum gas blow through case.	No action						
2.2.2	Reverse Flow	High flow to Station vent through Knock drum.	Possible damage to demister pad.		Review potential impact on reverse flow through KO pot and demister pad.	AECOM		Ph.1			
2.2.3	Instrumentation and controls	Unnecessary automated valves	Excess complication	N/A	• Review requirement for Emergency shut off valve EKG01AA161 upstream of KO drum. • Consider changing to a manual valve as remote operation of the valve is not required (by SH) ESD can remotely isolate each GT if fire on one unit • Provide a schematic drawing (updated PFD) of ESD and vent valves on gas supply line to each gas turbine.	AECOM	MHI say the valve is only required for maintenance. Name of valve has been changed in new revision of the drawing to emergency shut off valve	Ph.1			
2.2.4	Instrumentation and controls	Level gauge/transmitter in incorrect locations on Gas Knock Out Drum.	Level in the vessel not accurately measures/controlled.	none	Change location of level transmitter on the Gas Knock Out Drum of upper tapping point to below filter media.	AECOM		Ph.1			
2.2.5	Instrumentation and controls	High level switch LSHH EKG01CP001B faulty.	High level in fuel gas KO pot may trip gas turbine. Faulty LS may cause unnecessary trip of gas turbine	LSHH will trip gas turbine on high level.	• -Remove LSHH trip to shut turbine -Include LSH on maintenance schedule • Frequent tests to make sure it's working). • Do not require duplicate drainage system because LSHH trip deleted.	AECOM	MHI say do not normally have a HH trip on liquid level in upstream vessel. In combustion chamber there is a pressure fluctuation trip if liquid carried into the inlet that will protect the GT.	Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.2.6	Low temperature	Low ambient temperature.	Hydrate formation, lower than expected fluid temperature.	Designed according to specifications i.e., piping and equipment design temperatures selected accordingly, winterisation included in the design.	No action						
2.2.8	Maintenance	Access to Gas Knock Out Drum for cleaning and inspection.	Cleaning via manway.		Show a Manhole on Knock Out Drum on P&ID (HPP-AEC-MEC-GA-KOO-DRG-1090).	AECOM		Ph.1			
2.2.9	Loss of containment	Relief valve EKG09AA02040 discharges into the vent stack.	Venting of gas near people on site.	All gas vents and relief valves discharge into the common vent stack located on the Power island. Location will be finalised after fire safety study.	No action						

Table 13 Natural Gas System - Node 2.3

Project / Facility:	60666845 Hunter Valley Power Station - Natural Gas supply - Gas Meter & Heater Skid (MHI equipment)	Node #	2.3
Node Boundaries:	Natural gas flow meter, temperature bypass valve and gas heater	Revision Date:	21-Jan-22
Design Intent:	Measures the NG flowrate and heats the Natural gas to at least 11 deg C above the dew point to ensure no liquid is condensed when entering the Gas Turbine	Material / Chemical:	Natural gas
Design Conditions, Operating Envelope	Pressure: 4400 kPag, Temperature: 5 to 60 deg C, Flowrate: 75,000 Kg/h	Drawing:	HPP-AEC-MEC-GA-DTV-DRG-1094

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.3.1	Pressure	Blocked in System	Damage of equipment/piping	Relief valve downstream of gas heater	No Action		Raised an RFI to obtain details about the MHI heater MHI have responded to RV sizing in discussion that RV blocked in case is not a concern as gas will expand into up and downstream piping. Calculations have confirmed that RV sizing is small				
2.3.2	High Temperature	Temperature control valve fails last with flow through heater	Potential damage of equipment/piping	Equipment designed to cope with maximum temperature of 220 deg C. Design temperature is 340 deg C. Casing air is cooled from 500 to 210 deg C	No action						
2.3.3	Instruments and control	Control valve failure. No positioner on temperature control valve EKG06AA003	All gas directed through the Fuel Gas Heater and high temperature could trip the Gas Turbine.	MHI Gas Turbine gas high temperature alarm	Raise an RFI to MHI on whether the position of the temperature flow control valve is important. Difficult to know	AECOM	Clarified with MHI. No possibility of overheating gas to gas turbine. A low temperature will generate an alarm at the GT inlet and will alert operations to check valve operation	Ph.1	21/01/2022		Closed

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
					that TCV has failed.						
2.3.4	Maintenance Access	Impact of hot air of people accessing ladder to stack.	Possible injury.		Check distance from MHI heater to ladder access on stack.	MHI		Ph.1			

Table 14 Natural Gas System - Node 2.4

Project / Facility:	**60666845 Hunter Valley Power Station - Natural Gas supply - Dual Filter Coalescers**	**Node #**	**2.4**
Node Boundaries:	Dual Coalescers and liquid drainage	**Revision Date:**	21-Jan-22
Design Intent:	Removes remaining liquid or solid particles before entering gas turbine	**Material / Chemical:**	Natural gas
Design Conditions, Operating Envelope	Pressure: 4400 kPag, Temperature: 5 to 60 deg C, Flowrate: 75,000 Kg/h	**Drawing:**	HPP-AEC-MEC-GA-FCS-DRG-1091

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.4.1	Low Flow	Blockage in Filter Coalescer.	No gas to GTs.	DP measurement and alarm across filter coalescer, MHI Gas Turbine supply low pressure alarm and trip.	No action						
2.4.2	Instruments and control	Filter Coalescer pressure drop increasing across filter	Reduced or no flow to GTs. GT will trip on low pressure	DP alarm on Filter Coalescer.	Review setting level of DP alarm level value on Filter Coalescers to ensure sufficient time to swap to other filters (Duty/Standby).	AECOM	Automatic valves for 300mm valves difficult to obtain.	Ph.1			
2.4.3	Reverse flow	GT inlet gas supply ESD valve 90EKG1ODFOO1D open upstream of gas knock out drum and remote vent at gas piping at battery limit is opened to allow vent down.	Gas drawn through KO drum at a large rate potentially causing damage to filter elements.	none	Review potential impact on reverse flow through Knock Out Drum and demister when opening the remote vent at the station battery limit.	AECOM	See 2.1.4	Ph.1			
2.4.4	Changes in quantity - level	Unable to identify condition of filter coalescer	Difficult to inspect inside filter coalescer potentially causing inefficient operation of filter coalescer due to poor condition.	none	Consider adding sight glass on side of filter coalescers to determine condition of elements.	AECOM		Ph.1			
	Instruments and control	High level switch LSHH EKG02CL001B faulty.	High level in filter coalescer to trip gas turbine. Faulty LS may cause	LSHH will trip gas turbine on high level.	• Remove LSHH trip to shut turbine • Include LSH on maintenance schedule	AECOM	MHI say do not normally have a HH trip on liquid level in upstream vessel.	Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
			unnecessary trip of gas turbine.		(Frequent tests to make sure it's working). • Do not require duplicate drainage system because LSHH trip deleted.		In combustion chamber there is a pressure fluctuation trip if liquid passed to the inlet that will protect the GT.				
2.4.5	High Pressure	Blocked in system	Damage to filter coalescer because of high pressure.	Overpressure relief device installed. High DP alarm.	No action						
2.4.6	Contaminants	Contaminated gas supply	Liquid droplets or solid particulates cause damage to GTs.	Filter Coalescer to remove liquid and solid particulate contaminants.	No action						
2.4.7	Loss of containment	Leaks from drainage lines flanges containing liquid to drips tank.	Liquid leak from filter/coalescer flanges or drains to ground area.	No significant accumulation expected. All leaks will be contained to immediate area on impervious surface.	No action						
2.4.8	Instruments and control	Pressure instrumentation		PI EKG09DF001D upstream of the vessel, and differential pressure transmitter across the Filter Coalescer.	Change PI to PT upstream of filter for DCS indication.	AECOM		Ph.1			
2.4.9	Maintenance - access	Access into the Filter unit		Platform is provided to access the filters.	Consider stairs instead of ladders for access.	AECOM		Ph.1			
2.4.10	Maintenance - maintainability	Unable to isolate the Filter Coalescer and changeout filters		Duty/Standby Filter Coalescer arrangement has been provided to be able to changeover/maintain filters. Manual changeover so automated valves have not been provided. Differential pressure alarm to be set sufficiently low enough to give time to switch over.	No action						

Table 15 Natural Gas System - Node 2.5

Project / Facility:	**60666845 Hunter Valley Power Station - Natural Gas supply - Cartridge Filter skid and Final Drawing**	**Node #**	**2.5**
Node Boundaries:	Last chance cartridge filter (MHI supplied) and three purge credit valves with vent facilities	**Revision Date:**	21-Jan-22
Design Intent:	Final protective filter for gas turbine and quick purge supply valves	**Material / Chemical:**	Natural gas
Design Conditions, Operating Envelope	Pressure: 4400 kPag, Temperature: 5 to 60 deg C, Flowrate: 75,000 Kg/h	**Drawing:**	HPP-AEC-MEC-GA-DTV-DRG-1095

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.5.1	Low flow	Blockage in filter.	Low fuel supply to GTs causing a turbine trip.	Filter differential pressure measurement. MHI low gas pressure and low flow alarms.	No action						
2.5.2	Contaminants	Impurities in gas.	Solid particulates or oil cause damage to GTs	Upstream gas filtration vessels and the last change filter provided.	No action						
2.5.3	Loss of containment	Bleeding of gas line to unsafe location.	Creation of Hazardous area zone.	Individual gas vents to be discharged into a common vent stack located in a safe area.	Review where vents are discharge to e.g. Local High point vent	AECOM	RO in vent line is for noise suppression.	Ph.1			
2.5.4	Maintenance - maintainability	Isolation and access the filter for maintenance.	Clean/changeout filter elements.	The filter unit can be isolated for maintenance. Isolation is provided upstream of gas knock out drum. Gas turbine to be off line.	No action						
2.5.5	Maintenance	Purging at the filter not currently provided.	N2 connection	Nitrogen purging connections and high point vents have been provided at the knock out pot and filter coalescers.	Review requirements for nitrogen purge and vent connection between heater and filter to be used during maintenance of filter.	AECOM		Ph.1			

Table 16 Natural Gas System - Node 2.6

Project / Facility:	60666845 Hunter Valley Power Station - Natural Gas supply - Condensate tank and vent	Node #	2.6
Node Boundaries:	Condensate tank and connected vent stack	Revision Date:	21-Jan-22
Design Intent:	Collection tank for drains from Knock out pot and filter coalescers with high point vent stack	Material / Chemical:	Natural gas
Design Conditions, Operating Envelope	Design Pressure: 600 kPag, Design Temperature: -5 to 80 deg C, Operating Pressure: atmospheric, Operator Temperature: 30 deg C	Drawing:	HPP-AEC-MEC-GA-DTV-DRG-1093

+Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.6.1	High flow	Gas blow through from Filter Coalescer or KO pot. Two phase flow into tank due failure of LT or control valve and SDV or two phase due to lower pressure after CV leading to effervescing of gas coming out of solution	High pressure in the tank.	Restriction orifice in upstream drain line. Relief valve on tank to prevent overpressure. No high flow possible.	No action						
2.6.2	Loss of containment	Tank overfilling	Potential spillage of tank contents	Currently designed to be a double skinned tank. Material selection and vessel design, maintenance and regular inspections.	No action						
2.6.3	Reverse flow	High pressure in the tank from nitrogen system. Reverse flow of Nitrogen into Filter Coalescer via drain line.	Damage to gas turbine due to N2 mixed with natural gas causing misfiring.	NRV at Filter Coalescer and Knock Out Drum. Nitrogen not used in tank when system is operating.	No action						
2.6.4	Maintenance - maintainability	Tank drain or sampling point.	Unable to sample if no local drain.	Existing connection from the bottom of the tank to tanker loading connection.	Add small tank drain to allow sampling and flow to drain	AECOM		Ph.1			
2.6.5	Level	Low level in tank.	Tank does not drain into a tanker via tanker loading connection by gravity flow.	Nitrogen injection is to be used to load a tanker.	No action						
2.6.6	Low pressure	Ambient Temperature changes in tank i.e. low temperatures at night time will create low pressure.	Tank damage from slight vacuum due to the tank not being design for vacuum conditions.	Vacuum unlikely due to small amount of condensation of hydrocarbons.	Update datasheet to include a full vacuum conditions that may be caused by condensation of hydrocarbons.	AECOM		Ph.1			
2.6.7	Instruments and controls	Level indication should be visible.	Visual check of tank level to allow verification of LG.	Level instrument LT EGC00CF251A and level gauge LG EKG09DF002D.	Sight glass to be added on drips tank. Add to P&ID.	AECOM		Ph.1			

+Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
2.6.8	Maintenance - accessibility	Tank access if located below ground.	Inability to maintain tank.	Hatch to allow access. Tank to be above ground.	No action						
2.6.9	No flow	No flow through tank vent due to valves in vent line being closed.	Pressure relief valve on tank may lift.	Manual valves normally to be open.	Ball valves on P&IDs upstream of NRV to be locked open.	AECOM		Ph.1			
2.6.10	Drains from Vent pipe	Water flowing from gas vent pipe to drips tank	Filling of tank with water that will require the drips tank to be emptied more frequently.	none	Redirect drain from vent pipe away from drips tank to another location to avoid filling drips tank with water.	AECOM		Ph.1			

Table 17 Natural Gas System - Overview

Project / Facility:	60666845 Hunter Valley Power Station - Diesel Delivery to Gas Turbines	Node #	Overview
Node Boundaries:		Revision Date:	21-Jan-22
Design Intent:		Material / Chemical:	Natural Gas
Design Conditions, Operating Envelope	Design assumes ambient conditions	Drawing:	HPP-AEC-MEC-DS-LLS-DRG-1067/1068

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.6.1	Materials of construction - pumps, valves	Incompatible material used with gas	Premature corrosion of materials due to inadequate material of construction.	All pipes, vessels constructed of steel. Structures made of galvanized steel. Pipe is to be painted as per specification.	No action						
1.6.2	Physical damage	Vehicle impact of gas delivery pipeline or equipment.	Damage to gas piping and loss of containment.	Set back off the road to avoid physical damage from vehicles and Hazardous Areas. Bollards to prevent impacts to the pipelines.	No action						
1.6.3	Fire/explosion	Fire protection on site.	Natural gas ignition and plant/equipment damage.	Fire ring main with hydrants for control of fires within plant. Hazardous area classification. Site hot work permit system and other administrative controls to eliminate ignition sources.	Review requirement for ignition source control entry into hazardous areas e.g. separation barrier, post, chain. SH to provide procedures and training for entry to HA and ignition sources.	AECOM and SH		Ph.1			
1.6.4	Start up	Start-up of system if process is outside of specified operating conditions.	GTs not running, damage to equipment.	Start-up procedures to be followed. MHI turbine start-up permissive.	No action						
1.6.5	Noise	High gas velocities through vents and relief valves.	Loud noise from venting and potential hearing loss of personnel	Some vents have ROs to reduce flow/noise. Relief device datasheets to specify noise requirements and minimise if possible. Consider discharge silencers.	No action						

Process Gas & Air Systems

Table 18 Process Gas (Hydrogen) - Node 1.1

Project / Facility:	60666845 Hunter Valley Power Station - Process Gas (H2)	Node #	1.1
Node Boundaries:	Hydrogen Trailer and Hydrogen Bottles to High Pressure panel	Revision Date:	27-Jan-22
Design Intent:	Pressure reduction from Trailer and Bottle pressure (180 barg , 137 barg) to 50 barg	Material / Chemical:	Hydrogen
Design Conditions, Operating Envelope	Design Pressure - 245 barg, Design Temperature - 5 - 80 deg C	Drawing:	HPP-AEC-MEC-HY-GEN-DRG-1100

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.1	Flow - Quantity	No supply of H2 when changing from trailer to cylinders because cylinders are empty.	No H2 supply to generator may stop GT operating.	Five-day bottle supply of H2 currently included in design (2 pallets of 15 bottles each).	Review amount of H2 required. Consider using less H2 gas bottles. (**Raise RFI** to SH to ask about minimum requirement for H2 storage cylinders).	AECOM/ Snowy Hydro	15-cylinder rack will cover 2.7 days of normal leakage from 2xGT. @\2 racks will give 5 days coverage. If generators are not topped up the pressure will drop from nominal operating pressure of 4.5 barg to minimum operating pressure of 4.3 barg in 24 hours	Ph.1			
1.1.2	Flow -Low Flow/ No flow	Leak from gas cylinders losing H2 backup supply.	Cylinders might be empty when required as backup for trailer.	There are valves downstream of tube trailer and gas bottles which can be closed. There is a pressure transmitter with a low alarm downstream of both the trailer and gas bottles.	Review timing for H2 trailer delivery and determine if leakage rate from generator is low enough to not reach low pressure trip whilst H2 trailer is being delivered and changeover.	Snowy Hydro	Add new PTs to first point on the fixed inlet pipework before the DBB valves to transmit actual pressure in storage cylinders and tube trailer.	Ph.1			
1.1.3	Instrument and control system	Insufficient instruments to detect leak/low flow from H2 supply.	Unable to determine H2 supply source (i.e. trailer or bottles) remotely.	Local pressure indicators downstream of trailer and bottles only. A pressure transmitter on common outlet only.	Review requirement for pressure transmitters on cylinder and trailer H2 supply lines. Considering adding a position indicator on DBB valves on each H2 supply line - This option is not preferred because the position indicator will be in a Hazardous area from the H2 flanges.	AECOM	See item 1.1.1 - addition of 2x PITs will give required information.	Ph.1			
1.1.4	Flow-High	Potential for high flow if PRV fails.	Loss of large quantities of H2 due to venting as a result of PSV opening on high pressure.	Pressure transmitter upstream of PRV will not indicate high flow. Local Pressure indicator only downstream of the PRV.	Add pressure transmitter with alarm inside the H2 HP regulator panel downstream of PRV.	AECOM	Change PI immediately downstream of PRV to a PIT with high pressure alarm set at 5400kPag or just below relief setting of the 5500kPag PSV.	Ph.1			
1.1.5	Flow -Reverse flow	Valves on hydrogen supply line for bottles left open when H2 is being supplied from trailer.	High pressure to H2 gas bottles from H2 trailer because storage on the trailer it at a higher pressure.	NRV on N2 connection prevents backflow to N2 bottles.	Add NRVs to hydrogen supply line to lines adjoining trailer outlet and cylinder outlet.	AECOM	Insert NRVs between isolation valves EKG01AA002 and 016 and the incoming nitrogen tee so hydrogen cannot flow back from the trailer to the cylinders	Ph.1			
1.1.6	Pressure - low	Valve downstream of PRV to the vent line might be open.	H2 venting to H2 vent pipe. Loss of large quantity of H2.	Operating Procedures to close valve after maintenance.	Review purpose of valve on line connected to hydrogen vent pipe (downstream of PRV).	AECOM and MHI	Lock 15NB NC valve closed. Connection to vent is allow line to be depressurised and vent to local vent. The valve is required.	Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
					Consider locking bypass valve on PRV.						
1.1.7	Contaminants	Nitrogen supply attached to H2 line will introduce N2 into H2 line.	Potential for lower purity of H2 than required at the generator.	Nitrogen not normally connected when H2 is used. Valve on N2 supply line to be closed after purging for maintenance.	SH to provide operating procedures to close valve.	Snowy Hydro		Ph.2			
1.1.8	Contaminants	H2 supply purity less than required by MHI for generator.	Heat generation within generator.	Gas purity monitor with alarm at generator indicates if H2 purity is less than 90%.	no action						
1.1.9	Contaminants	Condensation in vent lines causing accelerated corrosion.	Potential failure of vent pipes or requiring earlier replacement.	Carbon steel to be used for vent lines. Vents lines, flame arrestors and vent stack on maintenance schedule and inspected on a regular basis.	no action						
1.1.10	Instrument and control system	ESD (SDV) valve fails to close.	Potential fire with gas continuing to flow.	Fire safety system to shut ESD (SDV) valve, Emergency shutdown button at H2 pressure reduction panel.	no action						
1.1.11	Instrument and control system	PRV fails shut (NB Normally fails open).	Loss of H2 flow.	PI downstream of PRV.	Consider a PT (downstream of the shutdown valve) that closes the shutdown valve. Review what the "shutdown" valve will be called from control perspective	AECOM	A PIT has been installed (see 1.1.4 above) with high and low alarms. A high high alarm has been added to shut the ESD (SDV) should that situation occur.	Ph.1			
1.1.12	Pressure - low	Filter downstream of ESD is blocked.	Low flow of H2 to generator.	PIT downstream of strainer would indicate low pressure.	No action						
1.1.13	Flow - no	Unavailability of H2 delivery (especially in large quantities such as the maxi trailer).	Limited or low H2 supply.	A normal H2 trailer delivery is required once every 100 days.	Discuss with the Hydrogen supplier (BOC) availability and reliability of H2 supply.	Snowy Hydro		Ph.2			
1.1.14	Contaminants	Carbon steel for Nitrogen supply line (that connects to common H2 line).	Rust particles carried over into H2 pipeline.	Filter upstream of PRV.	Review if small filter in N2 line is required to prevent any potential contamination carry over from N2 lines. Consider moving Nitrogen bottles to Hydrogen area to decrease the length of Nitrogen pipeline so this can be relatively cheaply changed to stainless steel.	AECOM	Filter upstream of the PRV to be 5-micron particulate filter to arrest any dirt or scale. Nitrogen racks do not need to be permanently connected as used infrequently so fork hoist a rack to the N2 connection point and purge out oxygen before allowing gas to pass into the hydrogen system.	Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.1 5	Pressure - low	Leakage of gas from PSV set at 5500 kPag	Loss of H2 gas.	PSV set pressure was selected to be between 15 to 150 barg	Review PSV set point downstream of PRV. Identify suitable set point based on the design pressure the downstream piping. Review pipe specification.	AECOM	PSV set at 5500 kPag is adequate.	Ph.1			

Table 19 Process Gas (Hydrogen - H_2) - Node 1.2

Project / Facility:	60666845 Hunter Valley Power Station - Process Gas (H2)	Node #	1.2
Node Boundaries:	Hydrogen from High Pressure panel MHI pressure control	Revision Date:	27-Jan-22
Design Intent:	Pressure reduction from 50 barg to 15 barg to supply MHI (Melco unit)	Material / Chemical:	Hydrogen
Design Conditions, Operating Envelope	Design Pressure - TBC, Design Temperature - TBC	Drawing:	HPP-AEC-MEC-HY-GEN-DRG-1124

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.1	Flow - High	Pressure reduction unit fails open.	High flow of Hydrogen to generator.	PSV set at 900 kPag. Pressure Transmitter with high pressure alarm downstream of H2 pressure reduction unit.	No action						
1.2.2	Flow - Misdirected	Valve downstream of PRV to vent line open.	H2 venting to vent pipe. Loss of H2.	The vent valve is normally closed.	Review valve fail positions and requirements of locking valves closed. Add valve Failure positions to the PID	AECOM	Lock normally closed valve in question closed.	Ph.1			
1.2.3	Pressure - High	PSV vents into common vent header. Very unlikely to have both RV's opening at the same time.	High back pressure at PSV outlet which may impact PSV operation.	40mm Vent line is connected to 80mm vent line and larger vent stack so high backpressure is unlikely.	Review vent line size and confirm large enough size for the number of RVs connected. Review choke velocity in vertical vent pipe and common vent header Review design pressure of vent line,	AECOM	Size of the PSV and the exhaust line to be based on the PRV orifice nozzle being sized on passing 150% of the GTG recharging rate of 715 Nm^3/hr at 1500 kPag	Ph.1			
1.2.4	Flow - Reverse flow	Air reverse flow into vent lines from vent stack.	Possible explosive mixture of air and gas.	None	Review vent stack design - potential for liquid seal at base of vent stack to avoid reverse flow of air.	AECOM	A liquid seal and combined flame trap to be installed at the base of the vent stack to isolate H2 from air entering the stack	Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.5	Instruments and control system	Location of ESD on common supply to both generators and will shut off supply to both generators if closed.	If ESD is too far away from the end supply panel there may be a larger quantity of H2 that supplies a fire due to quantity in the line.	H2 lines are small and will not hold a significant amount of H2 so consequence is expected to be minor.	Review the best location for ESD valve isolating H2 supply from GTs. Consider two ESD valves, one on the supply to each generator.	AECOM	ESDs for each GT should be located at the start of the branch lines to each GT so the ESD closure is only to the GTG with the problem so a GT running normally is not affected by the other's abnormal operation.	Ph.1			
1.2.6	Instruments and control system	Remote operated depressurising.	Allows remote depressurising of the line in event of a fire.	The volume in the 25mm line is small compared to the volume in the trailer and cylinders.	Review requirement for remote line depressurising in event ESD valves closing.	AECOM	H2 line depressurisation is a last resort action and should not be carried routinely for a GT shutting down as the gas supply is continuously required for topping up each generator. Venting the line down risks introducing air and water vapour into the H2 gas line with associated explosion risk. Additionally it may risk expensive damage to the GTG internals in the presence of CO2 and water vapour.	Ph.1			
1.2.7	Maintenance	Hydrotesting and then blow through with dry air.	Water ingress to the generator.		Hydrotest only to be done up to removable spool for each generator. Procedures for testing to prevent water being carried into the generator.	Snowy Hydro		Ph.2			
1.2.8	Pressure - High	PRV of MHI pressure reduction panel has been increased to 800 kPag from 700 kPag to allow for pressure drop between the process gas area and the generator. PSV set point has also been increased from 800 to 900 kPag	Changes in design may not be captured properly between AECOM and MHI		Advise MHI of distance between process gas area and generator at each unit. MHI to advise whether pressure increase is acceptable for the pressure reduction panel	AECOM MHI		Ph.1 Ph.1			

Table 20 Process Gas (Carbon Dioxide - CO_2) - Node 1.3

Project / Facility:	60666845 Hunter Valley Power Station - Process Gas (CO2)	Node #	1.3
Node Boundaries:	CO2 Bottles to Pressure regulating panel and to MHI supplied (Melco) panel	Revision Date:	27-Jan-22
Design Intent:	Pressure reduction from Bottle pressure (137 brag) to 50 brag	Material / Chemical:	Carbon Dioxide
Design Conditions, Operating Envelope	Design Pressure - TBC, Design Temperature - TBC	Drawing:	HPP-AEC-MEC-HY-GEN-DRG-1102

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.3.1	Flow - Reverse	Reverse flow from generator if Bottles empty/low .	Flow from pipes back into bottles.	Pressure in supply line is normally higher	Review requirement for NRV in system.	AECOM	Additional check valves to be installed immediately downstream of the first fixed pipework isolation valve (32NB Note 2) and immediately before the 40NB branch isolation valves upstream of the removable spools.	Ph.1			
1.3.2	Pressure - High	High pressure from CO2 gas cylinders.	Overpressure of downstream equipment.	PSV set at 770 kPag.	Review piping spec to ensure piping downstream of the PRV and inside the CO2 high pressure regulating panel is designed for maximum pressure supplied by cylinders.	AECOM	Pipework from the cylinders to be rated for 200 brag CL1500 to allow for HP PRV failure or leakage. From the 700barg PRV the weight of pipe can be reduced to CL600 as there is adequate protection from two LP PSVs.	Ph.1			
1.3.3	Maintenance	Hydrotest - drains/connections to drain water from the piping. Upstream isolation valve provided upstream of pressure reduction panel.	Water remaining in pipework.	Sufficient outlets provided in current design. N2 not connected when not in use. This connection is accessible (above ground) and can be used.	no action						
1.3.4	Maintenance	Access to replace cylinder pack	Fork lift access under roof cover.		Review method for getting CO2 cylinders from under roof cover (when cylinder packs are being replaced).	AECOM	CO2 cylinders will be racked and the racks are designed to be handled by fork hoists, hiab lifts or craned. Building roof line of covering building must be high enough to allow fork hoist access.	Ph.1			
1.3.5	Flow - low	CO2 quantity stored/connected.	Insufficient quantity for generator purging.	CO2 storage of 4 pallets in current design allows for purging of H2 and then purging of air for 2 generators.	No action						
1.3.6	Loss of containment	Leaks will be vented to atmosphere.	CO2 will dissipate - no major consequence.	none	No action						
1.3.7	Instrument and control system	Local pressure Indication on	Cannot be monitored remotely.	Pressure transmitter on outlet of pressure	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
		pressure reduction panel.		reduction panel. CO2 used for purging only and used infrequently. Purging is a manned operation.							
1.3.8	Instruments and control system	No provision for automatic addition of CO2 to be activated in an emergency.	CO2 system is controlled manually.	CO2 always connected but only used during maintenance.	Is an emergency activation of CO2 purging required? (i.e. can this wait until an operator is present which maybe an hour later) To be confirmed in the MHI HAZOP. MHI to review operating manual and confirm. Emergency venting of CO2 on the MHI Malco panel upstream of the generator. If there is a fire is venting of the Hydrogen and purging with CO2 for the generator required. CO2 is added to the generator via manual valves (no automated valves)	MHI	There is no automatic emergency venting of the GTG cooling circuit. Venting of H2 and purging with CO2 is a manual operation under the control of an operator at all times. Emergency venting of hydrogen is not recommended - the gas is safer locked inside the GTG cooling circuit where it cannot ignite.	Ph.1			

Table 21 Process Gas (Nitrogen - N_2) - Node 1.4

Project / Facility:	60666845 Hunter Valley Power Station - Process Gas(N2)	Node #	1.4
Node Boundaries:	N2 Bottles to Pressure regulating panel	Revision Date:	27-Jan-22
Design Intent:	Pressure reduction from Bottle pressure (137 brag) to 8 brag	Material / Chemical:	Nitrogen
Design Conditions, Operating Envelope	Design Pressure - TBC, Design Temperature - TBC	Drawing:	HPP-AEC-MEC-HY-GEN-DRG-1102

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.4.1	Flow - no flow	Requirements for BOP N2 supply.	Currently no supply of N2 to Balance of plant area.	none	Review requirement for N2 supply to the NG equipment and other areas on the Balance of Plant. Confirm whether forklifts can be used to take N2 bottles to the BOP when needed.	AECOM		Ph.1			
1.4.2	Pressure - High	High pressure from N2 cylinders.	Overpressure of downstream equipment.	Two pressure reduction valves. Relief valves downstream of PRV. The piping is designed for the maximum pressure of gas cylinders	Review piping spec to ensure piping downstream of the PRV and inside the N2 high pressure regulating panel is designed for maximum pressure supplied by cylinders	AECOM	Extra high pressure gas cylinders usually used at Colongra site	Ph.1			
1.4.3	Contaminants	Reverse flow of N2 to diesel tank.	N2 flowing to diesel tank. No major consequence expected	There is a vent on diesel tank to remove N2.	No action						
1.4.4	Maintenance	Time for shutdown/maintain general system equipment.	No significant consequence. System is run infrequently. Adequate downtime for maintenance of equipment.	Order enough N2 bottles before a shutdown.	No action						
1.4.5	Flow - no flow	Quantity of N2 required for purging the diesel system may be too low.	Only very small volume of N2 is required to ensure there is an air gap in the pipe.	Volume of N2 is small between purge credit valves B and C. Required to meet AS for purging fuel lines.	No action		As per AS purging requirements				
1.4.6	Maintenance	Access to replace cylinder pack.	Fork lift access under roof cover.		Review method for getting N2 cylinders from under roof cover (when cylinder packs are being replaced).	AECOM	1.4.7	Ph.1			

Table 22 Process Gas (H_2, CO_2, N_2) - Overview

Project / Facility:	60666845 Hunter Valley Power Station - Process gas	Node #	Overview
Node Boundaries:		Revision Date:	27-Jan-22
Design Intent:		Material / Chemical:	Hydrogen/ Carbon Dioxide/ Nitrogen
Design Conditions, Operating Envelope		Drawing:	HPP-AEC-MEC-HY-GEN-DRG-1100/1102/1124

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.5.1	Materials of construction - piping, valves	Potential for leaks from H2 piping.	Loss of H2 and potential fire if ignited.	Appropriate procedures for tightening connections used for H2 and other gases. Piping is generally welded for H2 service.	No action						
1.5.2	Hazardous substances	H2, N2, CO2 stored away from other chemicals.	Chemical interactions of DGs.	No incompatible Dangerous Goods or hazardous substances stored in the same area as the process gases.	No action						
1.5.3	Physical damage	Pressure regulating panels by impact with vehicles.	Damage to pressure regulating panels by impact from vehicles.	none	Review requirement for separation bollards between H2 trailer and reduction panels.	AECOM		Ph.1			
1.5.4	Hazardous substances	Second H2 Trailer causing an additional hazardous area when replacing empty trailer with full trailer.	Potential to create hazardous area in another area of the site.	Talk to BOC to provide two trucks to move the trailer. Backup supply of H2 bottles provide 5 days supply and generator can operate for 24 hours without the pressure reaching the low alarm.	Talk to BOC about changeover of the H2 trailers and timing of delivery. Look at possibility of providing two trailer parking spaces next to each other to allow for easier changeover with one prime mover.	Snowy Hydro AECOM		Ph.2 Ph.1			
1.5.5	System testing	H2 vent pipe	Thermal radiation from H2 vent pipe.	Fire safety study is being undertaken to determine radiation impacts.	Review if any barricade are required for the H2 vent area.	AECOM		Ph.1			
1.5.6	Natural hazards	Ember attack from bushfire.	No major consequence expected as materials of construction will not be effected by embers.	Materials of construction.	no action						
1.5.7	Procedures - development and documentation	O&M manual for system.	Incorrect operation and maintenance of system.		O&Ms to be developed	Snowy Hydro		Ph.2			

Table 23 Process Gas (Instrument Air) - Node 1.1

Project / Facility:	60666845 Hunter Valley Power Station - Instrument Air	Node #	1.1
Node Boundaries:	Instrument air from Instrument air Package to Air Receivers	Revision Date:	28-Jan-22
Design Intent:	Deliver Inst air to IA Receiver (1 at each GT and 1 at BOP)	Material / Chemical:	Instrument Air
Design Conditions, Operating Envelope	Op Pressure: 900 kPag (Design Pressure:1000 kPag Op Temperature: 40 deg C (Design Temperature: 65 deg C)	Drawing:	HPP-AEC-MEC-CP-IAS-DRG-1060-B/1118-B, HPP-AEC-MEC-CP-IAS-DRG-1061-B/1120-B

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.1	Flow - low	Purge air flow for gas turbine cooling air pipe too low.	Inadequate air for purging and other requirements on the PI.	Air receivers are sized to provide adequate air to power islands and BOP. Receivers have a 5 minute hold up time.	Confirm hold up time of 5 min of receivers is adequate. Check RFI response from MHI. Confirm all GT air consumptions with MHI.	AECOM and MHI		Ph.1			
1.1.2	Instrument and control system	Overuse of one air compressor.	Higher maintenance or failure rate of one compressor.	Lead/lag control of duty/standby compressors.	Review the lead/lag control by doing a setback in the control system.	AECOM		Ph.1			
1.1.3	Flow - reverse	Valves downstream of compressor closed.	Potential damage to compressor.	There is usually a NRV on discharge side of compressor.	No action						
1.1.4	High level	Build-up of condensate in KO drum within the compressed air package.	KO drum may have a high level of water which could lead to carry over of water.	There is usually automatic drainage on the knock out drum.	Confirm there is an automatic system for removing water level in air knock out drum downstream of the compressor.	AECOM		Ph.1			
1.1.5	High Pressure	Blockage in compressor outlet.	Overpressure of downstream equipment/ piping.	Package will include a PSV .	No action						
1.1.6	Instrument and control system	Instrument information transmitted from package.	Operators unable to diagnose the problem with the IA package remotely.	Normally a run/or not running and fault code is output from the package. The spare compressor will start automatically.	Review the need to provide detailed instrument information from the compressors/dryer packages to the DCS for remote analysis. The aim is to provide enough information as to whether to send an operator to the site after hours.	AECOM		Ph.1			
1.1.7	Contaminants	Filters not adequately specified for site	Air filter may block.	Filters on inlet and outlet of dryers.	Review specification to check the full range of ambient	AECOM		Ph.1			

		ambient conditions.			conditions are covered including wet air so vendor will select the appropriate type of filter.						
1.1.8	Contaminants	Oil in Inst Air.	Fouling of equipment.	Oil less compressor is specified.	No action						

Table 24 Process Gas (Instrument Air) - Node 1.2

Project / Facility:	**60666845 Hunter Valley Power Station - Instrument Air**	**Node #**	**1.2**
Node Boundaries:	Instrument air from Instrument air Receivers to users at GT and BOP	**Revision Date:**	28-Jan-22
Design Intent:	Deliver Inst air to users	**Material / Chemical:**	Instrument Air
Design Conditions, Operating Envelope	Op Pressure: 700 kPag (Design Pressure:1000 kPag Op Temperature: 40 deg C (Design Temperature: 65 deg C)	**Drawing:**	HPP-AEC-MEC-CP-IAS-DRG-1063-B, HPP-AEC-MEC-GN-GEN-DRG-1160-A

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.1	Pressure - High	Pressure control valve fails open.	Pressure too high in downstream equipment.	PSV on IA distribution lines after PCV on header.	No action						
1.2.2	Level - high	High level of condensate in air receivers.	Water accumulation in air receivers if the air dryers aren't working properly.	Automatic liquid traps on instrument air receivers. Only very small amounts of liquid are expected in these tanks.	No action						
1.2.3	Pressure - High	Blockage on outlet of air receiver while compressor is running.	Overpressure of tanks.	PSV on each receiver tank.	No action						
1.2.4	Loss of containment	Leak at flanges or valves.	Loss of air pressure in pipe.	Low pressure alarms.	No action						
1.2.5	Maintenance	Receiver maintenance.	No duty receiver. GT cannot operate when corresponding receiver needs to be maintained.	Maintenance on the AR scheduled when the GT are serviced. AR will have infrequent maintenance only. (10 yearly).	No action						
1.2.6	Instrument and control system	Plant trip on low IA pressure.	Unnecessary plant trip.	Low low pressure trips on IA supply lines downstream of receivers.	Remove low low pressure trips on IA supply lines downstream of air receivers. Leave low pressure alarms. MHI have a low pressure alarm on instrument air system. On the GT there are 3 bleed valves that are kept shut. If the air pressure drops the air valves open and the GT trips.	AECOM	PID updated	Ph.1	28/01/2022		
1.2.7	Flow - low	Potential to large flow of IA to CEMS required.	Reduced IA flow to other users.	none	Review CEMS IA consumption requirements. Add CEMS usage to IA consumption calculation if a large IA consumption is required.	AECOM	No large use expected - CEMS unit could be calibrated with IA. Package may also have valves that require IA. TBC by CEMS supplier	Ph.1			

Table 25 Process Gas (Service Air) - Node 1.3

Project / Facility:	60666845 Hunter Valley Power Station - Service Air	Node #	1.3
Node Boundaries:	Service air from Service air Package to Service Air Receivers	Revision Date:	28-Jan-22
Design Intent:	Deliver Service air to Receiver (1 at BOP)	Material / Chemical:	Service Air
Design Conditions, Operating Envelope	Op Pressure: 900 kPag (Design Pressure:1000 kPag Op Temperature: 40 deg C (Design Temperature: 65 deg C)	Drawing:	HPP-AEC-MEC-CP-PAS-DRG-1110/1111/1112/1126/1127

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.3.1	High level	Build-up of condensate in KO drum within the compressed air package.	KO drum may have a high level of water which could lead to carry over of water.	Usually there is automatic drainage on the knock out drum.	Confirm there is an automatic system for removing water level in air knock out drum downstream of the compressor.	AECOM		Ph.1			
1.3.2	High flow	Liquid build-up in refrigerated dryer package.	Water carry over to service air.	Drain on evaporator to remove water.	Confirm there is the facility for water removal in the evaporator in package.	AECOM		Ph.1			
1.3.3	Instrument and control system	Instrument information transmitted from package.	Operators unable to diagnose the problem with the SA package remotely.	Normally a run/or not running and fault code is output from the package The spare compressor will start automatically.	Review the need to provide detailed instrument information from the compressors/dryer packages to the DCS for remote analysis. The aim is to provide enough information as to whether to send an operator to the site after hours.	AECOM		Ph.1			
1.3.4	Instrument and control system	Overuse of one air compressor.	Higher maintenance or failure rate of one compressor.	Lead/lag control of duty/standby compressors.	Review the lead/lag control by doing a setback in the control system.	AECOM		Ph.1			
1.3.5	Contaminants	Filters not adequately specified for site ambient conditions.	Air filter may block.	Filters on inlet and outlet of dryers.	Review specification to check the full range of ambient conditions are covered including wet air so vendor will select the appropriate type of filter.	AECOM		Ph.1			
1.3.6	Contaminants	Oil in Service Air.	Fouling of equipment.	Oil less compressor is specified.	No action						
1.3.7	Maintenance	Commonality of service provider.	Different service provider for each compressor.	SA and IA packages are likely to be provided by the same vendor.	Consider common vendor for IA and SA packages to reduce need for multiple service agents.	AECOM/ Snowy Hydro		Ph.1			
1.3.8	Temperature-Low	Dew point of Service air is 4 deg C.	Service air maybe too wet for the purging service of the air nozzles.				MHI has no specific requirement for a maximum dew point temperature for the service air				

Table 26 PROCESS GAS (SERVICE AIR) - NODE 1.4

Project / Facility:	60666845 Hunter Valley Power Station - Service Air	Node #	2.4
Node Boundaries:	Service air from Air Receivers to users at GT and BOP	Revision Date:	28-Jan-22
Design Intent:	Deliver Service air to users	Material / Chemical:	Service Air
Design Conditions, Operating Envelope	Op Pressure: 700 kPag (Design Pressure:1000 kPag Op Temperature: 40 deg C (Design Temperature: 65 deg C)	Drawing:	HPP-AEC-MEC-CP-PAS-DRG-1112/1113

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.4.1	Low Flow	Service air compressor sizing for maximum demand,	If the air flow is not sufficient the air nozzles on the GT may have excessive coking which will lead to high demand for maintenance.	The service air compressor is sized for the maximum flow demand. Large purge air requirement for GT is to cool the air nozzles for the fuel oil system and prevent the coke build up.	No action		MHI confirmed that 1200 nm3/h for two GT is required for 960 minutes. 16 hours is the maximum purge time. It could be a common occurrence that both GTs are shutdown at the same time and the fuel oil line purging is required.				
1.4.2	Flow - Reverse	Purge air flowing from the piping to receiver due to closed valves downstream of air receiver.	No air purging of system .	NRV upstream of air receiver.	Confirm with MHI there are NRVs at the fuel module to prevent backflow into the SA system from high pressure purge air.	AECOM / MHI		Ph.1			
1.4.3	Level - high	High level of condensate in air receivers.	Water accumulation in air receivers if the air dryers aren't working properly .	Automatic liquid traps on instrument air receivers. Only very small amounts of liquid are expected in these tanks.	No action						
1.4.4	Temperature - low	Low ambient temperature.	Corrosion in the service air pipes from condensation in line at low temperatures Lines are carbon steel.	none	Include drainage of water in the long length of pipeline to the GT and also operation during cold temperatures i.e. freezing.	AECOM		Ph.1			
1.4.5	Temperature - low	Water accumulation in SA piping.	Corrosion in carbon steel pipes which could lead to rust/ scale in pipelines.	none	Consider using stainless steel for SA pipes.	AECOM - MECH		Ph.1			
1.4.6	Pressure - High	Blockage on outlet of air receiver while compressor is running.	Overpressure of air receiver.	PSV on the air receiver.	No action						
1.4.7	Pressure - Low	Leak at flanges or valves.	Loss of air pressure in pipe.	Low pressure alarms	No action		MHI said the pressure is not critical				

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.4.8	Instruments and control	Both duty/standby compressor not working.	No flow to cooling purge which could cause coke formation on the air nozzles which may block.	Two 100% duty compressor/dryer packages.	Confirm there is triple redundant pressure indication on instrument and service air purging to the diesel system for pre start condition.	MHI	The system at the gas turbine has a strainer. However, there is not pressure measurement or DP alarm For start-up on diesel the availability of service air is a permissive for starting the gas turbine.	Ph.1			
1.4.9	Flow - low	One common air receiver for service air.	Air supply for purging of the air nozzles after shutdown.	Sizing of compressors to meet the maximum demand of service air flow.	Review requirement for using individual air receivers on the power island compared to one receiver on the BOP.	AECOM		Ph.1			
1.4.10	Flow - low	Both duty/standby compressor not working.	No flow to cooling purge which could cause coke formation on the air nozzles which may block.	Two 100% duty compressor/dryer packages.	Consider installation of a temporary compressor fittings for attachment of hire compressors for IA and SA.	AECOM	Assume dryer operating and only compressors have failed. Connection point for portable compressor added upstream of the air dryers on one of the IA and one of the SA packages. RFI to be raised with SH if a temporary dryer is also to be bought onto site or if only a compressor that will be installed upstream of the IA and SA dryer will be required.	Ph.1			

Table 27 Process Gas (Instrument And Service Air) - Overview

Project / Facility:	60666845 Hunter Valley Power Station - Instrument and Service Air	Node #	Overview
Node Boundaries:		Revision Date:	28-Jan-22
Design Intent:		Material / Chemical:	Inst and Service Air
Design Conditions, Operating Envelope		Drawing:	HPP-AEC-MEC-CP-IAS-DRG-1060/1061/1062/1118/1120, HPP-AEC-MEC-CP-IAS-DRG-1063 HPP-AEC-MEC-GN-GEN-DRG-1160, HPP-AEC-MEC-CP-PAS-DRG-1110/1111/1112/1126/1127, HPP-AEC-MEC-CP-PAS-DRG-1113

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.5.1	Materials of construction - piping	Corrosion	Damage to pipework and loss of instrument/service air.		See comments	AECOM	note on material made on node 1.4 Consider using stainless steel for SA pipes	Ph.1			
1.5.2	Physical damage	Rain/wind severe weather events.	Damage to equipment due to weather.	Compressors/dryers are inside enclosure	No action						
1.5.3	Maintenance	No access to the top of receiver tanks.	Difficulties of maintaining the PSVs on receivers.	none	Ensure there is access for EWP to remove PSV's for maintenance.	AECOM		Ph.1			
1.5.4	Environmental impact	Liquid effluent (water)	Oil less compressors specified.	Effluent discharged to trade waste system.	No action						
1.5.5	Procedures	Confined space inside air receiver.	Entry and egress while inspecting the internal surface.	Manhole shown on receivers on P&ID.	Review vessel dimensions to cater for inspection entry and requirement for confined space access.	AECOM		Ph.1			

Service Water, Demin. Water, Waste & Effluent Systems

Table 28 Service Water System - Node 1.1

Project / Facility:	**60666845 Hunter Valley Power Station - Service water**	**Node #**	**1.1**
Node Boundaries:	Potable water supply to Service water tank and other users e.g. amenities and safety showers	**Revision Date:**	01-Feb-22
Design Intent:	Supply of potable water to service water tank and other site users of potable water	**Material / Chemical:**	Water
Design Conditions, Operating Envelope	Supply pressure: TBC A booster pump may be required to allow water to be supplied to the service water tank	**Drawing:**	HPP-AEC-MEC-PW-SMS-DRG-1050

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.1	Flow - High Flow	Higher flow than expected in HWC supply connection header.	Unlikely to occur, pressure from HWC connection is not capable of flows higher than the system is rated for .	HWC metering system and site metering system.	No action						
1.1.2	Flow - No Flow	Interruption to HWC supply	No water supply to site. Interruptions to site operation.	HWC metering system and site metering system. Water storage tank is sized to allow 10 hours of GT operation with the demin plant operating.	Review the requirements for backup water supply in event of loss of water.	AECOM	Water supply to site is critical. Header tank on the roof could be used for water to toilets.	Ph.1			
1.1.3	Flow -Low Flow	Loss of water supply from HWC connection	Loss of water supply to safety showers. Site cannot operate.	Water storage tanks on site.	Review back up water supply for critical services i.e. safety showers.	AECOM	Safety showers are supplied from the potable water supply upstream of service water tank so if supply is lost there will be no supply to the safety showers	Ph.1			
1.1.4	Temperature - low	Low ambient temperature at site	Freezing of water in small diameter pipelines. It is not expected the large diameter lines would freeze. However, the water pipelines are above ground which , increases the risk of freezing.	Winterisation considerations included in the detailed design (for example insulation)	Review potential impacts of extreme cold weather event and the impact of small drain lines freezing would have on site operation. Drain lines to be kept short to reduce risk of freezing.	AECOM	Supply line to service water tank is underground	Ph.1			
1.1.5	Temperature - high	High ambient temperature at site.	Hot water heated by solar radiation to safety showers may cause a burn injury.	Safety shower design as per the AS standards. AS states water temperature should be tepid (16 to 38 deg C)	Consider underground PE piping to safety showers and whether a heater is required in winter.	AECOM		Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.6	Contaminants	Service water may be mistaken as potable water and used for drinking water.	Service water used as potable water.	Site operating instructions and piping labelling.	Construction partner to check the Snowy hydro standard for labelling pipeline and label pipes after construction and before commissioning.	UGL/ Snowy Hydro		Ph.2			
1.1.7	Contaminants	Ability to sample the potable water supply line due to low water use.	Water aging and low residual chlorine.	Potable water tank has a sample point. Closed system.	Add a sampling point to potable water line downstream of the site water meter and upstream of the service water tank. Consider facility for potable water lines to be flushed through into the service water tank to replace aged water in the line with fresh water. Potable water to be tested at periodic times as specified by SH.	AECOM		Ph.1			
1.1.8	Maintenance - Maintainability	Valves not functioning properly/requires maintenance and needs to be taken offline.	Unable to maintain valves on supply line if they cannot be taken offline.	Most valving/equipment can be bypassed for maintenance as per current P&ID.	Consider isolation immediately after HW metering facility to allow ability to maintain downstream valves.	AECOM	First valve in series will always be difficult to maintain	Ph.1			

Table 29 Service Water System - Node 1.2

Project / Facility:	60666845 Hunter Valley Power Station - Service water	Node #	1.2
Node Boundaries:	Service Water tank	Revision Date:	01-Feb-22
Design Intent:	Storage of service water on site in case of supply interruptions from Hunter Water	Material / Chemical:	Water
Design Conditions, Operating Envelope	Design assumes ambient conditions	Drawing:	HPP-AEC-MEC-PW-FPS-DRG-1052

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.1	Maintenance - maintainability	Tank taken out of service for maintenance.	Isolation of tank causing loss of water from tank.	Valves shown on all tank nozzles except for the overflow, supply line and the LALL switch. Overflow line and Instrumentation would not require isolation if tank were taken out of service.	Review tank outlets/connections - all nozzles to be fitted with valves for isolation	AECOM		Ph.1			
1.2.2	High level	Level transmitter fails.	Tank overfilled.	High level alarm and High High level switch and overflow line.	Replace level switch (LS/LAHH) with another LT because of critical service of tank and add HH to level transmitter.	AECOM		Ph.1			
1.2.3	Contaminants	Biocide chemicals dosed into water for	Chemicals dosed could corrode tank	Carbon steel and painted internals including the roof.	Confirm tank paint internals on datasheet is compatible with anti-algacide chemicals	AECOM		Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
		prevention of algae growth.	material of construction.								
1.2.4	Loss of containment - leak	Leaks from tank connections/flanges.	Water leak from tank.	Drains under tanks.	Ensure that drains from tank are separated on model as per P&ID.	AECOM		Ph.1			
1.2.5	Maintenance	Manhole diameter.	Diver entry to tank.	900 mm diameter M/H on the side of the tank.	Review size of hatch on tank roof to facilitate access for diving. Consider 900mm opening.	AECOM		Ph.1			
1.2.6	Maintenance	Tank hatch open during maintenance.	Access into tank hatch for unauthorised personnel.	Site procedures for confined space access.	Confirm that there are facilities to install a barriers around hatch.	AECOM		Ph.1			

Table 30 Service Water System - Node 1.3

Project / Facility:	60666845 Hunter Valley Power Station - Service water	Node #	1.3
Node Boundaries:	Service water pumps to Gas turbines Evaporative Coolers	Revision Date:	01-Feb-22
Design Intent:	Supply of service water to gas turbine air inlet evaporative coolers	Material / Chemical:	Water
Design Conditions, Operating Envelope	Discharge Pressure of service water pumps is 750 kPag (TBC)	Drawing:	HPP-AEC-MEC-PW-FPS-DRG-1051

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.3.1	Low flow	Loss of a pump.	Loss of GT efficiency, running at lower capacity.	Duty/Duty/Standby arrangement of pumps.	No action						
1.3.2	High flow	Three pumps running.	PCV for minimum flow kick back will open at high pressure.	Duty/Duty/Standby arrangement of pumps.	No action						
1.3.3	Low flow	Standby pump takes too long to supply water.	GT running at lower capacity.	None	Confirm timing of third forwarding pump starting and affecting GT operation. Provide buffer time in evaporative cooler tank at GT	MHI		Ph.1			
1.3.4	High flow	Shut off valve downstream of Forwarding Pumps at evaporative water tank closes.	Potential water hammer in piping.	There are other users of service water e.g. Demin plant. The pipe sizes are designed for low velocities so piping hammer analysis is not required.	No action						
1.3.5	Contaminants	Larger sizes of solids in water to pumps.	Pump damage.	Strainers on pump inlet.	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.3.6	Contaminants	Reduction of Chlorine level in the service water over time.	Growth of algae in the water.	Potable chemical injection package included in current design.	Review use and quantities of portable chemical injection package. Check the quantities of chemicals in this package are kept under the DG minor storage thresholds.	AECOM	Package can be brought to site on a temporary basis for dosing.	Ph.1			
1.3.7	High pressure	PCV in pump kick back closed.	Measurement of pressure in pump kickback line during commissioning.	Local pressure indicator on pump discharge.	Review the requirements for pressure indicator upstream of kickback PCV in minimum pump flow line.	AECOM		Ph.1			
1.3.8	Instruments and control system	In the event of fluctuating pressures pumps may stop/start regularly.	Pump reliability issues.	Control philosophy includes parameters for pumps starting/stopping sequence	Review methods for smoothing or minimising the number of pumps starts. Contemplate scenario of leakage and no other flow . Consider whether an accumulator or jockey pump is required for small flows. Check if there is a signal from the GT whether the evaporative cooler is operating and the need for 1 or 2 pumps operating	AECOM MHI		Ph.1 Ph.1			

Table 31 Demineralised Water System - Node 1.4

Project / Facility:	60666845 Hunter Valley Power Station - Demin Plant	Node #	1.4
Node Boundaries:	Service water pumps to Demin Plant (RO Pumps)	Revision Date:	01-Feb-22
Design Intent:	Supply of service water to RO pumps	Material / Chemical:	Water
Design Conditions, Operating Envelope	Discharge Pressure of service water pumps is 750 kPag (TBC)	Drawing:	HPP-AEC-MEC-PW-FPS-DRG-1051, HPP-AEC-MEC-DW-WTS-DRG-1055 HPP-AEC-MEC-DW-WTS-DRG-1056

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.4.1	Low flow	Service water supply to demin package from discharge of pumps.	No water supplied to demin package.	3 service water pumps.	Review potential to provide direct connection from potable water supply upstream of service water tank to demin package.	AECOM	Minimum pressure required for Demin package is 200 kPag. Consider if flow is restricted to the demin plant when filling the FW tanks	Ph.1			
1.4.2	Instruments and control system	Instruments from demin package interface with DCS.	Operators at remote location unaware of alarms from demin package.	Vendor packages have common alarm provided in DCS.	Measured values and alarms from demin package PLC to be available for mimic on the DCS for monitoring remotely by operators.	AECOM	PLC based skid The DCS will mimic the status and alarms of the demin plant skid DCS will have supervisory control over the skid	Ph.1			
1.4.3	Reverse flow	Backwash water flowing to service water tank via the recycle line.	Backwash water to service water tank.	NRVs between service water lines. Automated valves on inlet to sand bed filter switch position during backwash.	No action						

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
				PCV is set at a higher pressure than back wash pump pressure.							
1.4.4	Loss of containment	Breakthrough of contaminants through filter caused by rat-holing.	Low pressure differential measurement across filters.	Indication of break through via pressure differential measurement.	No action						

Table 32 Demineralised Water System - Node 1.5

Project / Facility:	60666845 Hunter Valley Power Station - Demin Plant	Node #	1.5
Node Boundaries:	RO System pumps and units to demin tank including RO reject water to neutralisation pit	Revision Date:	01-Feb-22
Design Intent:	Supply of Demin water to Demin water tank	Material / Chemical:	Demin Water
Design Conditions, Operating Envelope	Discharge Pressure of RO pumps (TBC)	Drawing:	HPP-AEC-MEC-DW-WTS-DRG-1056

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.5.1	Low Flow	Failure of pump inside package.	Loss of 50% of supply.	Site maintenance procedures.	Review requirements for duty/standby pumps within the packages or requirement to keep uninstalled spares. Alternatively, increase capacity of package to 55m3/h which removes the need for 2 packages to operate simultaneously to supply demin for 3 days continuous operation of GT on diesel.	AECOM	Note: It is usually not practical to source demin water from outside sources. However, facilities have been provided to fill the demin tank from a tankers. Both packages can run simultaneously to supply demin water if the level is low.	Ph.1			
1.5.2	Low Flow	High flow to neutralisation pit.	Loss of flow to demin tank.	Flow transmitter on demin line to demin storage. Low DP on RO units.	No action						
1.5.3	Contaminants	Leaks from equipment.	Potential for trips or slips.	All equipment inside contained area.	No action						
1.5.4	Instruments and control systems	Ability of Demin Plant to be started/stopped remotely.	If site is unmanned SH prefers the ability to start the package remotely.	Starting/stopping of demin package will be interfaced with DCS.	No action						
1.5.5	Composition	Biocide dosed into service water tank.	Biocide could potentially impact RO plant.	RO plant specification will include water quality information.	Notify the RO vendor of potential biocide use in the water supplied to demin package. Include in demin package specification.	AECOM		Ph.1			
1.5.6	Maintenance	Demin plant may not used for long periods of time.	Equipment may not work when required.	Site operating procedures and maintenance procedures.	Notify the vendor that demin plant may not be used for long periods of time. Confirm demin plant can cope with periods of standby.	AECOM	Demin water will require polishing. Demin plant could be run for a few hours a day to help with maintenance of the system (as per other SH plants).	Ph.1			

Table 33 Demineralised Water System - Node 1.6

Project / Facility:	60666845 Hunter Valley Power Station - Demin Plant	Node #	1.6
Node Boundaries:	Demin tank	Revision Date:	01-Feb-22
Design Intent:	Storage of Demin water	Material / Chemical:	Demin Water
Design Conditions, Operating Envelope	Ambient Conditions	Drawing:	HPP-AEC-MEC-DW-SFP-DRG-1057

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.6.1	Level - high	Level transmitter fails.	Tank overfilled.	High level alarm and High high level switch and overflow line.	Include two level transmitters instead of a LSH and LT.	AECOM		Ph.1			
1.6.2	Level - overflow	Failure of high level switch.	Demin water overflows to stormwater - pH of demin water too low to be sent to stormwater/environment.	Overflow currently shown going to storm water.	Review the overflow discharge location based on pH of demin and relocate to trade waste.	AECOM		Ph.1			
1.6.3	Low Pressure	CO2 filter on tank vent blocked.	Vacuum created in tank and not designed for vacuum.	None	Review the possibility of CO2 filter (on tank vent) blocking and causing tank to be under vacuum. Consider adding an N2 blanket in tank.	AECOM	NOTE: SH confirmed they prefer not to have N2 blanketing CO2 filter can be installed at ground level for ease or replacement and have duty / stand by arrangement	Ph.1			
1.6.4	Containment	Demin water from drains.	pH too low to be sent straight to stormwater/environment.	None	Review location of tank drains from storm water to trade waste	AECOM		Ph.1			
1.6.5	Containment	Demin from drains.	Could also be harmful to operators if demin water comes into contact with their skin/eyes.	Operators to wear PPE e.g. Safety glasses pH of demin water is likely to only be 5 (slightly acidic).	No action						
1.6.6	Maintenance	Manhole diameter.	Diver entry to tank.	900 mm diameter M/H on the side of the tank.	Review size of hatch on tank roof to facilitate diving access. Consider 900mm opening	AECOM	SH commented they would put a RO camera into the tank in preference to a person	Ph.1			
1.6.7	Maintenance	Manhole opened during maintenance.	Potential for workers to fall into open manhole. Access into tank hatch for unauthorised personnel.	Site confined space entry procedures.	Confirm that there are facilities to install a barrier around hatch and locking facility.	AECOM		Ph.1			
1.6.8	Maintenance - maintainability	Tank taken out of service for maintenance.	Water leak from tank.	Valves on tank nozzles.	Review tank outlets/connections - all nozzles to be fitted with valves for isolation.	AECOM		Ph.1			

Table 34 Demineralised Water System - Node 1.7

Project / Facility:	60666845 Hunter Valley Power Station - Demin Plant	Node #	1.7
Node Boundaries:	Demin Water Pumps to gas turbines and demin return	Revision Date:	01-Feb-22
Design Intent:	Supply of Demin water to Gas turbines for NOX Suppression	Material / Chemical:	Demin Water
Design Conditions, Operating Envelope	Discharge Pressure of Demin water pumps : 750 kPag (TBC)	Drawing:	HPP-AEC-MEC-DW-SFP-DRG-1058

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.7.1	Low flow	Flow drops off when spare pump turns on.	GT trips or NOX suppression is not adequate.	Spare pump will be started firstly by a fault on the running pump. Secondly spare pump will be started by low flow and low pressure.	Confirm if one pump is lost there is sufficient time for another pump to turn on before the flow switch trips the GT. **RFI to be raised to MHI.**	AECOM MHI	SH commented at other sites there is 15 minutes before the GT stops. MHI commented there is a low pressure switch at the GT demin pump that will trip the pump.	Ph.1 Ph.1			
1.7.2	High flow	Three pumps running.	No major consequence, line is sized large enough for this.	Third pump would shut down based on control.	No action						
1.7.3	Low flow	Orifice in demin return line from MHI scope.	MHI orifice (in return line to demin tank) may be too small to facilitate commissioning.	None	Consider bypass line around MHI orifice plate to facilitate commissioning. **Raise an RFI to MHI.**	AECOM MHI		Ph.1 Ph.1			
1.7.4	Instruments and control systems	Manual valves to direct demin water from forwarding pumps to treatment package or distribution.	No ability to switch between demin polishing/forwarding remotely through DCS.	None	Review potential to install automated valves on lines from forwarding pumps to demin treatment package for polishing and demin distribution to allow remote switchover between lines. Add polishing sequence to DCS to allow for remote operation.	AECOM	The pump is not sized to do both polishing and supplying water to the GT. Mode of operation to be selected by changing position of automated valves.	Ph.1			
1.7.5	Pressure	Leaks from pumps/seals.	Loss of demin water to environment.	All releases of demin water to go to drains to trade waste.	No action						
1.7.6	High pressure	PCV in pump kick back closed.	Measurement of pressure in pump kickback line during commissioning.	Local pressure indicator on pump discharge.	Review requirement of pressure indicator upstream of PCV.	AECOM		Ph.1			
1.7.7	Maintenance - isolation	Pumps access for maintenance.	Ability to service pumps.	Maintenance isolation valves either side of all pumps.	No action						

Table 35 Demineralised Water System - Node 1.8

Project / Facility:	**60666845 Hunter Valley Power Station - Demin Plant**	**Node #**	**1.8**
Node Boundaries:	Demin water to Filter backwash and effluent	**Revision Date:**	01-Feb-22
Design Intent:	Supply of Demin water to Demin plant for filter backwash	**Material / Chemical:**	Demin Water
Design Conditions, Operating Envelope	Discharge Pressure of Demin Pumps : 750 kPag (TBC)	**Drawing:**	HPP-AEC-MEC-DW-SFP-DRG-1057, HPP-AEC-MEC-DW-WTS-DRG-1059 HPP-AEC-MEC-DW-WTS-DRG-1055, HPP-AEC-MEC-DW-WTS-DRG-1056

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.8.1	Low Flow	Pump failure.	Loss of supply.	Standby pump/package available (TBC with Demin plant supplier).	No action		Pump control from Demin package PLC				
1.8.2	Level - high	Overfilling of tank.	Spilling to ground.	Demin system contained and sent to neutralisation pit.	No action						
1.8.3	High Pressure	Valve closed on outlet of pump.	Damage to pump/piping.	System designed for deadhead of pump.	No action						
1.8.4	Contaminants	Too many chemicals dosed	Wasting chemicals - no safety consequence	Chemicals and quantities to be dosed will be proposed by a water treatment vendor as required by the system	No action						
1.8.5	Loss of containment	Leaks from pumps/seals.	Spilling to ground.	Demin system contained and sent to neutralisation pit.	No action						

Table 36 DEMINERALISED WATER SYSTEM - NODE 1.9

Project / Facility:	**60666845 Hunter Valley Power Station - Demin Plant**	**Node #**	**1.9**
Node Boundaries:	Cleaning chemicals from demin plant to neutralisation pit	**Revision Date:**	01-Feb-22
Design Intent:	Cleaning chemicals from demin plant to treatment in neutralisation pit	**Material / Chemical:**	Demin Water, Citric Acid
Design Conditions, Operating Envelope	Discharge Pressure of CIP pumps (TBC)	**Drawing:**	HPP-AEC-MEC-DW-WTS-DRG-1059

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.9.1	Instruments and control systems	Package output to show if chemicals quantity are low.	Potential to run low on chemicals - no safety consequence.	Instrumentation within package.	Chemicals and the dosing will be proposed by a water treatment vendor as required by the system. Check there is indication for low levels of chemicals	AECOM		Ph.1			
1.9.2	High flow	Automated valves directing CIP chemicals to RO or waste to neutralisation pit not in correct position .	Large flow of waste water to neutralisation pit.	Control flow sizing.	Confirm if automated valves are not in position and there is an output into the DCS to show this. Confirm with package supplier if these valves are interlocked.	AECOM		Ph.1			

Table 37 Service Water & Demineralised Water Systems - Overview

Project / Facility:	60666845 Hunter Valley Power Station - Service Water and Demin	Node #	Overview Water and demin
Node Boundaries:		Revision Date:	01-Feb-22
Design Intent:		Material / Chemical:	Water and Demin Water
Design Conditions, Operating Envelope	Design assumes ambient conditions	Drawing:	See previous Tabs

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.10.1	Materials of construction - pumps, valves, tanks	Demin water can cause corrosion in incompatible materials.	Corrosion	All pumps/valves used for demin to be specified for demin water.	Raise RFI to SH to confirm stainless steel grade required (304 or 316).	AECOM	AECOM piping is specified as 316. MHI has put 304 SS on their PIDS for Demin water lines/ equipment 316 is more expensive than 304 SS.	Ph.1			
1.10.2	Physical damage	Vehicle impact to equipment.	Breaking/damage of equipment.	Demin water skid is not located near roads or large vehicles access.	No action						
1.10.3	Shutdown	Emergency shutdown requirement.	Impact of emergency shutdown of the demin plant on electricity network security.	Demin tank of 1.6 ML has capacity to allow running of both GT on diesel for 10 hours.	Determine desired system response in emergency shutdown (from safety perspective). Apply this to all subsystems Provide a list of impacts of any system shutdowns on ability of GT to operate.	AECOM	Demin package stoppage does not stop GT	Ph.1			
1.10.4	Environmental impact	Demin water from drains may have lower pH.	The demin water pH is too low to be sent to stormwater/environment.	Action Ref 1.6.4 to review drains that are not shown to go to neutralisation pit.	Review location of all demin drains to ensure they all go to neutralisation pit.	AECOM		Ph.1			

Table 38 FIRE WATER - NODE 1.1

Project / Facility:	60666845 Hunter Valley Power Station - Fire Water	Node #	1.1
Node Boundaries:	Water supply to Fire water Tanks	Revision Date:	02-Feb-22
Design Intent:	Water supply to Fire water Tanks	Material / Chemical:	Water
Design Conditions, Operating Envelope	TBC	Drawing:	HPP-AEC-MEC-PW-SMS-DRG-1050, HPP-AEC-MEC-FP-FWS-DRG-1070

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.1	Low flow	Leaks from flanges.	Loss of water visible. Non-Hazardous.	Tanks hold sufficient water for firefighting protection and AS2419	No action						
1.1.2	Reverse flow	Reverse flow from tank to water supply.	No flow to tanks.	RPZ valves in water supply line	No action						
1.1.3	High level	Float valve stays open.	Tank overflows.	High level alarm on tanks.	No action						
1.1.4	Low level	Float valve sticks shut.	Insufficient water in tank to fight fires.	Low level alarm on tanks.	No action						
1.1.5	No flow	Valves that are critical to supplying fire water to plant are accidentally closed.	No firewater flow to site.	Site operating procedures.	Update critical valves to be locked open e.g. for valves on fire fighting system (Show on P&ID).	AECOM	Discussion was referring about whether the drain valves on the FW tanks should be locked closed.	Ph.1			
1.1.6	Low Pressure	Pressure at water supply connection too low.	Tanks cannot be filled quickly enough to satisfy AS2419 requirements.	One Tank to be filled within 24 hours.	Confirm the pressure drop to the tank and flowrate meet the requirements of AS2419.	AECOM		Ph.1			
1.1.7	No flow	Interruption to water supply and tank to be filled by tanker.	Low level in tanks.	Spare nozzle on tank.	Review requirement for nozzle fill point on tanks for emergency tank filling by tanker.	AECOM	There is a bypass around the water fill valve	Ph.1			
1.1.8	No flow	RFS attending fire on/near site require access to water in tanks.	Escalation of fire near/on site.	Spare nozzle on tank.	Confirm that RFS connection standards are met.	AECOM		Ph.1			
1.1.9	Contamination	Water sitting in tanks for long periods.	Bacteria or sediments in tanks.	None	Review need for sample point on firewater system. Review best location for sample point i.e. one on each tank or upstream of fire water pumps.	AECOM	SH prefer the ability to sample from each tank	Ph.1			
1.1.10	Maintenance - access	Restriction of inspection of tank due to tank liner.	Cannot maintain/inspect tank.	Bladders normally connected to the wall at manway.	Review access provisions through tank liner and manhole access.	AECOM		Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.11	Maintenance	Fire water availability when tanks are out of service.	Insufficient fire water during fire event.	One tank to be taken offline at a time only to ensure 50% of firewater is always available.	No action						
1.1.12	Maintenance - maintainability	Tank taken out of service for maintenance.	Isolation of tank causing loss of water from tank .	Valves on tank nozzles.	Review tank outlets/connections - all nozzles to be fitted with valves for isolation.	AECOM		Ph.1			
1.1.13	Contamination	Biocide dosing to tank.	Damage to tank bladder.	None	Confirm tank bladder is compatible with biocides that may be required for water treatments.	AECOM		Ph.1			
1.1.14	Maintenance	Maintenance of auto fill valve.	Requirement to drain a large quantity of water from the upstream line.	Upstream isolation valve at flow meter.	Provide description of how the auto fill valve will be maintained, isolated and bypass used.	AECOM		Ph.1			

Table 39 Fire Water - Node 1.2

Project / Facility:	60666845 Hunter Valley Power Station - Fire Water	Node #	1.2
Node Boundaries:	Fire water pumps to Fire water ring main	Revision Date:	02-Feb-22
Design Intent:	Water supply to Fire water ring main	Material / Chemical:	Water
Design Conditions, Operating Envelope	TBC	Drawing:	HPP-AEC-MEC-FP-FWS-DRG-1071

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.1	Maintenance - maintainability	Diesel tank need to be refilled / topped up.	Difficult to refill / top up diesel tanks.	Tank has a manual fill connection.	Review the potential to provide auto fill from site diesel storage tanks to the smaller diesel tank near diesel driven firewater pump. If diesel tank for pump is filled manually consider manual handling requirements of how this tank is filled.	AECOM		Ph.1			
1.2.2	Maintenance	No isolation on diesel pump relief valve line return to tank.	Inability to take one tank out of service with no isolation valve.	Vendor package indicative drawing only - detailed package design to include isolation valves.	Add locked open valve on relief line. Review AS2941 to see if this is permitted.	AECOM		Ph.1			
1.2.3	Flow - low	Accumulation of silt in the balance line between tanks .	Possible blockage of balance line.	Piping design.	Review the position of balance line to minimise potential of silting in line. Confirm height of line above tank base.	AECOM		Ph.1			
1.2.4	Flow - high	Additional hydrants used during fire fighting.	Two fire pumps maybe operating.	The line will be sized for two firewater pumps operating.	No action						

1.2.5	Maintenance	Valve downstream of diesel pump PSV closed for maintenance of diesel pump.	Valve accidently left shut after maintenance.	Single PSV on diesel pump outlet because of over speed. The relief valve is not required for the electric pump.	No action						
1.2.6	Instrumentations and controls	Integration of pump package with DCS system.	Inability to remotely monitor package system alarms.	Currently common alarm and pumps status displayed in DCS. Relay of low battery alarm back to alarm panel.	Review battery system monitoring alarm interface with DCS for monitoring.	AECOM		Ph.1			
1.2.7	Temperature - high	Heating of water in firewater pump discharge.	Person standing near the TRV impacted by hot water.	Discharge directed to ground.	Review where the outlet of TRV on firewater pump outlet is to be directed and select a suitable location.	AECOM		Ph.1			
1.2.8	Flow - no	Pumps functioning (failing to start) affected due to filtering of air to the engine of the diesel pumps.	Engine overheats.	Pumps are inside a container with a ventilation system.	Review the potential for embers and overloading the air intake system in the event of a bushfire.	AECOM		Ph.1			

Table 40 OILY WATER COLLECTION & TREATMENT - NODE 1.3

Project / Facility:	**60666845 Hunter Valley Power Station - Oily Water Collection and Treatment**	**Node #**	**1.3**
Node Boundaries:	Oily water drains and Oily Water Pit	**Revision Date:**	02-Feb-22
Design Intent:	Collection of oily water drain, storage and preliminary separation to oil water separator	**Material / Chemical:**	Water / Oil
Design Conditions, Operating Envelope	Ambient Conditions	**Drawing:**	HPP-AEC-MEC-GN-GEN-DRG-1085

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.3.1	High flow	Transformers oil leak.	Large flow of oil to oily water pit	Pit is sized for spill of one transformer which is the largest expected volume of oil (100,000L) that could flow to this system. Spill of oil from 2 transformers at the same time is very unlikely.	No action		Transformer is bunded and can contain all the oil from the transformer. Drain to oily water pit has a flame arrestor to prevent transfer of any flame. Discharge valve from transformer bund is always open in case of a storm event.				
1.3.2	High level	Heavy rain event with large water inflow.	Potential for overflow of oily water pit	Emergency overflow line from the bottom of pit to overflow clean water to storm water. There will be a designated pit for overflow	No action		Pit Sized for the 100-year storm event				

1.3.3	Composition	Variations in oily water flow depending on where in the plant this is coming from.	No consequence	Oily water system designed for flow composition variations	No action						Closed
1.3.4	Contamination	Algae growth due to lack of coverage of pits and sunlight.	Blocking filters upstream of pumps.	None	Review management of algae in pit. Include in package spec and discuss potential options with vendors.	AECOM	Pit is not covered presently to prevent inflow of rain in the area of the pit	Ph.1			
1.3.5	Loss of containment	Leaking from tanks/equipment due to leaks on flanges.	Spills outside of equipment.	System is designed with concrete aprons that drain to oily water pit	No action						
1.3.6	Maintenance - access	Difficulty in access pit via ladder.	Potential injury of personnel on ladder.	None	Review use of stairs instead of ladder into pit. Look at removable type of stairs to prevent fouling of stairs.	AECOM	Pit to be maintained annually.	Ph.1			
1.3.7	Maintenance - maintainability	Oily water flowing into pit while maintenance workers are in the pit.	Potential injury of personnel in pit due to slips.	Permit to work procedures.	Review requirement for isolation of incoming drains to allow access to pit to provide correct isolation.	AECOM		Ph.1			
1.3.8	Maintenance - access	No (or limited) access for trucks to come in when required.	Cannot remove oil from decanting pit.	Adequate access for sucker truck.	No action						

Table 41 Oily Water Collection & Treatment - Node 1.4

Project / Facility:	**60666845 Hunter Valley Power Station - Oily Water Collection and Treatment**	**Node #**	**1.4**
Node Boundaries:	Oily water separator and discharge to oily water pit	**Revision Date:**	02-Feb-22
Design Intent:	Separation of oil and water to allow disposal	**Material / Chemical:**	Water / Oil
Design Conditions, Operating Envelope	Ambient Conditions	**Drawing:**	HPP-AEC-MEC-GN-GEN-DRG-1085

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.4.1	Instrumentation and controls	Instruments from oil/water package interface with DCS.	Inability to remotely monitor package system operation and alarms.	Vendor packages have common alarm provided in DCS	Confirm interface of package with DCS. Determine what information needs to be transferred to DCS.	AECOM		Ph.1			
1.4.2	Low flow	Pump failure	Flow out of oil skimmer too low.	Standby pump	No action						
1.4.3	Pressure - vacuum	Blockage upstream of filter. Positive Displacement pump creates vacuum.	Pumps continue to run and causes a vacuum in filter.	Design pressure of filter.	Confirm if piping between filter and pumps and filter is designed for a vacuum conditions.	AECOM		Ph.1			

1.4.4	Maintenance - maintainability	System may not be used for extended period of time.	Equipment may not work as expected e.g. sludge build up in system.	Vendor package design	Vendor supplier to confirm if oil water separator does not operate for a period of time what (if any) effects this would cause on the reliability of the unit. Specification of package to include mention of extended periods on downtime.	AECOM	Separator package may need to be run when not required to keep all equipment working properly	Ph.1			
1.4.5	Temperature - low	Low ambient temperature and infrequent operation.	Freezing of water in small diameter pipework or instrument lines.	Vendor package design	Review potential impacts of winter operation. Include in specification that unit needs to operate during low ambient conditions	AECOM		Ph.1			
1.4.6	Maintenance - maintainability	Low flows causing sludge build up in pit.	Difficult to clean thick sludge from pit.	None	Review the operational area of the skimmer pit. Consider sloped floor on main pit to concentrate sludge for ease of cleaning and allow oil/ water to be diluted.	AECOM		Ph.1			
1.4.7	Contaminants	Leaks from flanges in package.	Spills of oil to ground.	Slop tank and oily water separator package to be located inside self-bunded concrete apron to catch spills	No action						
1.4.8	Electrical safety	Decomposition of biological material producing H2S in slops tank.	Affect on workers and possible creation of Hazardous area.	None	Ensure vent location is at an adequate height to disperse any hazardous vapours.	AECOM	This isn't expected as this does not occur at Colongra.	Ph.1			

Table 42 Oily Water Collection & Treatment - Node 1.5

Project / Facility:	60666845 Hunter Valley Power Station - Oily Water Collection and Treatment	Node #	1.5
Node Boundaries:	Discharge of waste water to Stormwater	Revision Date:	02-Feb-22
Design Intent:	Discharge of clean water to stormwater	Material / Chemical:	Water / Oil
Design Conditions, Operating Envelope	Ambient Conditions	1	HPP-AEC-MEC-GN-GEN-DRG-1085

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.5.1	Loss of containment	Diesel spilling out of vent valve at gas turbine due to valves being left open (operator error).	Diesel / oil being discharged in turbine hall.	All diesel / oil vents should drain to oily water pit.	Review oil and diesel vent points in the GT area to ensure no diesel can flow to the stormwater discharge point. All oil vents to drain to oily water system with concrete apron.	AECOM		Ph.1			
1.5.2	Loss of containment	Big rain event during construction.	Potential for sediments to be discharged to environment.	Preliminary earthworks channel and then seal the channel quickly during construction.	Review requirements for capture during construction for containment of drainage carryover. To be reviewed in CHAIR.	AECOM		Ph.1			
1.5.3	Loss of containment	Large spill of oil due to mis-operation or failure of equipment.	Potential for oil release to the environment.	Equipment that is filled with oil is connected to the oily water system and has concrete aprons.	No action						

Table 43 Oily Water Collection & Treatment - Overview

Project / Facility:	60666845 Hunter Valley Power Station - Diesel Delivery to Gas Turbines	Node #	OVERVIEW
Node Boundaries:		Revision Date:	21-Jan-22
Design Intent:		Material / Chemical:	Natural Gas
Design Conditions, Operating Envelope	Design assumes ambient conditions	Drawing:	HPP-AEC-MEC-DS-LLS-DRG-1067/1068

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.6.1	Fire/explosion	Ignition of oil in oily water system	Damage to personnel and plant/ equipment.	May already be considered in fire safety study.	Confirm if oily water system is considered in fire safety study.	AECOM		Ph.1			
1.6.2	Fire/explosion	Flame trap maintenance is not frequent enough.	Fire traps not working when required.	Plant maintenance routines and operator checks.	Review the requirement for monitoring of fire traps liquid level and regular maintenance of fire traps.	AECOM		Ph.1			
1.6.3	Loss of containment	Concentrated spill of oil flowing to oily water pit.	Large accumulation of oil in decanting tank.	Level instrument in decanting pit.	Review potential to install a smaller initial volume within decanting pit for concentrated spills. Consider interface level detection. Review operational response to a high-level oil in the decanting pit. Review requirement for detection of high-level oils in the observation pit and how this can be achieved.	AECOM SNOWY HYDRO AECOM		Ph.1 Ph.1 Ph.1			
1.6.4	Natural hazards	Humceptor discharge level could be underwater if/when site is flooding .	Stormwater from site might be below flood level.	The flood study showed the site flood level was below site level.	Review location of humeceptor in location to highest flood level.	AECOM		Ph.1			
1.6.5	Natural hazards	Embers from bush fire can land oily water pit .	No major consequence likely. Ember unlikely to ignite oily water.	None	No action						
1.6.6	Environmental Impact	Firefighting foam from fire fighting. Large flow of liquids from the site due to storm.	Contaminants being discharged into environment. Large surge of liquid into creek.	None	Seek further guidance from SH environmental team on whether a penstock valve is required on humeceptor discharge line to the environment.	SNOWY HYDRO		Ph.1			

Table 44 Trade Waste & Sewer - Node 1.1

Project / Facility:	60666845 Hunter Valley Power Station - Trade waste	Node #	1.1
Node Boundaries:	Blade washing effluent and Blade washing Pits on each Power Island	Revision Date:	03-Feb-22
Design Intent:	Collection tank for blade washing effluent	Material / Chemical:	Water/ Detergent/ Contaminants
Design Conditions, Operating Envelope	Ambient condition	Drawing:	HPP-AEC-MEC-GN-GEN-DRG-1087

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.1.1	High flow	Wash water pit sizing too small for peak flow during blade washing.	Pit overflows	none	Confirm final pit volume is sufficient to contain all the flows from blade washing and closed loop cooling water volumes.	AECOM	Evaporative cooler blowdown water currently drains to the neutralisation pit downstream of the blade wash pit. Offline water maximum water volume with detergent is 1.5m3 (without detergent, maximum volume is 1 m3) During on-line washing there is no water drained from the exhaust duct.	Ph.1			
1.1.2	Temperature - High	Compressor blades are hot when during on-line washing.	No high temperature are expected because on-line wash water will exit via the stack because the water evaporates.	The piping is designed for 60 deg C. MHI waste water list has 35 deg C	No action						
1.1.3	Contaminants	Detergent is used during off line blade washing.	Waste water from blade washing including detergent (high chemical oxygen demand and high iron) might not be suitable for neutralisation pit / sewer connection.	There is the facility for the blade washing water to be removed by truck.	Determine if the blade washing water with detergent can be disposed to the trade waste (HWC criteria for maximum concentration). When detergent is used for off-line blade washing (approx. once a year) the GT compressor wash pit should be isolated and removed by sucker truck.	AECOM	Laverton blade washing pit is not connected to trade waste system and is pumped out by a truck. Blade washing with detergent is likely to be infrequent (once a year). MHI confirmed that detergent is used during off-line blade washing. SH confirmed detergent is used for the best clean to remove residue. The wash water is removed by a truck. Blade washing is a supervised procedure.	Ph.1			

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
					Test the blade wash water after commissioning to check analysis meets HWC criteria for trade waste. Confirm the iron concentration in wash water. Is 220 mg/l the normal concentration during off line washing?	SNOWY HYDRO MHI		Ph.3 Ph.1			
1.1.4	Contaminants	Stagnant water in pit	Algae growth. No major consequence expected.	Pit will not have water in it very often	No action						

Table 45 Trade Waste & Sewer - Node 1.2

Project / Facility:	60666845 Hunter Valley Power Station - Trade waste	Node #	1.2
Node Boundaries:	Blade washing effluent Neutralisation Pit and discharge to trade waste	Revision Date:	03-Feb-22
Design Intent:	pH adjustment for blade washing and demin effluent	Material / Chemical:	Water/ Detergent/ Contaminants
Design Conditions, Operating Envelope	Ambient condition	Drawing:	HPP-AEC-MEC-GN-GEN-DRG-1087, HPP-AEC-MEC-GN-GEN-DRG-1123

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.1	High flow	HW limitations on connection to trade waste	Neutralisation pit will not have the ability to pump out at all times	The neutralisation pit is sized to retain 2 hrs of flow capacity.	Review the neutralisation pit capacity to cater for emergency storage in the event of not having access to pump out to the trade waste.	AECOM	Maximum pump out rate maybe 17 LPS (61 m3/h) to existing 60-year-old rising main. There was an earlier pump station that was at 17 LPS pumping rate. Expected flow rate from the PS is 6 -8 LPS (25-28 m3/h). Pump out rate should be approximately 1.5 times the production rate. In future there will be a new pressurised shared sewer main (several years in the future).	Ph.1			
1.2.2	High flow	Rain water collection in pit.	Potential to overflow the neutralisation pit.	Shelter over pit.	No action		If there is no cover water can be used for dilution, however discharge to TW will be charged by volume.				

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.2.3	Level high	Transfer pumps stop operating OR SDV downstream of pumps closed.	Overflow of water from pit.	High level alarm	No action						
1.2.4	Temperature	Ambient temperatures.	No consequence								
1.2.5	Contaminants	Clean in Place chemicals used in demin plant. (Citric Acid, Ethylene diamine tetra Acetic acid, Potassium Hydroxide).	Possible chemical interactions.	Quantities will be small in volume.	Confirm the impacts of chemicals used in demin plant CIP to neutralisation pit Confirm if the concentration of COD from the CIP chemicals from the demin plant will be suitable for discharge to trade waste or whether removal by tanker is more appropriate.	AECOM	Volumes of CIP water is likely to be small (1-2 m3). HW may sample the waste from time to time Trade Waste limit on COD is 1500 mg/L.	Ph.1			
1.2.6	High pressure	Overpressure of the old HWC trade waste main.	Damage to the trade waste main.	Local pressure indicator downstream of transfer pumps.	Replace local PI with pressure transmitter downstream of transfer pumps to prove there is no damage to HWC trade waste main from the transfer pump. Review best location for this PT to measure discharge pressure.	AECOM		Ph.1			
1.2.7	Instruments and controls	Valves failure action.	Accidently discharging from neutralisation pit to trade waste caused by valve failure.	Detailed design.	SDV's downstream of the transfer pumps to HWC line to fail closed. SDV's downstream of the transfer pumps returning to pit fail open to prevent dead heading of pump.	AECOM	During discharge to the trade waste both valves can be open to maintain circulation	Ph.1			
1.2.8	Maintenance - accessibility	Pump removal for maintenance.	A roof will make pump removal more difficult.	Detailed design.	Consider removal of pump with a roof above the pit	AECOM		Ph.1			
1.2.9	Concentration of chemicals	Acid and caustic dosing.	Damage to materials of construction.	Design will consider pH and materials of pit.	Materials of pit to consider acid and caustic dosing. (Epoxy coating).	AECOM		Ph.1			
1.2.10	Concentration of chemicals	Acid and caustic dosing location too close to pump suction	High concentration of acid or caustic is discharge water	Location of dosing and pump suction.	Ensure dosing of acid and caustic is located at opposite end of pump suction and adequate recirculation time to ensure good mixing of neutralisation chemicals.	AECOM		Ph.1			

Table 46 Trade Waste & Sewer - Node 1.3

Project / Facility:	60666845 Hunter Valley Power Station - Trade waste	Node #	1.3
Node Boundaries:	Acid/caustic injection packages	Revision Date:	03-Feb-22
Design Intent:	dosing of acid and caustic to neutralisation pit	Material / Chemical:	acid, caustic
Design Conditions, Operating Envelope	Ambient condition	Drawing:	HPP-AEC-MEC-GN-GEN-DRG-1128, HPP-AEC-MEC-GN-GEN-DRG-1088

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.3.1	High flow	Pump fault e.g. pump left running.	Chemical tank emptied in short time.	none	Include either an alarm for continual operation of the pump (or too frequent operation) or investigate other solutions to reduce overdosing (Review requirement for two pH meters for checking that pH is moving in the expected direction).	AECOM		Ph.1			
1.3.2	Temperature - low	Low ambient temperature.	Potential for freezing of caustic at 2 deg C in small diameter lines.	Vendor package - design	Chemicals to be dosed are TBC. If caustic is used potential for freezing in lines needs to be considered. Include in the package specification the range of ambient temperature.	AECOM		Ph.1			
1.3.3	Loss of containment	Overfilling of tanks, physical damage to tanks, leaks from flanges.	Spilling of chemicals to the bund.	Spills contained within the bund with separate bunds for acid and caustic to prevent chemical reaction. Drain to neutralisation pit.	No action						
1.3.4	Maintenance	Decanting of acid/caustic to refill dosing drum.	Chemical burn to personnel when decanting chemicals.	Wearing PPE	Review the replacement process for the chemicals (tank or drum) and if minimal contact with the chemical for the operator.	AECOM		Ph.2			
1.3.5	Maintenance - access	Accessibility to pumps for maintenance.	Unable to maintain pumps and interruption to dosing	Pumps are small and easily accessible/removeable	No action						
1.3.6	Maintenance	Calibration of equipment.	Incorrect acid/caustic dosage.	Requirement of calibration equipment (flow tube or calibration cylinder) should be included in chemical injection package specification.	No action						
1.3.7	Flow- Low	Vapour locking in line due to HCL vaporisation.	Vapour locking and inability to dose.	Vendor package - design	Consider the type of acid and potential to vaporise. Dilute sulphuric acid is preferred.	AECOM		Ph.1			
1.3.8	Flow - Low	PSV opens and stays open.	Dosing of acid/caustic too low.	Vendor package - design	FS is sometimes included in the line downstream of the PSV to indicate the PSV has lifted. Check the vendor package includes this.	AECOM		Ph.1			

Table 47 Trade Waste & Sewer - Node 1.4

Project / Facility:	60666845 Hunter Valley Power Station - Sewer	Node #	1.4
Node Boundaries:	Sewer Collection	Revision Date:	03-Feb-22
Design Intent:	Collection tank for sewer and pump out	Material / Chemical:	Sewer waste
Design Conditions, Operating Envelope	Ambient condition	Drawing:	HPP-AEC-MEC-GN-GEN-DRG-1086

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.4.1	High flow	Large number of people on site with large amounts of water being used in office and workshop and discharge to sewer.	Overflow	The sewage pit is sized for maximum flowrate. The capacity is 5000 L with a 10,000 L overflow.	No action		Peak flow is proportional to the number of fixtures. There is an overflow tank included in the onsite sewage system. A pump with a steep curve is usually selected so when capacity to pump out is available the pump will be operating on circulation and then pump out to the trade waste system.				
1.4.2	Reverse flow	Higher pressure in HWC sewer main header than pump outlet.	Reverse flow from the trade waste to the sewer pit.	NRV on outlet of the pumps and at the boundary kit.	No action						
1.4.3	Contaminants	Oil poured down kitchen sinks to sewer.	Unlikely to occur as cooking is not expected to be done on site.	none	No action						
1.4.4	Maintenance	A GT scheduled outage may increase people on site and the need for extra toilets.	Not sufficient toilets for personnel on site.	none	Consider providing a sewer connection in temporary. offices/facilities area. Review potential to use temporary toilet blocks on site.	AECOM	Portable toilets are not preferred by SH because of industrial relations issues. Maximum number of people on site is expected to be 50 during a scheduled outage.	Ph.1			
1.4.5	Instruments and controls	High/low level alarm activated.	No one aware of high/low level in pit.	none	Alarms from sewerage pit to DCS so operators are aware of high/low level in sewerage pit when no one on site	AECOM		Ph.1			
1.4.6	Maintenance	Pump maintenance.	Inability to maintain pumps.	Pumps can be lifted out	No action						
1.4.7	Flow - Low	Low flow of water through the system.	Generation of odour from the tank.	Vent to safe location.	Consider odour from the tank and a filter.	AECOM	Note: Usually filters are used on larger municipal facilities.	Ph.1			

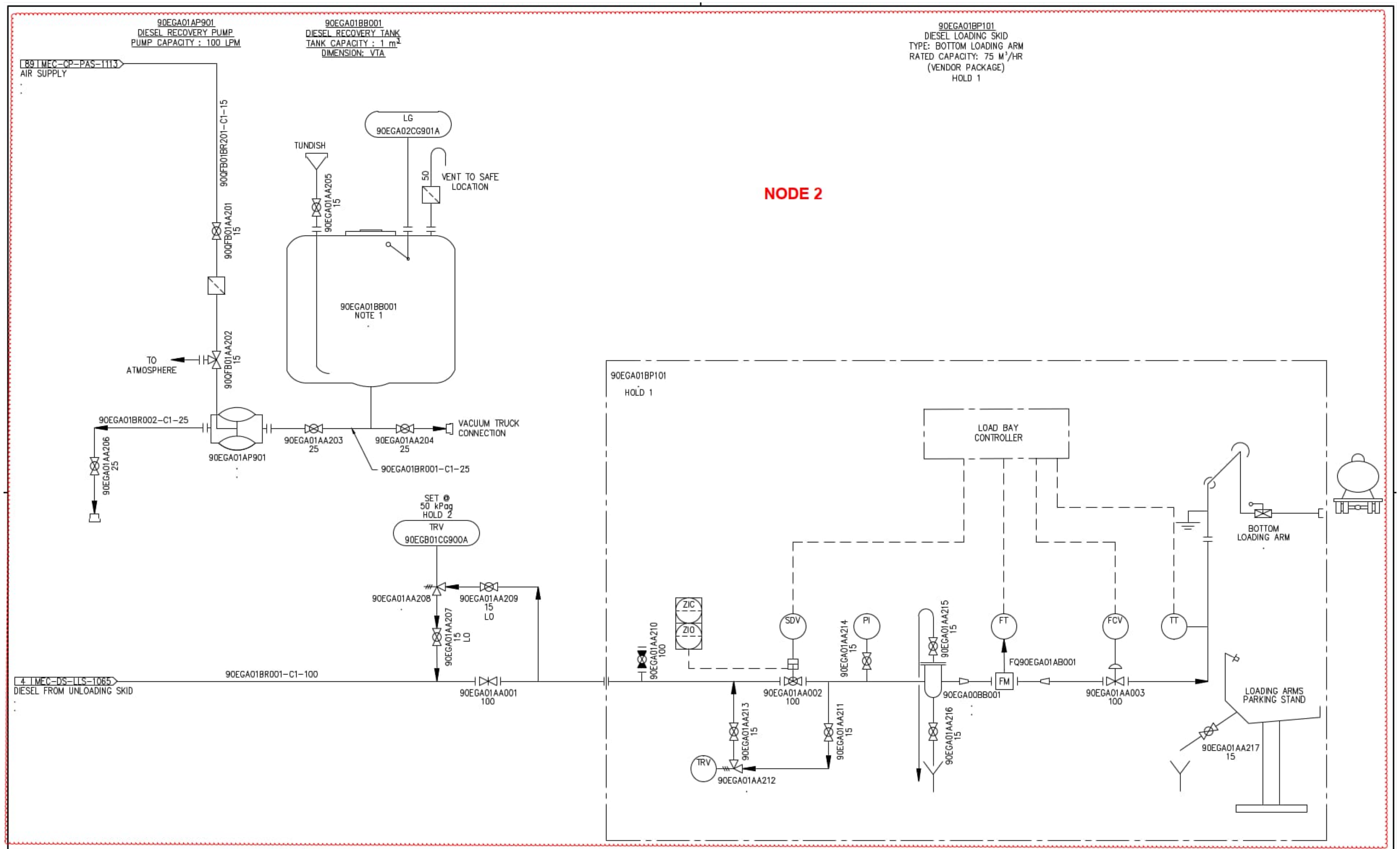
Table 48 Trade Waste & Sewer - Overview

Project / Facility:	**60666845 Hunter Valley Power Station - Trade Waste -Sewer**	**Node #**	**Overview Trade waste and Sewer**
Node Boundaries:		**Revision Date:**	03-Feb-22
Design Intent:		**Material / Chemical:**	Sewer waste
Design Conditions, Operating Envelope	Design assumes ambient conditions	**Drawing:**	HPP-AEC-MEC-DS-LLS-DRG-1067/1068

Ref No:	Guideword	Possible Cause	Possible Consequence	Existing Mitigation	Recommendations	Owner	Comments	Action by	Date complete	Verified By	Action Status
1.5.1	Materials of construction - pumps, valves	Pumps/valves materials incompatible with chemicals used.	Corrosion of pumps.	Appropriate materials of construction listed in specifications (especially with acid and caustic)	No action						
1.5.2	Utilities and services	Service water is a long distance from sewage pit.	Difficulties get service water to sewage pit.	none	Review application of flushing water to the pit and potential to use potable water and a garden hose	AECOM		Ph.1			
1.5.3	Physical damage	Vehicle collision with equipment.	Damage to dosing pumps.	None of the pits and associated equipment are directly adjacent to roads within site. Pits have raised edges.	No action						
1.5.4	Environmental impact - noise	Sewer pumps could be noisy and close to boundary.	Noise pollution and impact on neighbours. Industrial area.	Noise limits to be included in package specs	Confirm noise limits included in the package specifications	AECOM		Ph.1			
1.5.5	Safety systems	Safety shower location.	Too long to reach safety shower.	none	Ensure safety shower is no further than 10 m from chemical storage if dosing chemicals are being decanted	AECOM		Ph.1			

Appendix B

Diesel System P&IDs Showing Nodes Applied in the HAZOP



NOTES:

1. ALL SAMPLE RETURN AND DRAINS WILL BE COLLECTED IN THE IBC TANK AND WILL BE TRANSFORMED TO STORAGE TANK OR REMOVED BY VACUUM TRUCK FROM SITE DEPENDS ON QUALITY.

HOLDS:

1. DETAIL INSIDE THE PACKAGE IS INDICATIVE ONLY AND WILL BE FINALIZED BY SUPPLIER.
2. ALL PSV AND TRV SET PRESSURE WILL BE FINALISED LATER.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

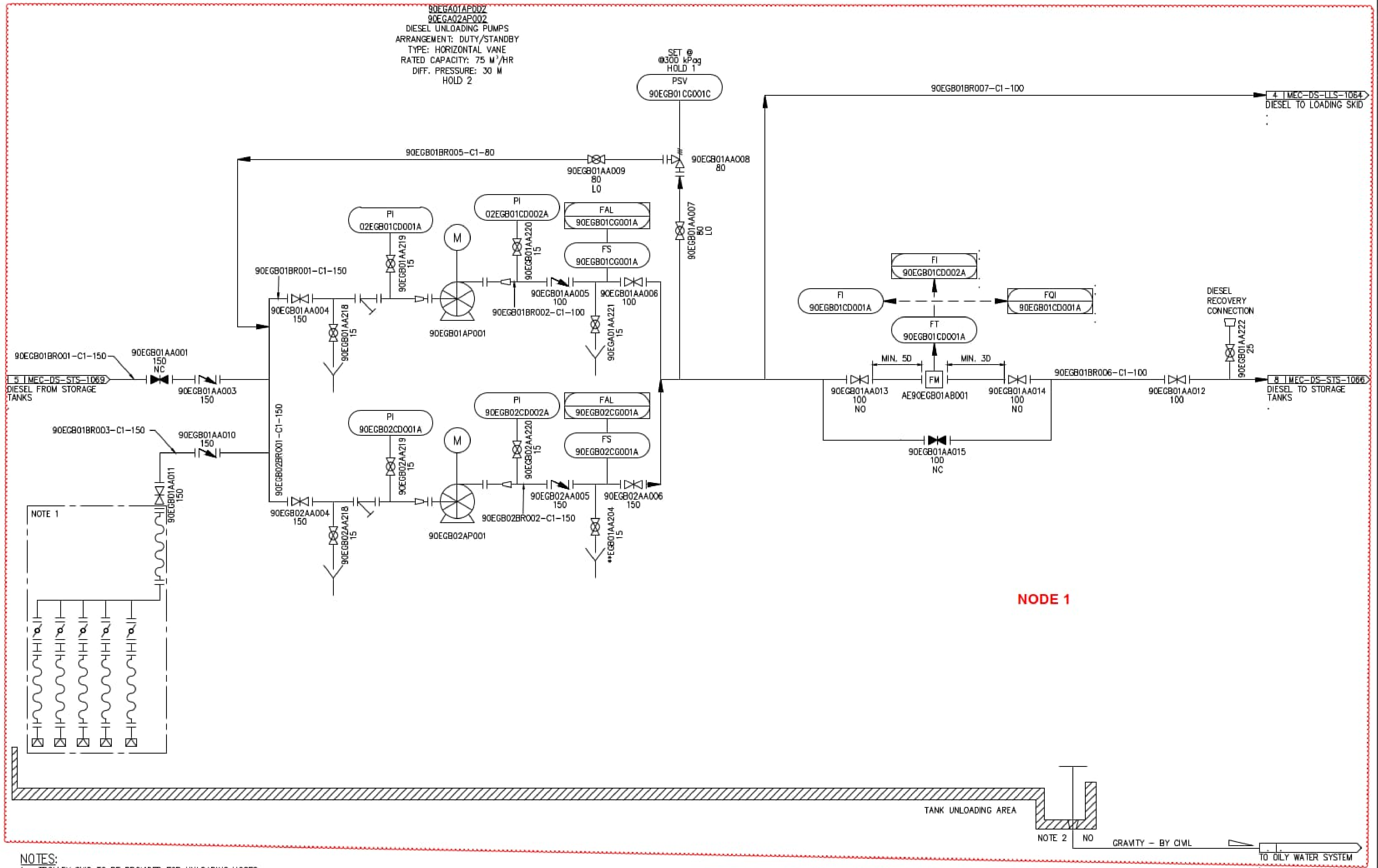
ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	14.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-DS-LLS-DRG-1064
REV: B

DRAWN CAR 14.01.2022	DRAWING CHECKED BVA 14.01.2022
DESIGNED JD 14.01.2022	DESIGN CHECKED KW 14.01.2022
SCALE	APPROVED CDT 14.01.2022
WORK ORDER No	
SECTION No/KKS EGA	A1 SHEET SIZE

snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DIESEL FUEL UNIT – LOADING SYSTEM
B SH 1 OF 1



NOTES:
1. TROLLEY SKID TO BE PROVIDED FOR UNLOADING HOSES.
2. OILY WATER DRAIN VALVE IS NORMALLY OPEN, HOWEVER SHOULD BE KEPT CLOSED DURING TANKER LOADING/ UNLOADING.

HOLDS:
1. ALL PSV AND TRV SET POINT ARE HOLD AND WILL BE FINALISED LATER.
2. PUMP CAPACITY AND HEAD WILL BE FINALIZED AFTER FINALIZING THE PIPE ROUTES AND 3D MODEL.
3. THE USE OF **WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

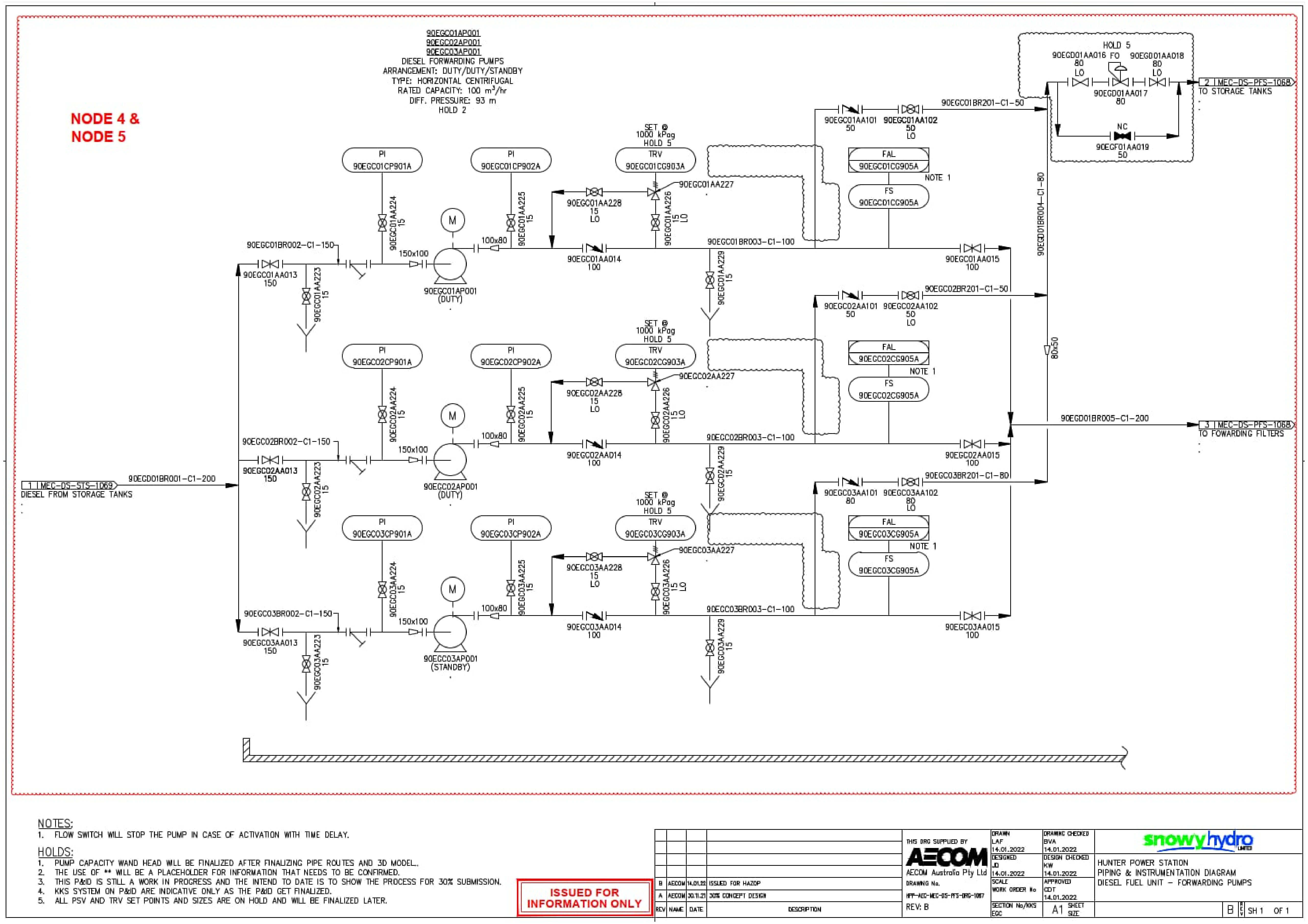
ISSUED FOR INFORMATION ONLY

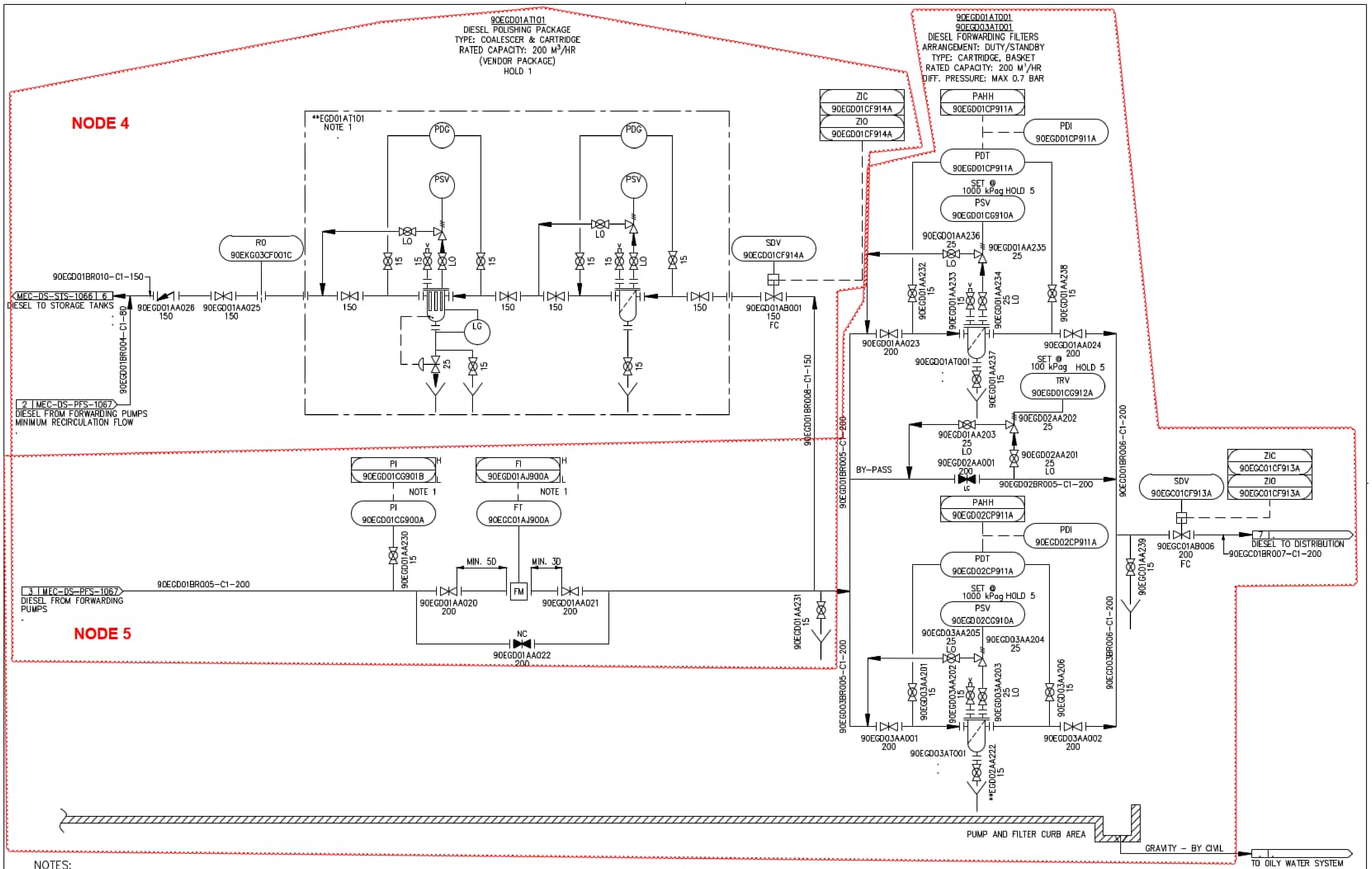
REV	NAME	DATE	DESCRIPTION
B	AECOM	14.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-DS-LLS-DRG-1065
REV: B

DRAWN CAR 14.01.2022	DRAWING CHECKED BVA 14.01.2022
DESIGNED JD 14.01.2022	DESIGN CHECKED KW 14.01.2022
SCALE	APPROVED CDT 14.01.2022
WORK ORDER No	
SECTION No/KKS EGB	A1 SHEET SIZE

snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DIESEL FUEL UNIT – UNLOADING SYSTEM
B SH 1 OF 1


NODE 4 &
NODE 5
90EGC01AP001
90EGC02AP001
90EGC03AP001
DIESEL FORWARDING PUMPS
ARRANGEMENT: DUTY/DUTY/STANDBY
TYPE: HORIZONTAL CENTRIFUGAL
RATED CAPACITY: 100 m³/hr
DIFF. PRESSURE: 93 m
HOLD 2
1 MEC-DS-STS-1069
DIESEL FROM STORAGE TANKS
90ECD01BR001-C1-200
2 MEC-DS-PFS-1068
TO STORAGE TANKS
3 MEC-DS-PFS-1068
TO FOWARDING FILTERS
90EGD01BR005-C1-200
90EGD01BR004-C1-80
HOLD 5
90EGD01AA016 FO 80 LO
90EGD01AA017 80
90EGD01AA018 80 LO
NC
90EGF01AA019 50
90EGC01BR201-C1-50
90EGC02BR201-C1-50
90EGC03BR201-C1-80
90EGC01AA101 50
90EGC01AA102 50 LO
FAL 90EGC01CG905A
FS 90EGC01CG905A
NOTE 1
SET @ 1000 kPag HOLD 5
TRV 90EGC01CG903A
PI 90EGC01CP901A
PI 90EGC01CP902A
90EGC01AA227
90EGC01AA228 15 LO
90EGC01AA226 15 LO
90EGC01AA224 15
90EGC01AA225 15
90EGC01BR002-C1-150
90EGC01AA013 150
90EGC01AA223 15
150x100
100x80
90EGC01AP001 (DUTY)
90EGC01AA014 100
90EGC01BR003-C1-100
90EGC01AA229 15
90EGC01AA015 100
90EGC02AP001 (DUTY)
90EGC03AP001 (STANDBY)
90EGC03BR003-C1-100
80x50
NOTES:
1. FLOW SWITCH WILL STOP THE PUMP IN CASE OF ACTIVATION WITH TIME DELAY.
HOLDS:
1. PUMP CAPACITY WAND HEAD WILL BE FINALIZED AFTER FINALIZING PIPE ROUTES AND 3D MODEL.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
5. ALL PSV AND TRV SET POINTS AND SIZES ARE ON HOLD AND WILL BE FINALIZED LATER.
ISSUED FOR INFORMATION ONLY
B AECOM 14.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM
AECOM Australia Pty Ltd
DRAWING No.
REV: B
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DIESEL FUEL UNIT – FORWARDING PUMPS
A1
SH 1 OF 1



NOTES:

1. PUMPS SEQUENCING SYSTEM WILL BE BASED ON SUPPLY LINE PRESSURE AND FLOW, LOW PRESSURE OR HIGH FLOW WILL START THE NEXT PUMP.

HOLDS:

1. DETAIL INSIDE THE PACKAGE IS INDICATIVE ONLY AND WILL BE FINALIZED BY SUPPLIER.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
5. ALL PSV AND TRV SET PRESSURES ARE HOLD AND WILL BE FINALISED LATER.

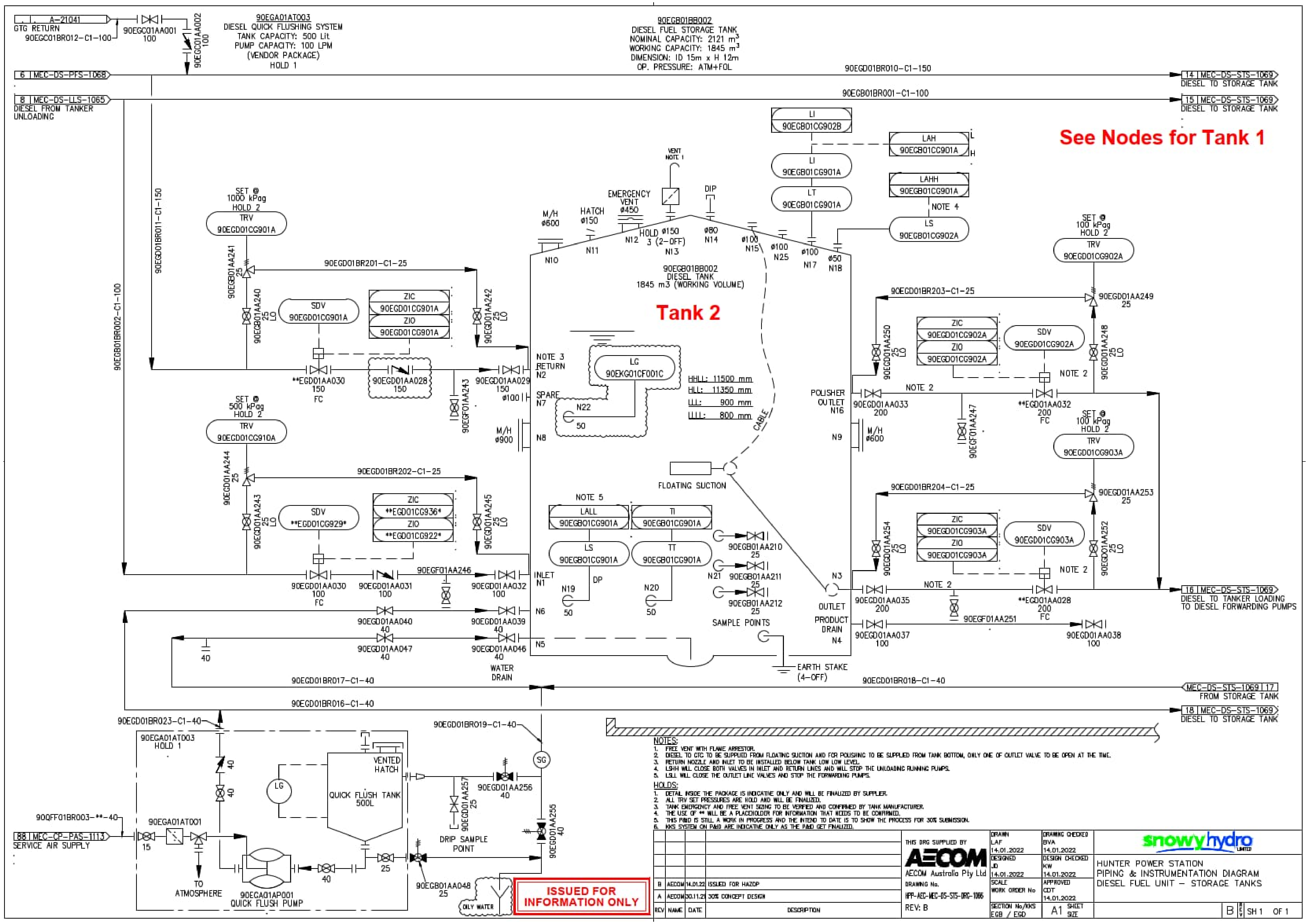
ISSUED FOR INFORMATION ONLY

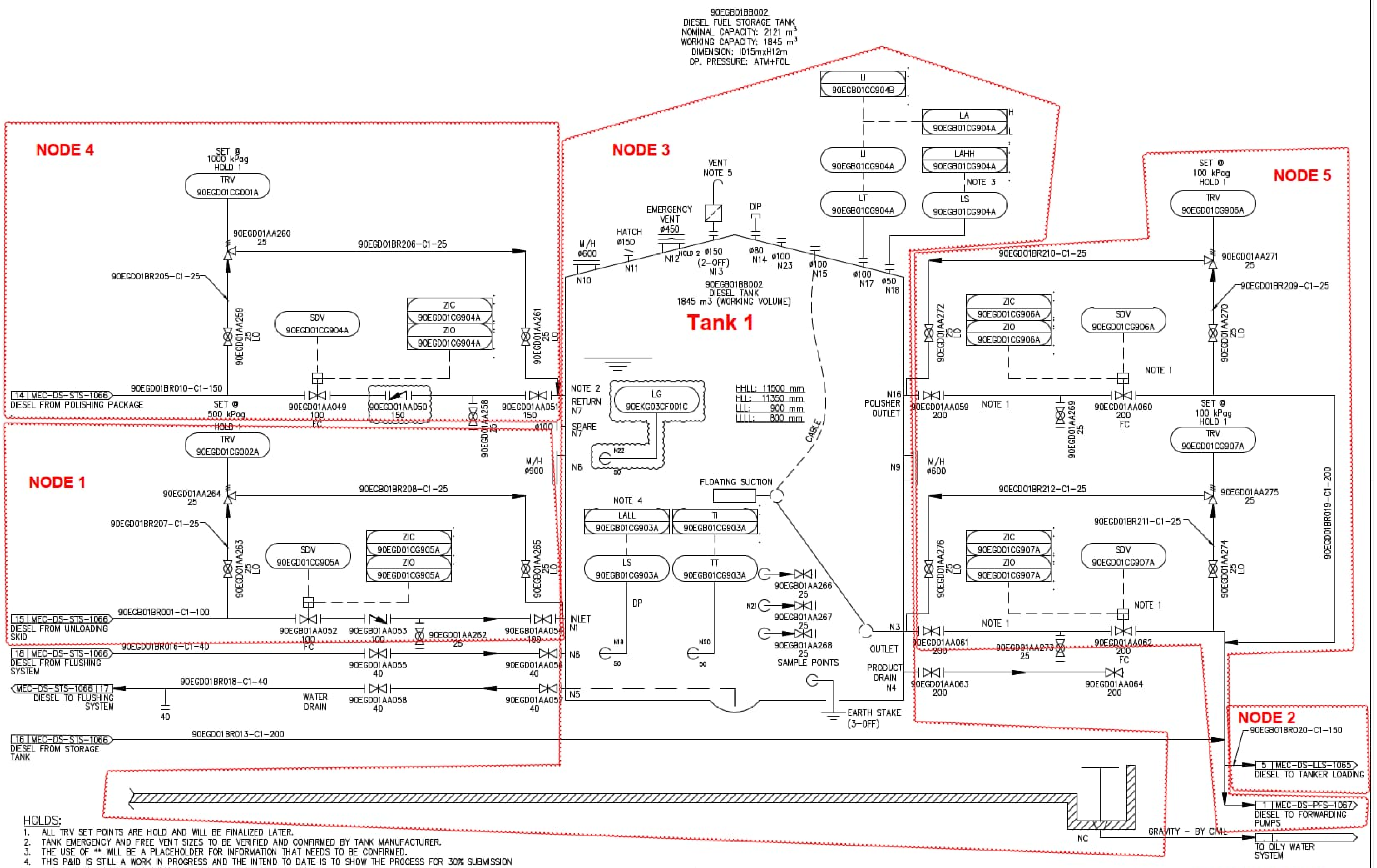
REV	NAME	DATE	DESCRIPTION
B	AECOM	14.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-DS-PFS-DRG-1068
REV: B

DRAWN CAR 14.01.2022 | DRAWING CHECKED BVA 14.01.2022
DESIGNED JD 14.01.2022 | DESIGN CHECKED KW 14.01.2022
SCALE | APPROVED CDT 14.01.2022
WORK ORDER No
SECTION No/KKS EGD | A1 SHEET SIZE

snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DIESEL FUEL UNIT – POLISHING & FORWARDING FILTERS
B | SH 1 OF 1


See Nodes for Tank 1
Tank 2
90EGA01AT003
DIESEL QUICK FLUSHING SYSTEM
TANK CAPACITY: 500 Lit
PUMP CAPACITY: 100 LPM
(VENDOR PACKAGE)
HOLD 1
90EGB01BB002
DIESEL FUEL STORAGE TANK
NOMINAL CAPACITY: 2121 m3
WORKING CAPACITY: 1845 m3
DIMENSION: ID 15m x H 12m
OP. PRESSURE: ATM+FOL
90EGB01BB002
DIESEL TANK
1845 m3 (WORKING VOLUME)
GTG RETURN
DIESEL FROM TANKER UNLOADING
DIESEL TO STORAGE TANK
DIESEL TO TANKER LOADING TO DIESEL FORWARDING PUMPS
FROM STORAGE TANK
SERVICE AIR SUPPLY
FLOATING SUCTION
SAMPLE POINTS
EARTH STAKE (4-OFF)
WATER DRAIN
POLISHER OUTLET
PRODUCT DRAIN
QUICK FLUSH TANK 500L
VENTED HATCH
DRIP SAMPLE POINT
TO ATMOSPHERE
90EGA01AP001 QUICK FLUSH PUMP
OILY WATER
HHLL: 11500 mm
HLL: 11350 mm
LLL: 900 mm
LLLL: 800 mm
NOTES:
1. FREE VENT WITH FLAME ARRESTOR.
2. DIESEL TO GTG TO BE SUPPLIED FROM FLOATING SUCTION AND FOR POLISHING TO BE SUPPLIED FROM TANK BOTTOM, ONLY ONE OF OUTLET VALVE TO BE OPEN AT THE TIME.
3. RETURN NOZZLE AND INLET TO BE INSTALLED BELOW TANK LOW LOW LEVEL.
4. LSHH WILL CLOSE BOTH VALVES IN INLET AND RETURN LINES AND WILL STOP THE UNLOADING RUNNING PUMPS.
5. LSLL WILL CLOSE THE OUTLET LINE VALVES AND STOP THE FORWARDING PUMPS.
HOLDS:
1. DETAIL INSIDE THE PACKAGE IS INDICATIVE ONLY AND WILL BE FINALIZED BY SUPPLIER.
2. ALL TRV SET PRESSURES ARE HOLD AND WILL BE FINALIZED.
3. TANK EMERGENCY AND FREE VENT SIZING TO BE VERIFIED AND CONFIRMED BY TANK MANUFACTURER.
4. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
5. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
6. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
ISSUED FOR INFORMATION ONLY
B AECOM 14.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-DS-STS-DRG-1066
REV: B
DRAWN LAF 14.01.2022
DESIGNED JD 14.01.2022
DRAWING CHECKED BVA 14.01.2022
DESIGN CHECKED KW 14.01.2022
APPROVED CDT 14.01.2022
SECTION No/KKS EGB / EGD
A1 SHEET SIZE
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DIESEL FUEL UNIT – STORAGE TANKS
B SH 1 OF 1



HOLDS:

1. ALL TRV SET POINTS ARE HOLD AND WILL BE FINALIZED LATER.
2. TANK EMERGENCY AND FREE VENT SIZES TO BE VERIFIED AND CONFIRMED BY TANK MANUFACTURER.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

NOTES:

1. DIESEL TO GTG TO BE SUPPLIED FROM FLOATING SUCTION AND FOR POLISHING TO BE SUPPLIED FROM TANK BOTTOM, ONLY ONE OF OUTLET VALVE TO BE OPEN AT THE TIME.
2. RETURN AND INLET LINE TO BE INSTALLED BELOW TANK LOW LOW LEVEL.
3. LSHH WILL CLOSE BOTH VALVES IN INLET AND RETURN LINES AND WILL STOP THE UNLOADING RUNNING PUMPS.
4. LSLL WILL CLOSE THE OUTLET LINE VALVES AND STOP THE FORWARDING PUMPS.
5. FREE VENT WITH FLAME ARRESTOR.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	14.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM — AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-DS-STS-DRG-1069
REV: B

DRAWN LAF 14.01.2022	DRAWING CHECKED BVA 14.01.2022		
DESIGNED JD 14.01.2022	DESIGN CHECKED KW 14.01.2022		
SCALE	APPROVED CDT 14.01.2022		
WORK ORDER No			
SECTION No/KKS EGB / EGD	A1 SIZE	SHEET	

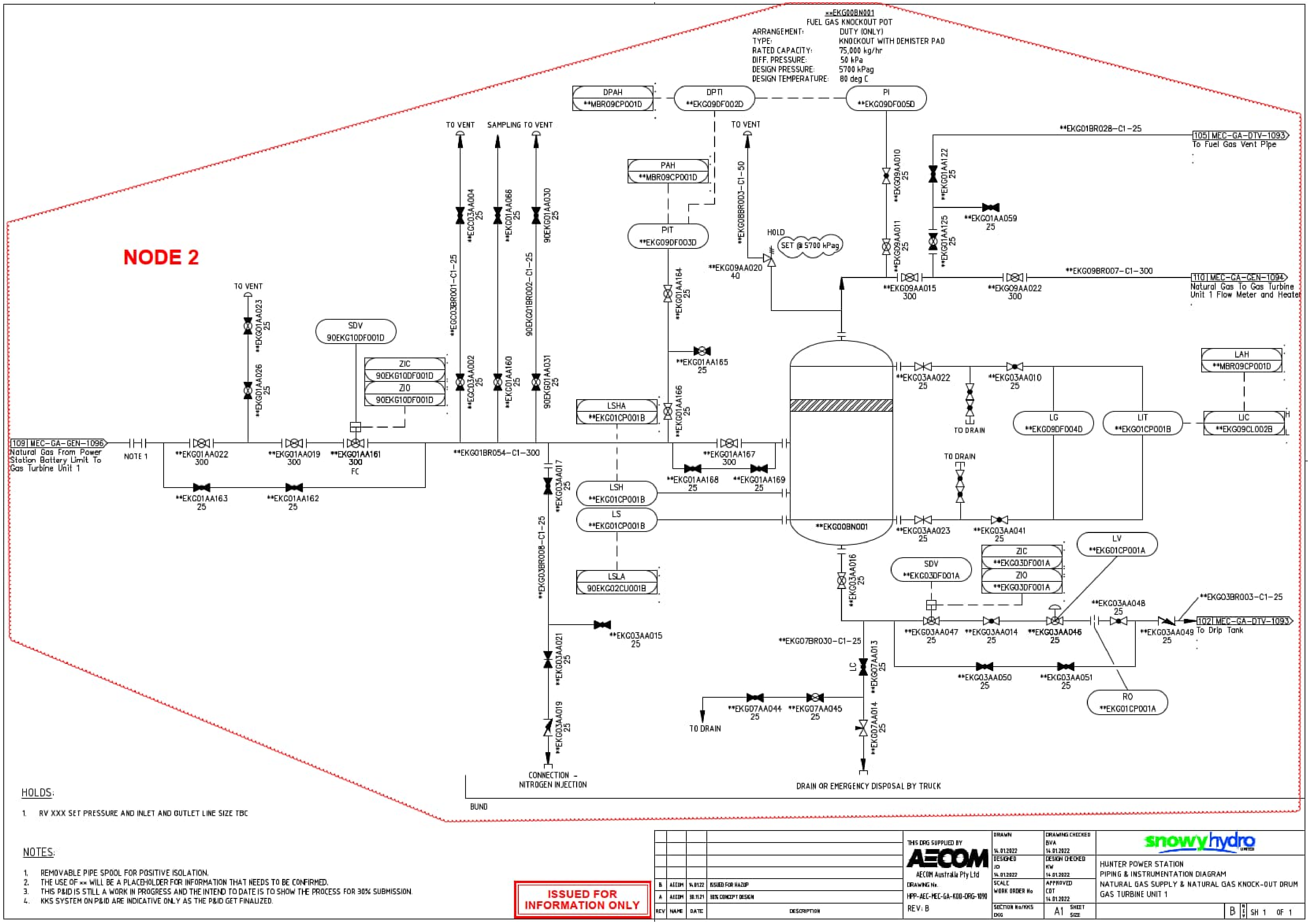
snowyhydro LIMITED

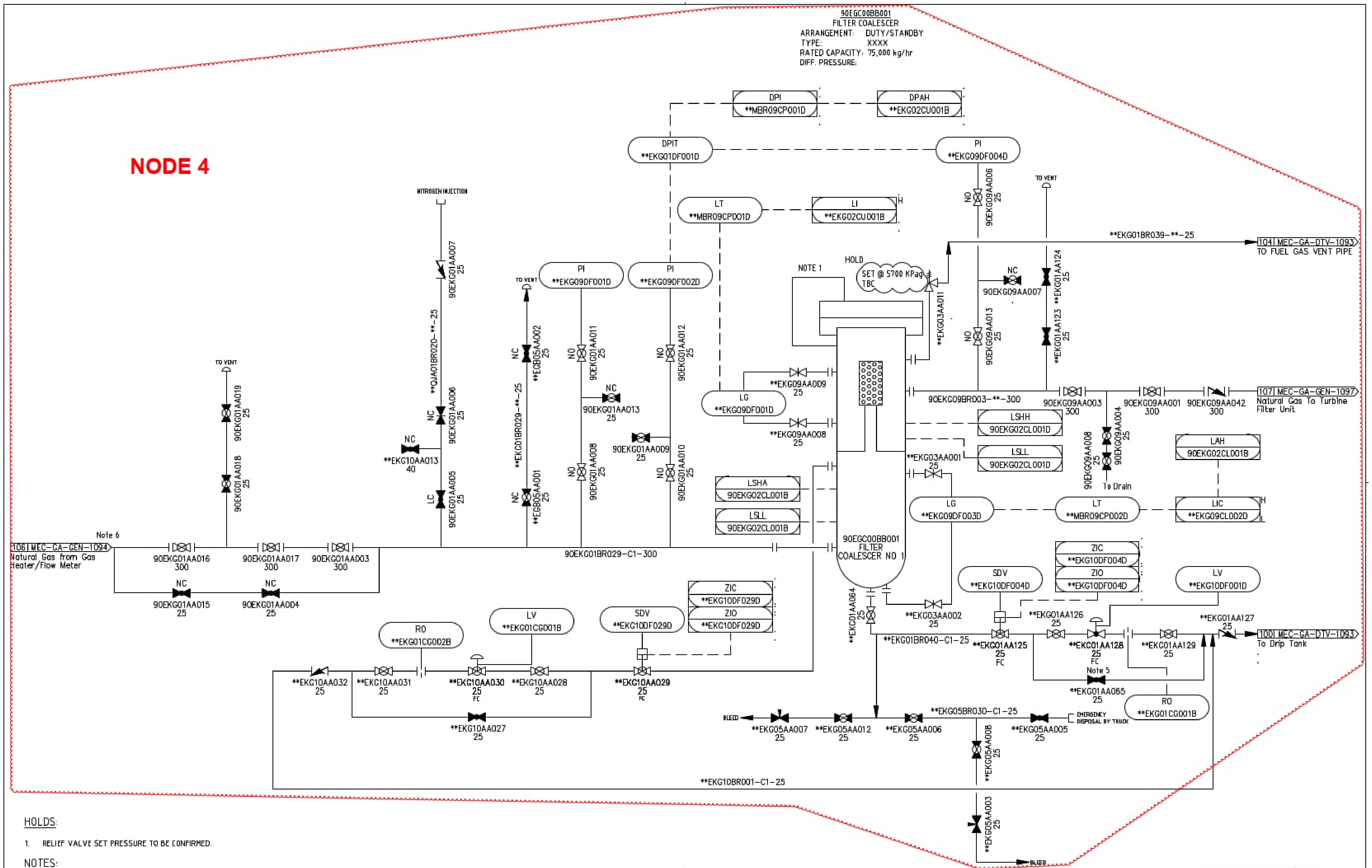
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DIESEL FACILITY - DIESEL STORAGE TANKS

B | SH 1 OF 1

Appendix C

Natural Gas P&IDs Showing Nodes Applied in the HAZOP


NODE 2
**EKG00BN001
FUEL GAS KNOCKOUT POT
ARRANGEMENT: DUTY (ONLY)
TYPE: KNOCKOUT WITH DEMISTER PAD
RATED CAPACITY: 75,000 kg/hr
DIFF. PRESSURE: 50 kPa
DESIGN PRESSURE: 5700 kPag
DESIGN TEMPERATURE: 80 deg C
DPAH **MBR09CP001D
DPIT **EKG09DF002D
PI **EKG09DF005D
PAH **MBR09CP001D
PIT **EKG09DF003D
TO VENT
SAMPLING TO VENT
HOLD
SET @ 5700 kPag
**EKG01BR028-C1-25
105 MEC-GA-DTV-1093 To Fuel Gas Vent Pipe
**EKG09BR007-C1-300
110 MEC-GA-GEN-1094 Natural Gas To Gas Turbine Unit 1 Flow Meter and Heater
109 MEC-GA-GEN-1096 Natural Gas From Power Station Battery Limit To Gas Turbine Unit 1
NOTE 1
SDV 90EKG10DF001D
ZIC 90EKG10DF001D
ZIO 90EKG10DF001D
**EKG01BR054-C1-300
LSHA **EKG01CP001B
LSH **EKG01CP001B
LS **EKG01CP001B
LSLA 90EKG02CU001B
LAH **MBR09CP001D
LG **EKG09DF004D
LIT **EKG01CP001B
LIC **EKG09CL002B
LV **EKG01CP001A
SDV **EKG03DF001A
ZIC **EKG03DF001A
ZIO **EKG03DF001A
RO **EKG01CP001A
**EKG03BR003-C1-25
102 MEC-GA-DTV-1093 To Drip Tank
**EKG07BR030-C1-25
TO DRAIN
CONNECTION - NITROGEN INJECTION
DRAIN OR EMERGENCY DISPOSAL BY TRUCK
BUND
HOLDS:
1. RV XXX SET PRESSURE AND INLET AND OUTLET LINE SIZE TBC
NOTES:
1. REMOVABLE PIPE SPOOL FOR POSITIVE ISOLATION.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
ISSUED FOR INFORMATION ONLY
B AECOM 14.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-GA-K00-DRG-1090
REV: B
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
NATURAL GAS SUPPLY & NATURAL GAS KNOCK-OUT DRUM
GAS TURBINE UNIT 1
A1 SHEET SIZE
SH 1 OF 1



HOLDS:

1. RELIEF VALVE SET PRESSURE TO BE CONFIRMED.

NOTES:

1. DAVIT FOR LID REMOVAL.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
5. MANUAL BYPASS GLOBE VALVE TO HAVE A MAXIMUM CV NOT TO EXCEED THE CONTROL VALVE CV (FULLY OPEN). IN CASE THE CONTROL VALVE HAS AN INTERNAL STOP THE GLOBE VALVE CV WILL NOT EXCEED THE RESTRICTED CV FOR THE CONTROL VALVE.
6. DBB UP AND DOWNSTREAM OF ESD TO ALLOW REPLACEMENT.

ISSUED FOR INFORMATION ONLY

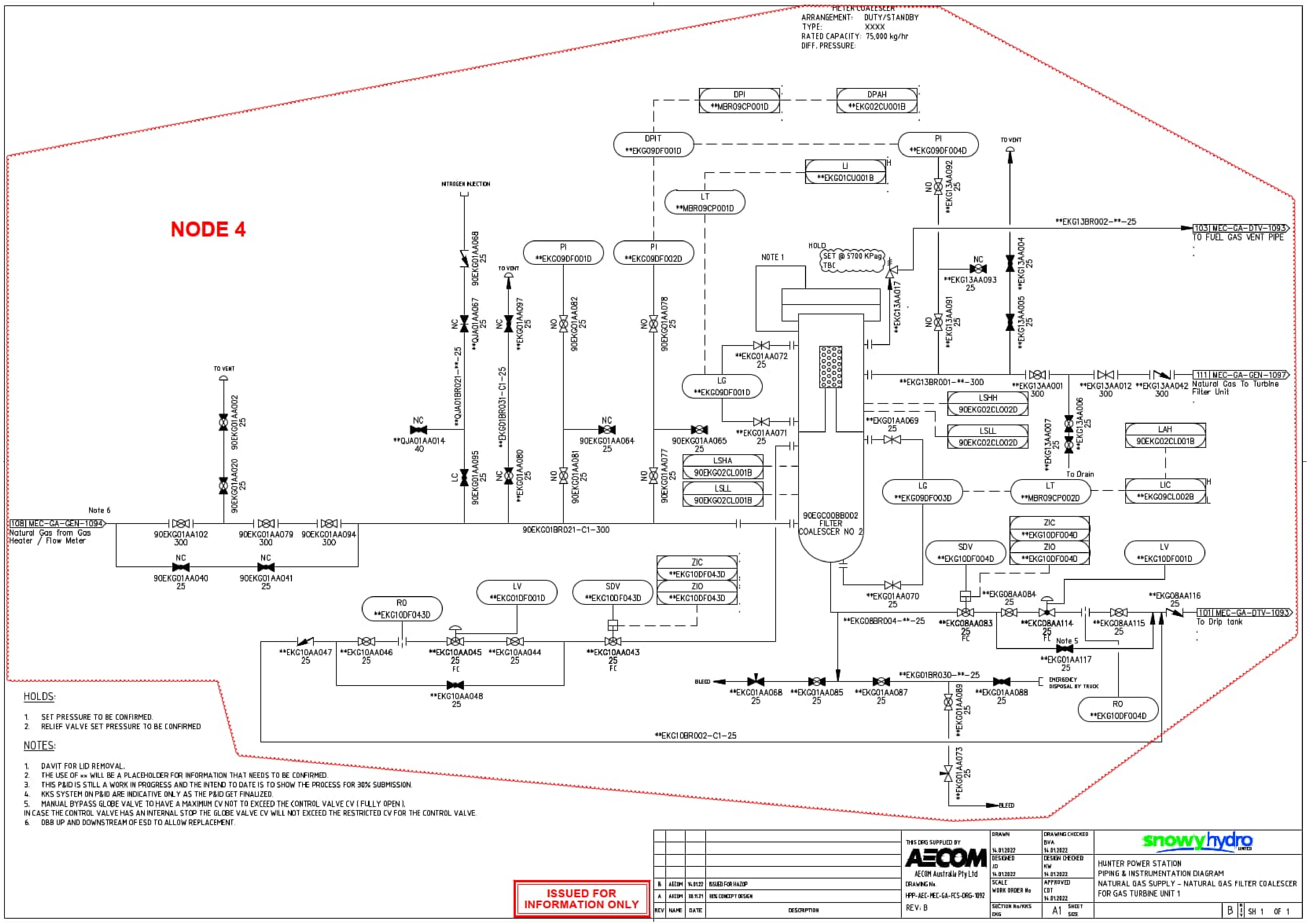
REV	NAME	DATE	DESCRIPTION
B	AECOM	14.01.22	ISSUED FOR HAZOP
A	AECOM	18.11.21	30% CONCEPT DESIGN

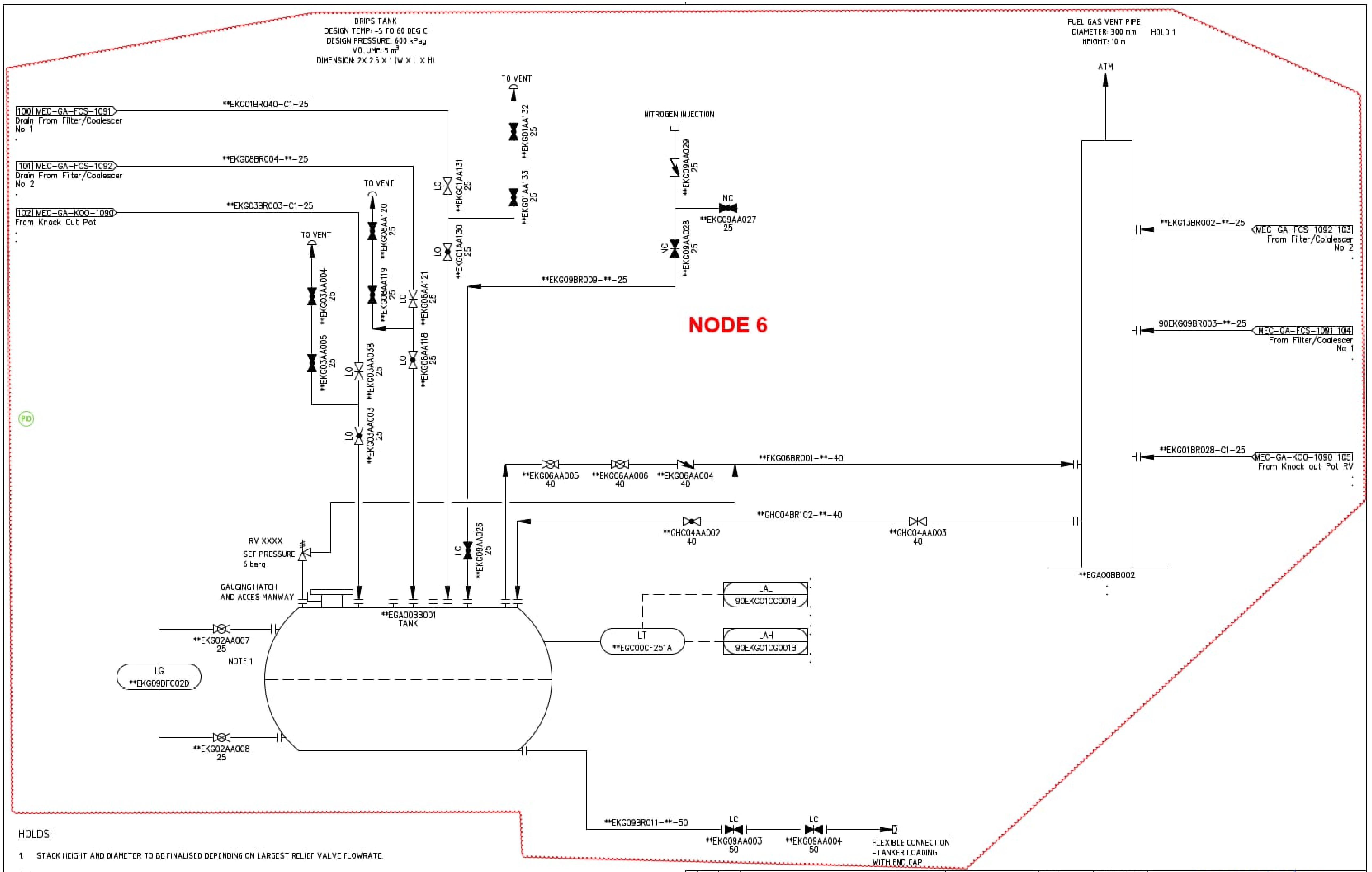
THIS DRG SUPPLIED BY AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-GA-FCS-DRG-1091 REV: B
DRAWN BVA 14.01.2022 · DRAWING CHECKED JD 14.01.2022 · DESIGNED KW 14.01.2022 · DESIGN CHECKED CDT 14.01.2022 · APPROVED 14.01.2022
SCALE · SECTION No/KKS · SIZE A1

snowy hydro

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
NATURAL GAS SUPPLY – NATURAL GAS FILTER COALESCER FOR GAS TURBINE UNIT 1

B SH 1 OF 1


NODE 4
FILTER COALESCER
ARRANGEMENT: DUTY/STANDBY
TYPE: XXXX
RATED CAPACITY: 75,000 kg/hr
DIFF. PRESSURE:
90EGC00BB002 FILTER COALESCER NO 2
108 MEC-GA-GEN-1094 Natural Gas from Gas Heater / Flow Meter
103 MEC-GA-DTV-1093 TO FUEL GAS VENT PIPE
111 MEC-GA-GEN-1097 Natural Gas To Turbine Filter Unit
101 MEC-GA-DTV-1093 To Drip tank
NITROGEN INJECTION
TO VENT
BLEED
EMERGENCY DISPOSAL BY TRUCK
To Drain
HOLD
SET @ 5700 KPag TBC
NOTE 1
Note 5
Note 6
HOLDS:
1. SET PRESSURE TO BE CONFIRMED.
2. RELIEF VALVE SET PRESSURE TO BE CONFIRMED
NOTES:
1. DAVIT FOR LID REMOVAL.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
5. MANUAL BYPASS GLOBE VALVE TO HAVE A MAXIMUM CV NOT TO EXCEED THE CONTROL VALVE CV (FULLY OPEN).
IN CASE THE CONTROL VALVE HAS AN INTERNAL STOP THE GLOBE VALVE CV WILL NOT EXCEED THE RESTRICTED CV FOR THE CONTROL VALVE.
6. DBB UP AND DOWNSTREAM OF ESD TO ALLOW REPLACEMENT.
ISSUED FOR INFORMATION ONLY
B AECOM 14.01.22 ISSUED FOR HAZOP
A AECOM 08.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-GA-PCS-DRG-1092
REV: B
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
NATURAL GAS SUPPLY - NATURAL GAS FILTER COALESCER
FOR GAS TURBINE UNIT 1
A1
SH 1 OF 1



HOLDS:

1. STACK HEIGHT AND DIAMETER TO BE FINALISED DEPENDING ON LARGEST RELIEF VALVE FLOWRATE.

NOTES:

1. DRIPS TANK WILL BE ABOVE GROUND (TBC).
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

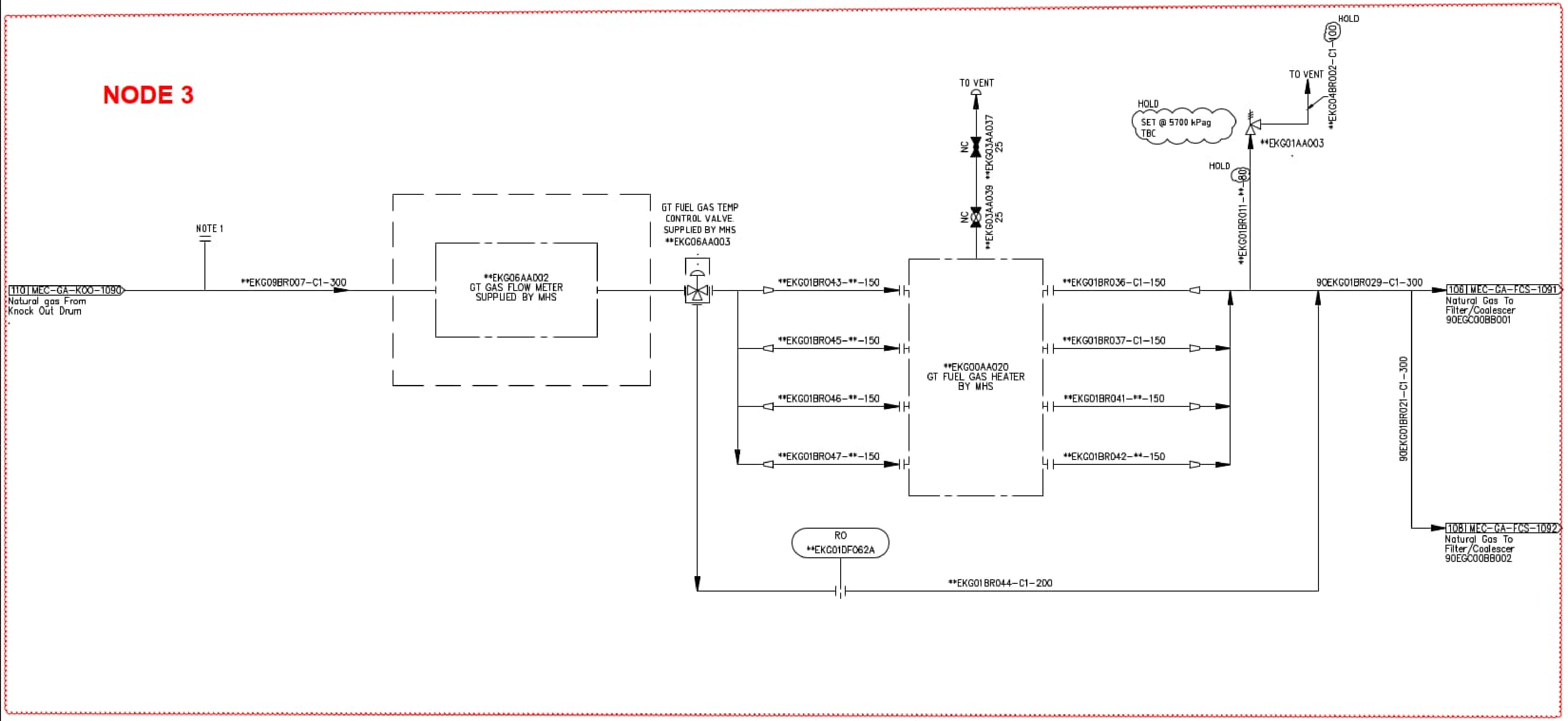
REV	NAME	DATE	DESCRIPTION
B	AECOM	14.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-GA-DTV-DRG-1093
REV: B
DRAWN BVA 14.01.2022 | DRAWING CHECKED BVA 14.01.2022
DESIGNED JD 14.01.2022 | DESIGN CHECKED KW 14.01.2022
SCALE | APPROVED
WORK ORDER No | CDT 14.01.2022
SECTION No/KKS EKG | A1 SHEET SIZE

snowy hydro

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
NATURAL GAS SUPPLY - DRIPS TANKS AND VENT
GAS TURBINE 1

B SH 1 OF 1



HOLDS:

1. RV XXXX SET PRESSURE TBC BY MHI.

NOTES:

1. PIPING MATERIAL AND THICKNESS SHALL BE DETERMINED BY EPC IN CONSIDERATION OF H_2S CONTENT IN FUEL GAS.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
5. EQUIPMENT IN VENDOR PACKAGE WILL BE DETERMINED AND SUPPLIED BY SUPPLIER.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	14.01.22	ISSUED FOR HAZOP
A	AECOM	08.11.21	30% CONCEPT DESIGN

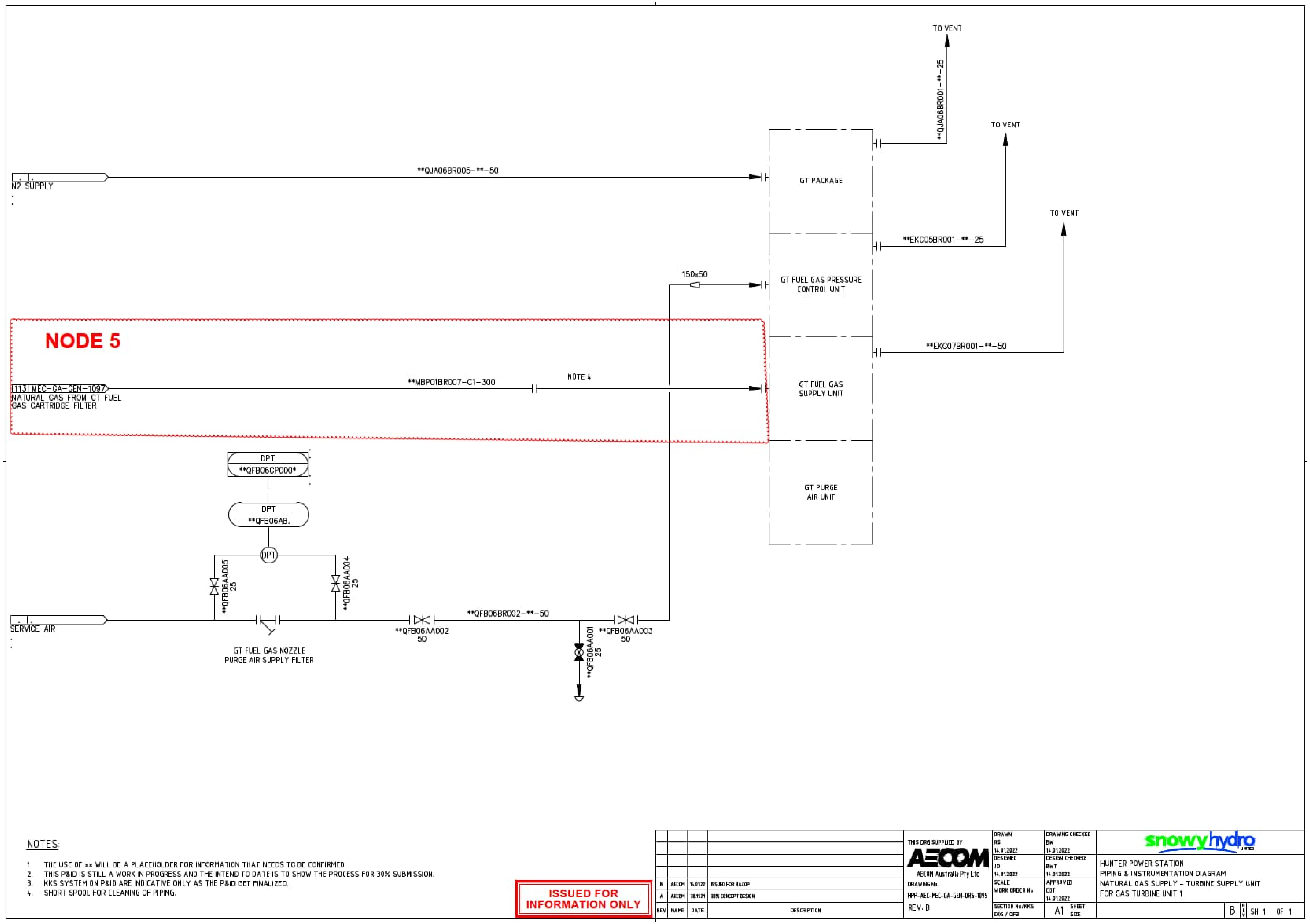
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No: HPP-AEC-MEC-GA-GEN-DRG-1094
REV: B

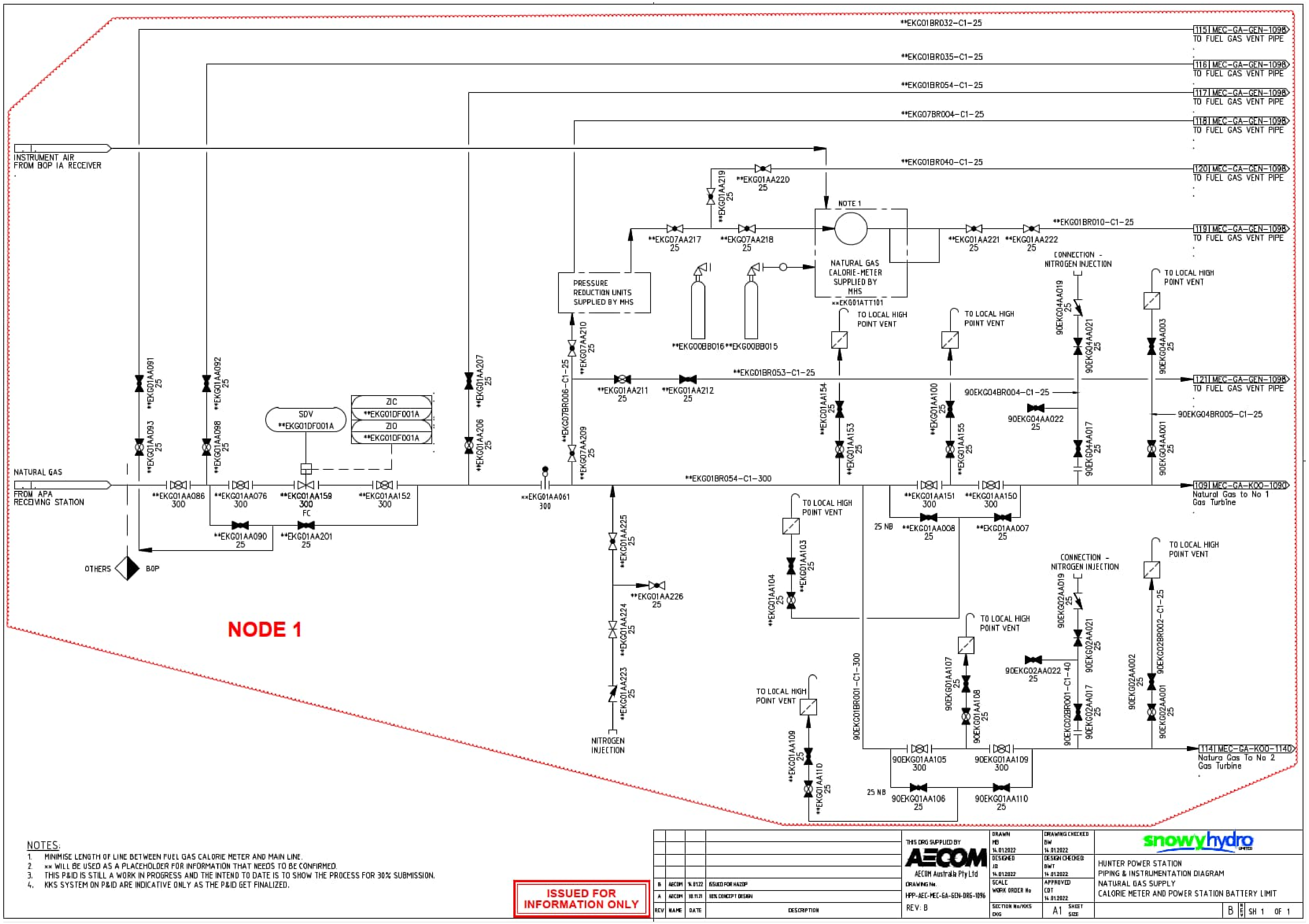
DRAWN RS 14.01.2022	DRAWING CHECKED BW 14.01.2022		
DESIGNED ID 14.01.2022	DESIGN CHECKED BWT 14.01.2022		
SCALE	APPROVED		
WORK ORDER No	CDT 14.01.2022		
SECTION No/KKS DWG / GMA	A1 SHEET SIZE		

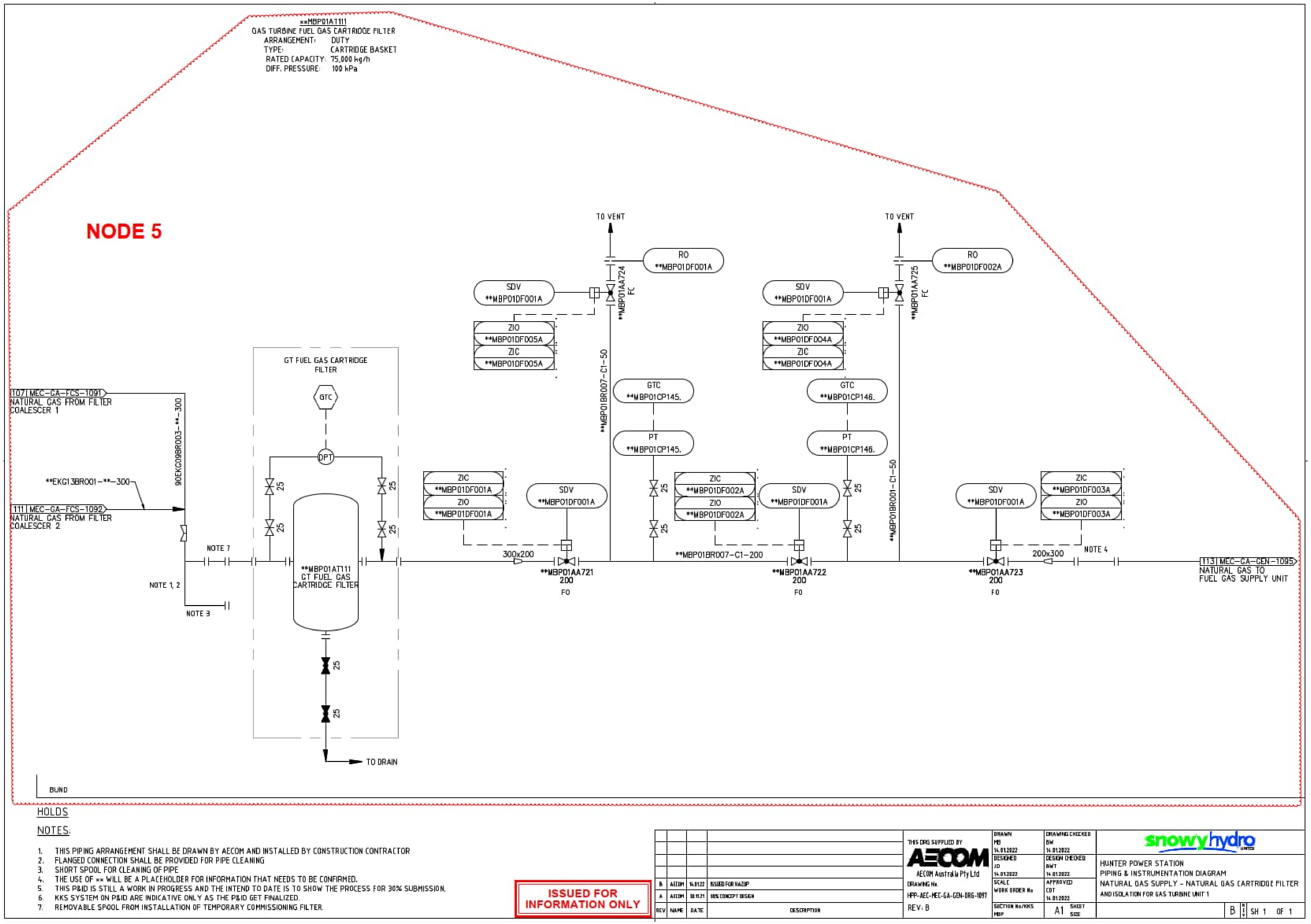
snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
NATURAL GAS SUPPLY - NATURAL GAS METERING AND HEATING FOR GAS TURBINE UNIT 1

B SH 1 OF 1

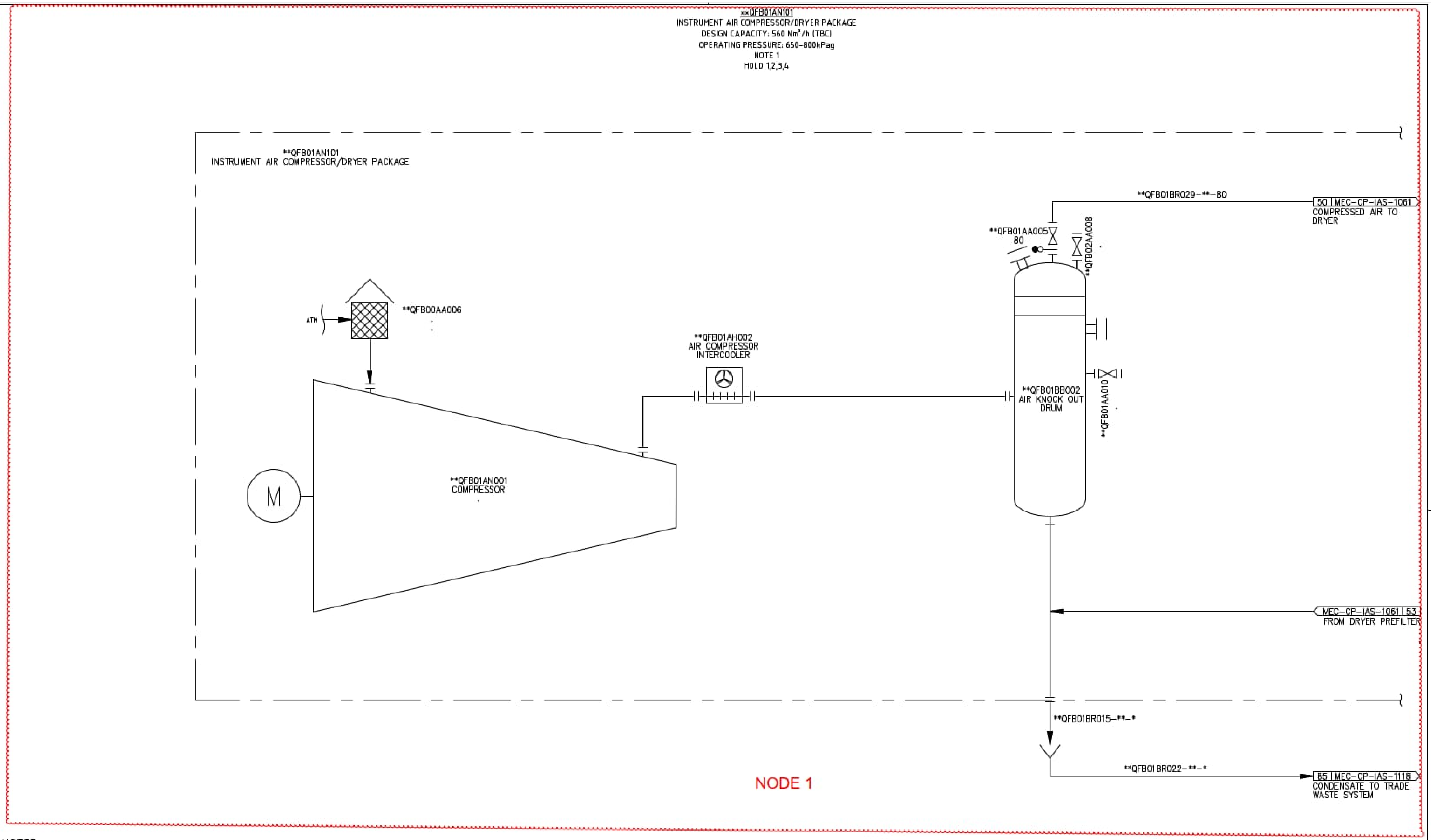

TO VENT
QJA06BR001--25
TO VENT
QJA06BR005--50
N2 SUPPLY
GT PACKAGE
TO VENT
EKG05BR001--25
150x50
GT FUEL GAS PRESSURE CONTROL UNIT
NODE 5
EKG07BR001--50
NOTE 4
**MBP01BR007-C1-300
113 MEC-GA-GEN-1097
NATURAL GAS FROM GT FUEL GAS CARTRIDGE FILTER
GT FUEL GAS SUPPLY UNIT
DPT
**QFB06CP000*
GT PURGE AIR UNIT
DPT
**QFB06AB.
DPT
**QFB06AA005
25
**QFB06AA004
25
QFB06BR002--50
SERVICE AIR
**QFB06AA002
50
**QFB06AA003
50
**QFB06AA001
25
GT FUEL GAS NOZZLE PURGE AIR SUPPLY FILTER
NOTES:
1. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
2. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
3. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
4. SHORT SPOOL FOR CLEANING OF PIPING.
ISSUED FOR INFORMATION ONLY
B AECOM 14.01.22 ISSUED FOR HAZOP
A AECOM 18.11.21 10% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-GA-GEN-DRG-1095
REV: B
DRAWN RS 14.01.2022
DRAWING CHECKED BW 14.01.2022
DESIGNED JD 14.01.2022
DESIGN CHECKED BWT 14.01.2022
SCALE
WORK ORDER No
APPROVED CDT 14.01.2022
SECTION No/KKS EKG / QFB
A1 SHEET SIZE
snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
NATURAL GAS SUPPLY - TURBINE SUPPLY UNIT
FOR GAS TURBINE UNIT 1
B REV SH 1 OF 1


**EKG01BR032-C1-25
**EKG01BR035-C1-25
**EKG01BR054-C1-25
**EKG07BR004-C1-25
**EKG01BR040-C1-25
**EKG01BR010-C1-25
TO FUEL GAS VENT PIPE
INSTRUMENT AIR FROM BOP IA RECEIVER
NATURAL GAS CALORIE-METER SUPPLIED BY MHS
PRESSURE REDUCTION UNITS SUPPLIED BY MHS
NATURAL GAS FROM APA RECEIVING STATION
NODE 1
NITROGEN INJECTION
CONNECTION - NITROGEN INJECTION
TO LOCAL HIGH POINT VENT
Natural Gas to No 1 Gas Turbine
Natural Gas To No 2 Gas Turbine
OTHERS
BOP
NOTES:
1. MINIMISE LENGTH OF LINE BETWEEN FUEL GAS CALORIE METER AND MAIN LINE.
2. ** WILL BE USED AS A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
ISSUED FOR INFORMATION ONLY
AECOM Australia Pty Ltd
HPP-AEC-MEC-GA-GEN-DRG-1096
REV: B
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
NATURAL GAS SUPPLY
CALORIE METER AND POWER STATION BATTERY LIMIT
snowyhydro


NODE 5
**MBP01AT111
GAS TURBINE FUEL GAS CARTRIDGE FILTER
ARRANGEMENT: DUTY
TYPE: CARTRIDGE BASKET
RATED CAPACITY: 75,000 kg/h
DIFF. PRESSURE: 100 kPa
TO VENT
TO VENT
RO
**MBP01DF001A
RO
**MBP01DF002A
SDV
**MBP01DF001A
ZIO
**MBP01DF005A
ZIC
**MBP01DF005A
SDV
**MBP01DF001A
ZIO
**MBP01DF004A
ZIC
**MBP01DF004A
**MBP01AA724
FC
**MBP01AA725
FC
**MBP01BR007-C1-50
**MBP01BR001-C1-50
GT FUEL GAS CARTRIDGE FILTER
GTC
DPT
GTC
**MBP01CP145.
PT
**MBP01CP145.
GTC
**MBP01CP146.
PT
**MBP01CP146.
107 MEC-GA-FCS-1091
NATURAL GAS FROM FILTER COALESCER 1
90EKG09BR003-**-300
EKG13BR001--300
111 MEC-GA-FCS-1092
NATURAL GAS FROM FILTER COALESCER 2
NOTE 7
NOTE 1, 2
NOTE 3
**MBP01AT111
GT FUEL GAS CARTRIDGE FILTER
ZIC
**MBP01DF001A
ZIO
**MBP01DF001A
SDV
**MBP01DF001A
ZIC
**MBP01DF002A
ZIO
**MBP01DF002A
SDV
**MBP01DF001A
SDV
**MBP01DF001A
ZIC
**MBP01DF003A
ZIO
**MBP01DF003A
300x200
**MBP01AA721
200
FO
**MBP01BR007-C1-200
**MBP01AA722
200
FO
**MBP01AA723
200
FO
200x300
NOTE 4
113 MEC-GA-GEN-1095
NATURAL GAS TO FUEL GAS SUPPLY UNIT
25
TO DRAIN
BUND
HOLDS
NOTES:
1. THIS PIPING ARRANGEMENT SHALL BE DRAWN BY AECOM AND INSTALLED BY CONSTRUCTION CONTRACTOR
2. FLANGED CONNECTION SHALL BE PROVIDED FOR PIPE CLEANING
3. SHORT SPOOL FOR CLEANING OF PIPE
4. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
5. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
6. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
7. REMOVABLE SPOOL FROM INSTALLATION OF TEMPORARY COMMISSIONING FILTER.
ISSUED FOR INFORMATION ONLY
B AECOM 14.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-GA-GEN-DRG-1097
REV: B
DRAWN MB 14.01.2022
DRAWING CHECKED BW 14.01.2022
DESIGNED JD 14.01.2022
DESIGN CHECKED BWT 14.01.2022
SCALE
WORK ORDER No
APPROVED CDT 14.01.2022
SECTION No/KKS MBP
A1 SHEET SIZE
snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
NATURAL GAS SUPPLY - NATURAL GAS CARTRIDGE FILTER
AND ISOLATION FOR GAS TURBINE UNIT 1
B REV SH 1 OF 1

Appendix D

Instrument Air System P&IDs Showing Nodes Applied in the HAZOP



NOTES:

1. TWO CENTRIFUGAL COMPRESSOR PACKAGES ARE REQUIRED FOR THE PROJECT. IN NORMAL OPERATION ONE IS IN SERVICE (DUTY) AND THE SECOND ONE IS STAND-BY.

HOLDS:

1. DESIGN CAPACITY AN OPERATING PRESSURE TO BE DETERMINED.
2. DETAIL INSIDE PACKAGES IS SCHEMATIC ONLY. DETAIL DESIGN SHALL BE DESIGNED, MANUFACTURED, PURCHASED AND FABRICATED INSIDE THE PACKAGES IN ACCORDANCE WITH ENGINEERING CODES AND STANDARDS DEFINED FOR THE PROJECT.
3. SUITABLE PRESSURE CONTROL METHOD SHALL BE FINALISED DURING DETAIL DESIGN BY VENDOR.
4. SIZE OF INSTRUMENT AIR LINES FOR AIR COMPRESSOR PACKAGE WILL BE FINALIZED IN DETAIL DESIGN AFTER RECEIVING VENDOR DATA.
5. THE USE OF ×× WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
6. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
7. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	27.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

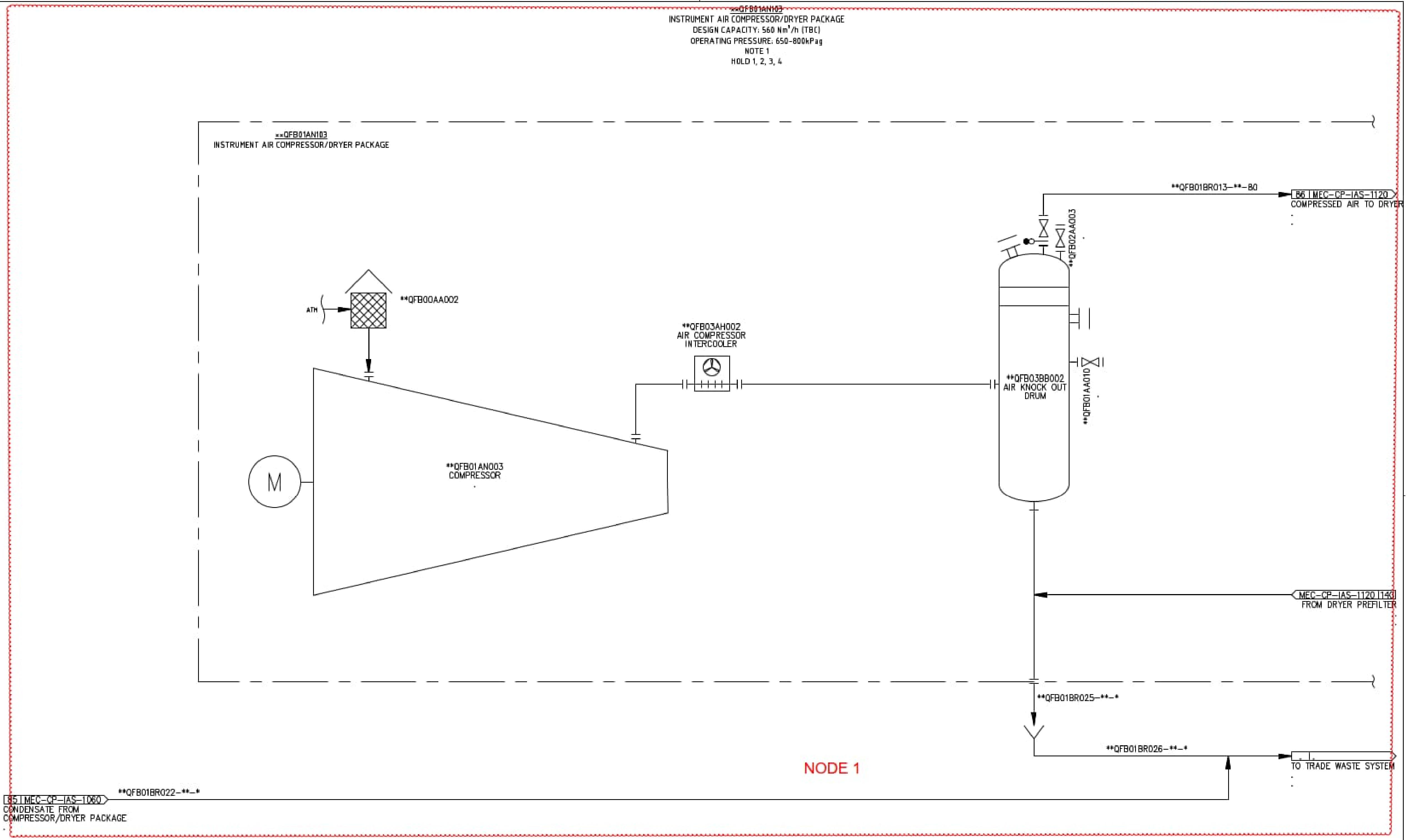
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-CP-IAS-DRG-1060
REV: B

DRAWN RPP 30.11.2021	DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021	DESIGN CHECKED BWT 30.11.2021
SCALE WORK ORDER No	APPROVED CDT 30.11.2021
SECTION No/KKS QFB	A1 SHEET SIZE

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
INSTRUMENT AIR UNIT - AIR COMPRESSORS

B REV SH 1 OF 2



NOTES:

1. TWO CENTRIFUGAL COMPRESSOR PACKAGES ARE REQUIRED FOR THE PROJECT. IN NORMAL OPERATION ONE IS IN SERVICE (DUTY) AND THE SECOND ONE IS STAND-BY.

HOLDS:

1. DESIGN CAPACITY AN OPERATING PRESSURE TO BE DETERMINED.
2. DETAIL INSIDE PACKAGES IS SCHEMATIC ONLY. DETAIL DESIGN SHALL BE DESIGNED, MANUFACTURED, PURCHASED AND FABRICATED INSIDE THE PACKAGES IN ACCORDANCE WITH ENGINEERING CODES AND STANDARDS DEFINED FOR THE PROJECT.
3. SUITABLE PRESSURE CONTROL METHOD SHALL BE FINALISED DURING DETAIL DESIGN BY VENDOR.
4. SIZE OF INSTRUMENT AIR LINES FOR AIR COMPRESSOR PACKAGE WILL BE FINALIZED IN DETAIL DESIGN AFTER RECEIVING VENDOR DATA.
5. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
6. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
7. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

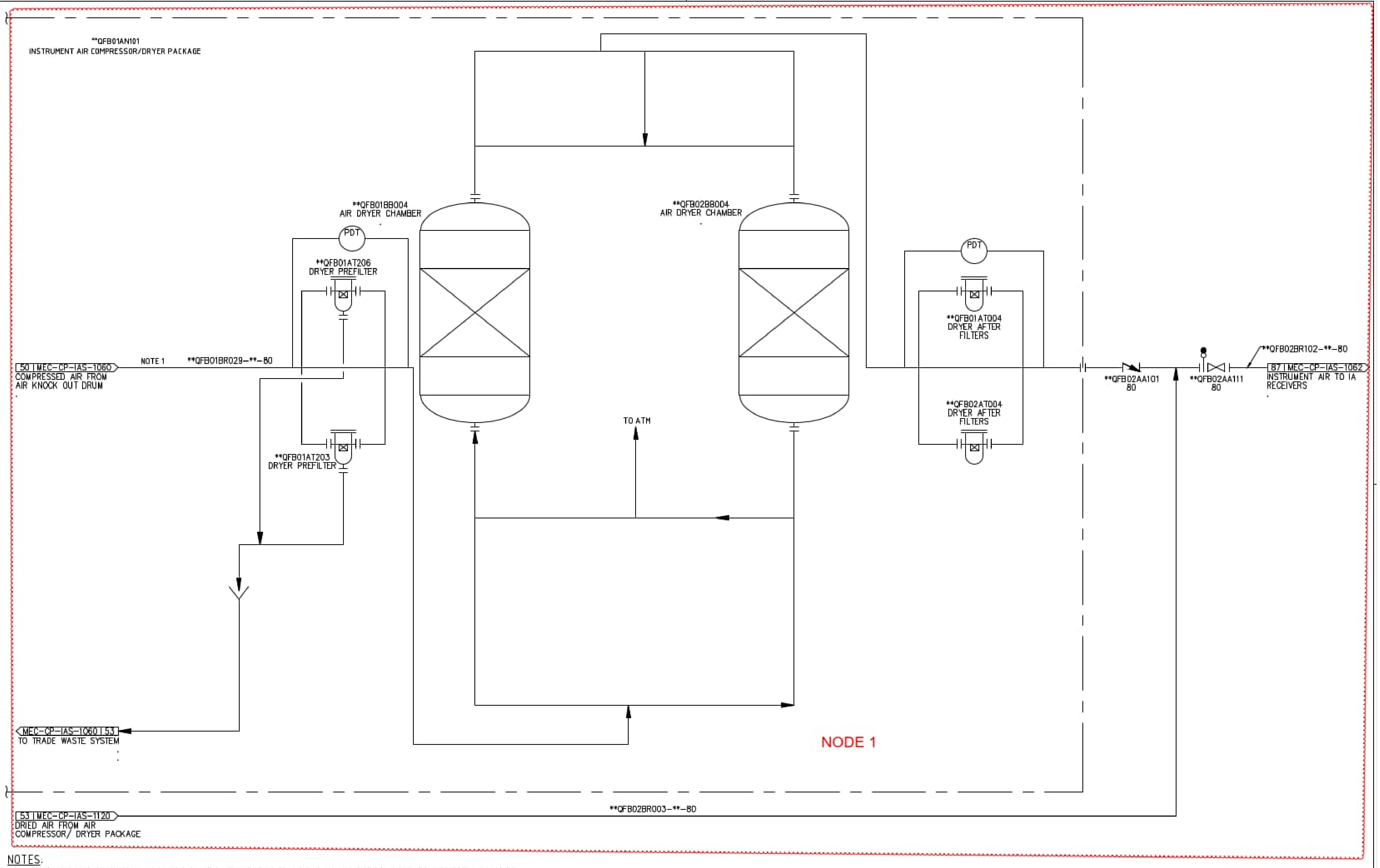
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-CP-IAS-DRG-1118
REV: B

DRAWN RPP 30.11.2021	DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021	DESIGN CHECKED BWT 30.11.2021
SCALE / WORK ORDER No	APPROVED CDT 30.11.2021
SECTION No/KKS QFB	A1 SHEET SIZE

snowyhydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
INSTRUMENT AIR UNIT - AIR COMPRESSORS

B REV SH 2 OF 2



NOTES:

1. PIPING BETWEEN THE COMPRESSOR DISCHARGE AND DRYER INLET SHALL HAVE AUTOMATIC CONDENSATE DRAINING FACILITIES AT ALL LOW POINTS.

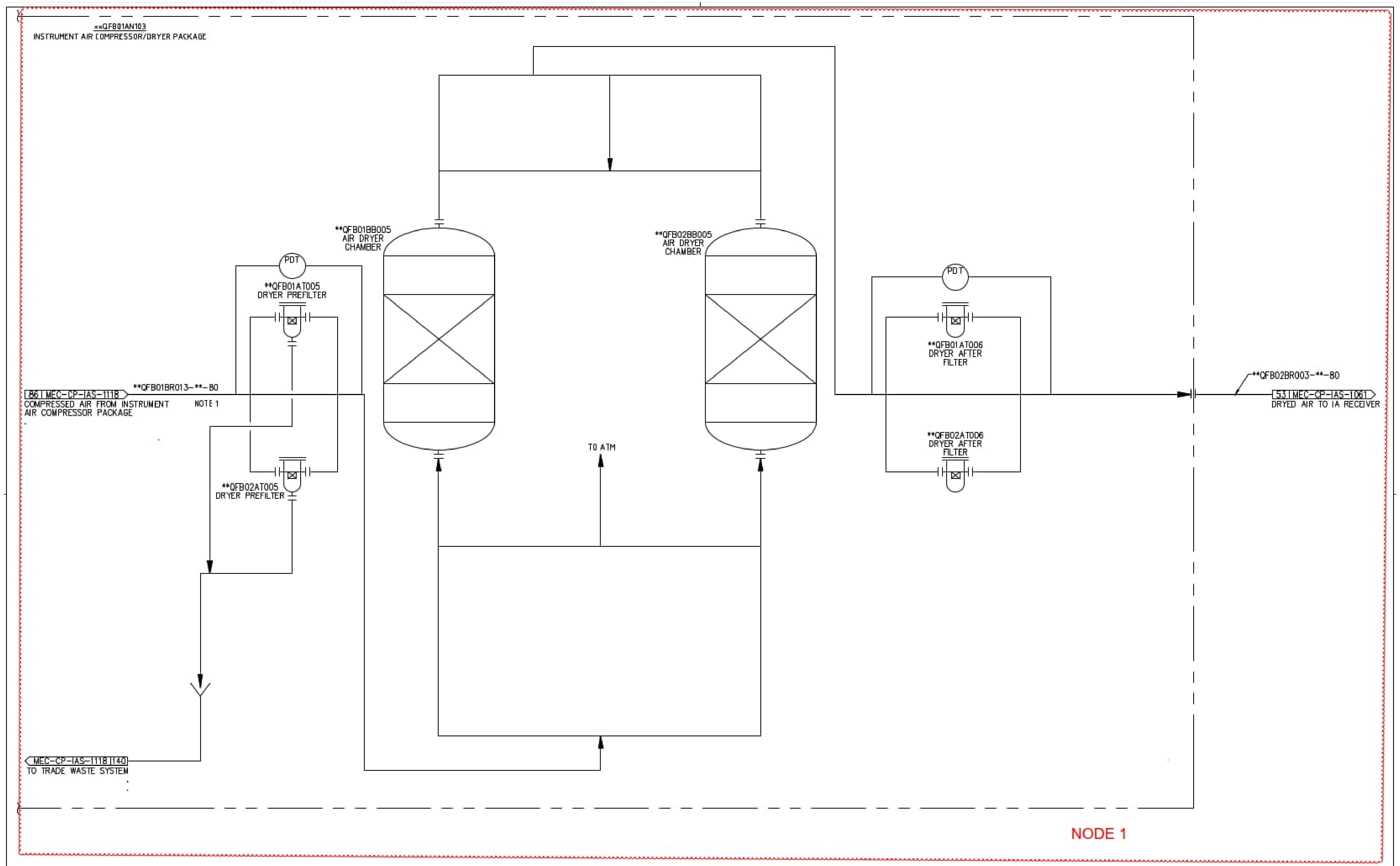
HOLDS:

1. CAPACITY IS BASED ON PRODUCED INSTRUMENT AIR, PRELIMINARY DATA FOR THE CAPACITY TO BE CONFIRMED BY VENDOR.
2. DETAIL INSIDE THE PACKAGES IS SCHEMATIC ONLY DETAIL DESIGN SHALL BE BESIGNED, MANUFACTURED, PURCHASED AND FABRICATED INSIDE THE PACKAGES IN ACCORDANCE WITH ENGINEERING CODES AND STANDARDS DEFINED FOR THE PROJECT.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM AECOM Australia Pty Ltd	DRAWN LAF 30.11.2021	DRAWING CHECKED BVA 30.11.2021	snowyhydro LIMITED
	DESIGNED KW 30.11.2021	DESIGN CHECKED BWT 30.11.2021	HUNTER POWER STATION PIPING & INSTRUMENTATION DIAGRAM INSTRUMENT AIR UNIT - AIR DRYERS
DRAWING No. HPP-AEC-MEC-CP-IAS-DRG-1061	SCALE WORK ORDER No	APPROVED CDT 30.11.2021	
REV: B	SECTION No/KKS QFB	A1 SHEET SIZE	B REV SH 1 OF 2



NOTES:

1. PIPING BETWEEN THE COMPRESSOR DISCHARGE AND DRYER INLET SHALL HAVE AUTOMATIC CONDENSATE DRAINING FACILITIES AT ALL LOW POINTS.

HOLDS:

1. CAPACITY IS BASED ON PRODUCED INSTRUMENT AIR. PRELIMINARY DATA FOR THE CAPACITY TO BE CONFIRMED BY VENDOR.
2. DETAIL INSIDE THE PACKAGES IS SCHEMATIC ONLY DETAIL DESIGN SHALL BE DESIGNED, MANUFACTURED, PURCHASED AND FABRICATED INSIDE THE PACKAGES IN ACCORDANCE WITH ENGINEERING CODES AND STANDARDS DEFINED FOR THE PROJECT.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	27.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

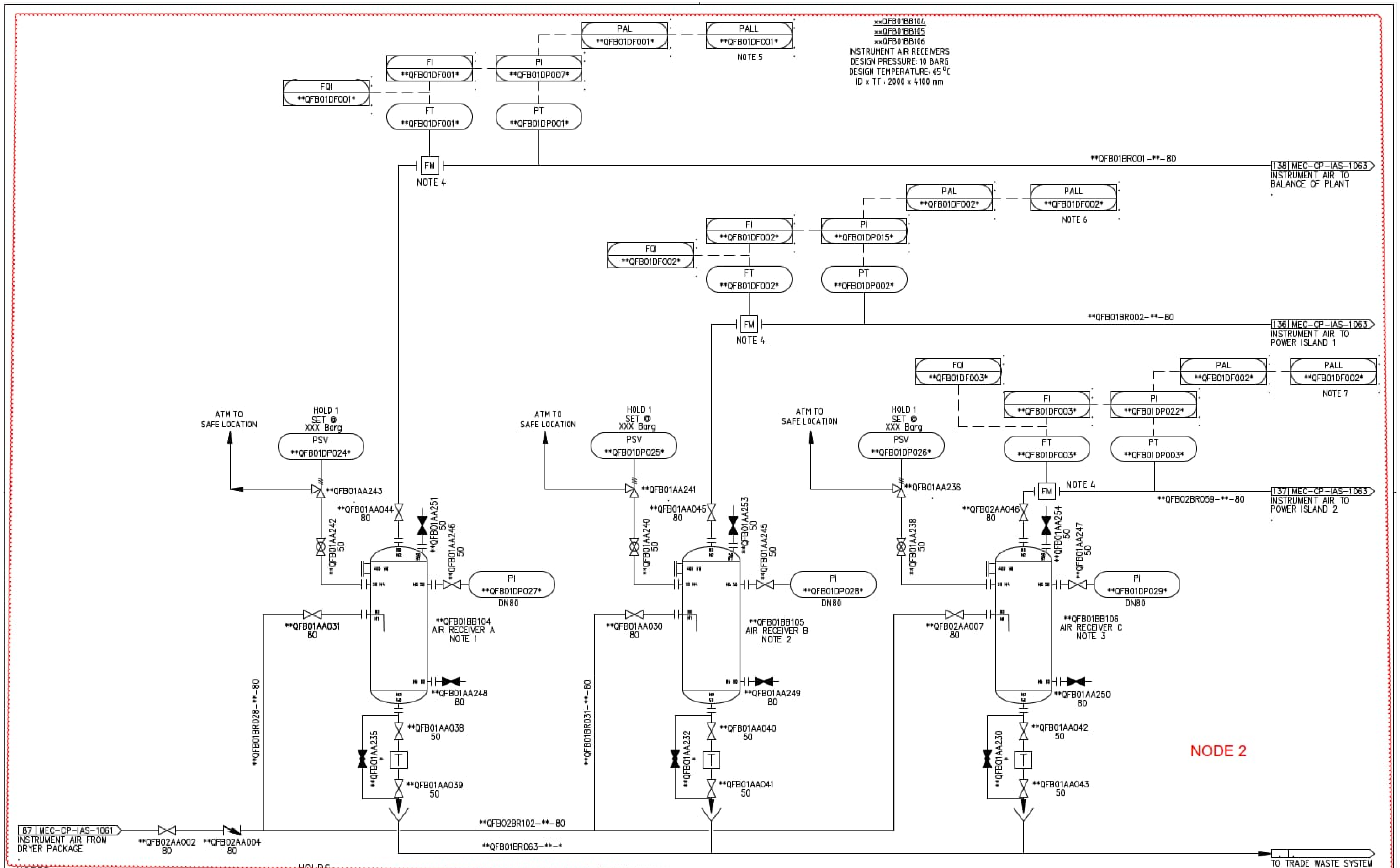
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-CP-IAS-DRG-1120
REV: B

DRAWN LAF 30.11.2021	DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021	DESIGN CHECKED BWT 30.11.2021
SCALE / WORK ORDER No	APPROVED CDT 30.11.2021
SECTION No/KKS QFB	A1 SHEET SIZE

snowyhydro

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
INSTRUMENT AIR UNIT - AIR DRYERS

B REV SH 2 OF 2



NOTES:

1. TO BE LOCATED ON BOP.
2. TO BE LOCATED ON POWER ISLAND 1.
3. TO BE LOCATED ON POWER ISLAND 2.
4. FLOW ORIFICE TYPE FLOW METER.
5. LOW LOW PRESSURE ALARM TO INITIATE BOTH GTs SHUTDOWN AND CLOSE THE NG SUPPLY SDV.
6. LOW LOW PRESSURE ALARM TO INITIATE POWER ISLAND 1 SHUTDOWN.
7. LOW LOW PRESSURE ALARM TO INITIATE POWER ISLAND 2 SHUTDOWN.

HOLDS:

1. SIZE OF PSV WILL BE FINALIZED IN DETAIL DESIGN AFTER RECEIVING VENDOR DATA FOR COMPRESSOR PACKAGE.
2. THE USE OF xx WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

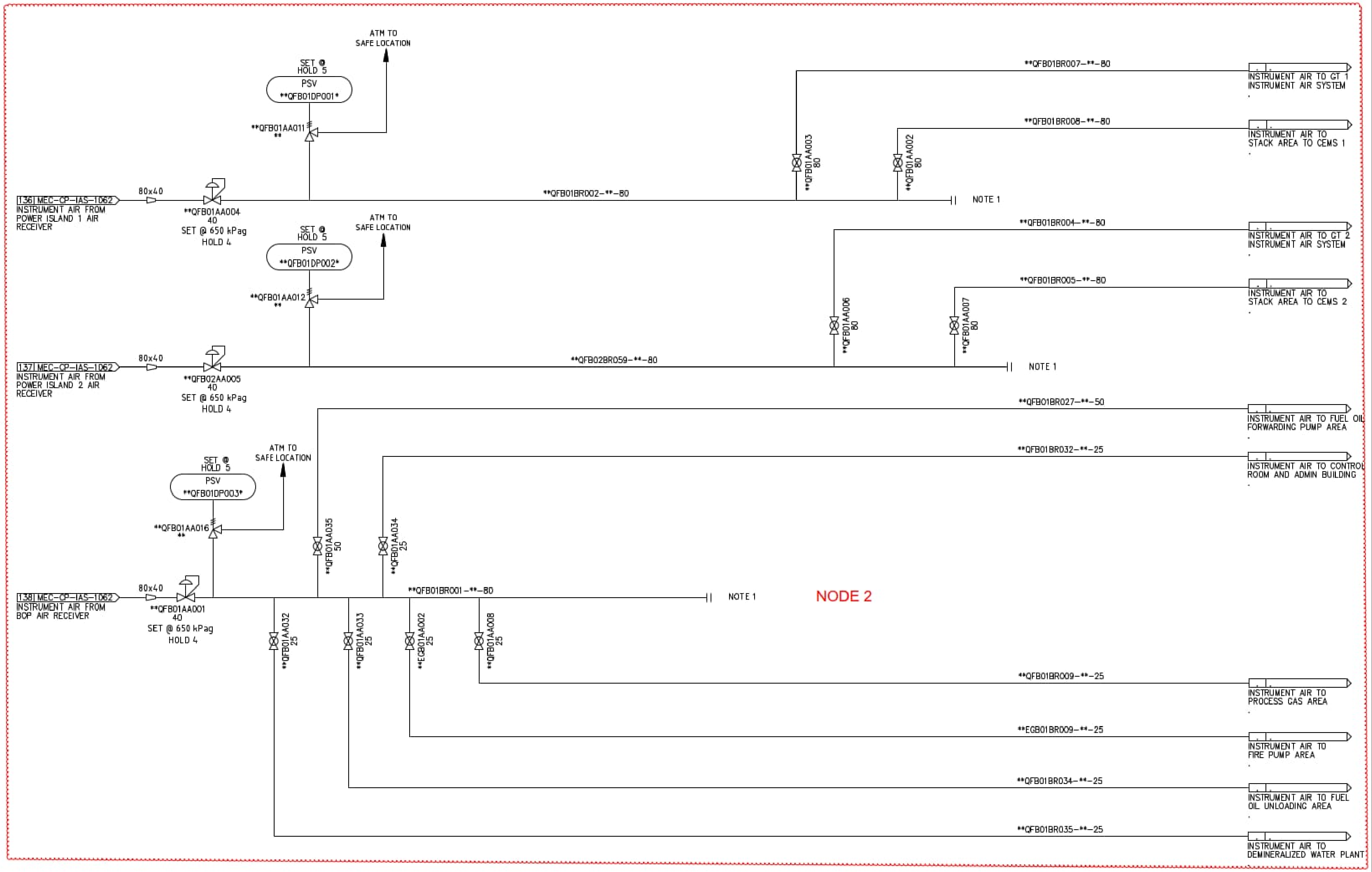
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-CP-IAS-DRG-1062
REV: B

DRAWN LAF 30.11.2021	DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021	DESIGN CHECKED BWT 30.11.2021
SCALE / WORK ORDER No	APPROVED CDT 30.11.2021
SECTION No/KKS QFB	A1 SHEET SIZE

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
INSTRUMENT AIR UNIT - AIR RECEIVERS

B REV SH 1 OF 1



NOTES:

1. HEADER DEAD LEG TO BE CLOSE TO LAST TAKE OFF TO PREVENT DEAD LEG IN THE SYSTEM.

HOLDS:

1. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
2. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
3. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
4. PRESSURE REGULATOR SET PRESSURE TO BE CONFIRMED.
5. PRESSURE RELIEF VALVE SET PRESSURE TO BE CONFIRMED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-CP-IAS-DRG-1063
REV: B

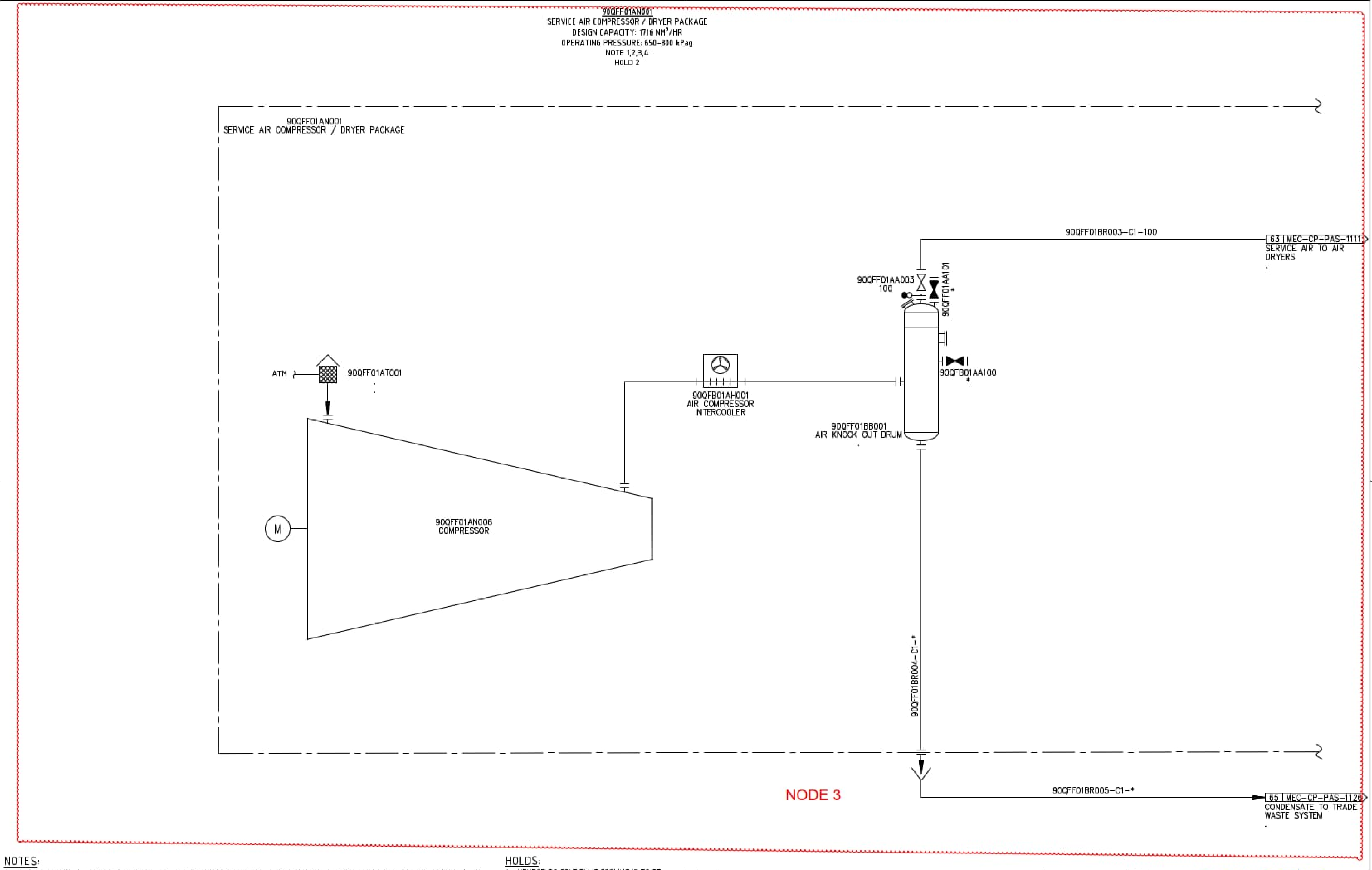
DRAWN SR 30.11.2021	DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021	DESIGN CHECKED BWT 30.11.2021
SCALE WORK ORDER No	APPROVED CDT 30.11.2021
SECTION No/KKS QFB	A1 SHEET SIZE

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
INSTRUMENT AIR UNIT - AIR DISTRIBUTION

B REV SH 1 OF 1

Appendix E

Service Air System P&IDs Showing Nodes Applied in the HAZOP



NOTES:

1. TWO CENTRIFUGAL COMPRESSOR PACKAGES ARE REQUIRED FOR THE PROJECT. IN NORMAL OPERATION ONE IS IN SERVICE (DUTY) AND THE SECOND ONE IS STAND-BY.
2. DETAIL INSIDE THE PACKAGES IS SCHEMATIC ONLY. DETAIL DESIGN SHALL BE DESIGNED, MANUFACTURED, PURCHASED AND FABRICATED INSIDE THE PACKAGES IN ACCORDANCE WITH ENGINEERING CODES AND STANDARDS DEFINED FOR THE PROJECT.
3. SUITABLE PRESSURE CONTROL METHOD SHALL BE FINALIZED DURING DETAIL DESIGN BY VENDOR.
4. SIZE OF INSTRUMENT AIR LINES FOR AIR COMPRESSOR PACKAGE WILL BE FINALIZED IN DETAIL DESIGN AFTER RECEIVING VENDOR DATA.
5. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
6. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
7. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

HOLDS:

1. VENDOR TO CONFIRM IF COOLING IS TO BE SUPPLIED THROUGH BATTERY LIMITS OR IF PACKAGE HAS ITS OWN COOLING UNIT.
2. PACKAGE DETAILS TO BE CONFIRMED.

ISSUED FOR INFORMATION ONLY

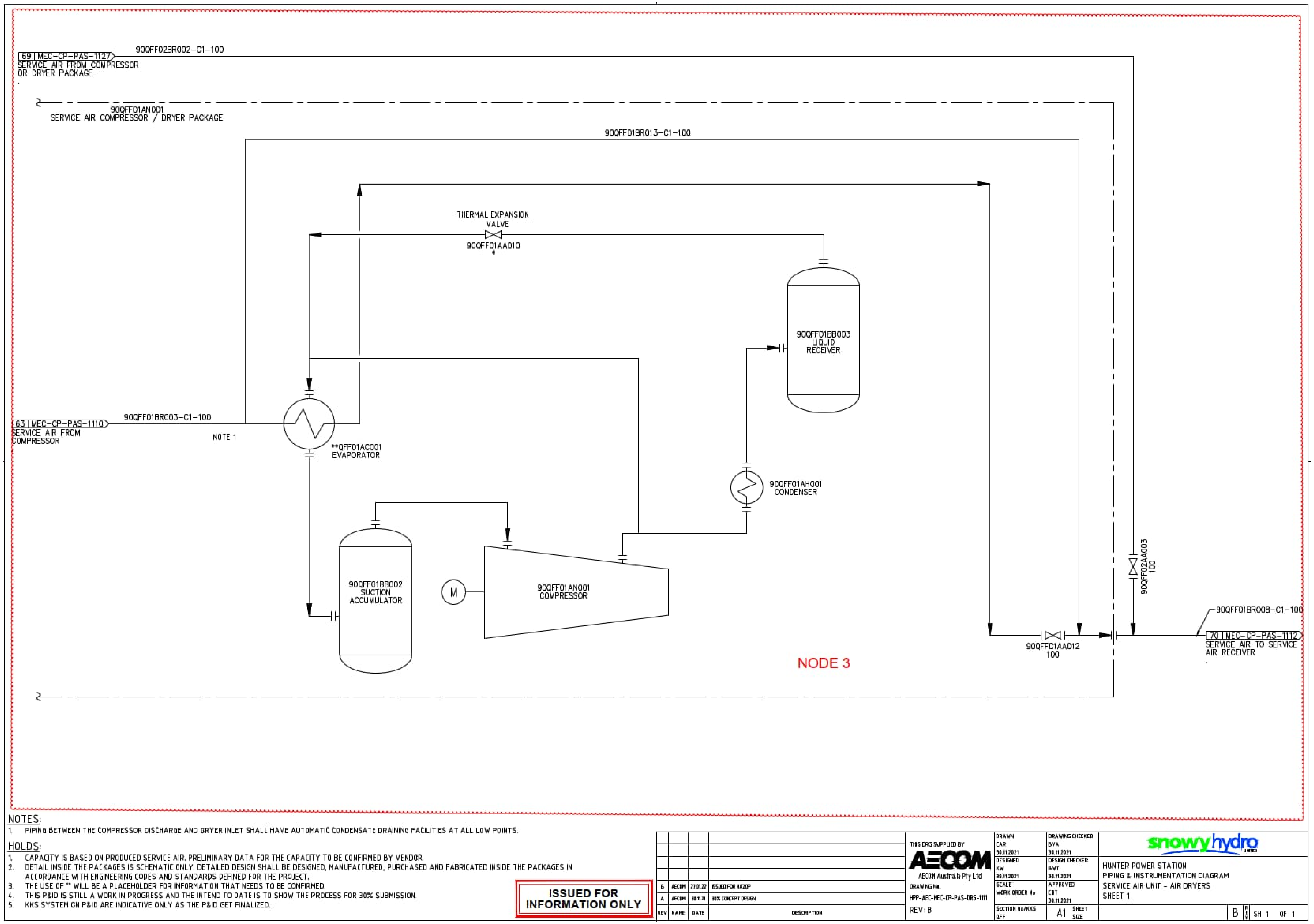
REV	NAME	DATE	DESCRIPTION
B	AECOM	27.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

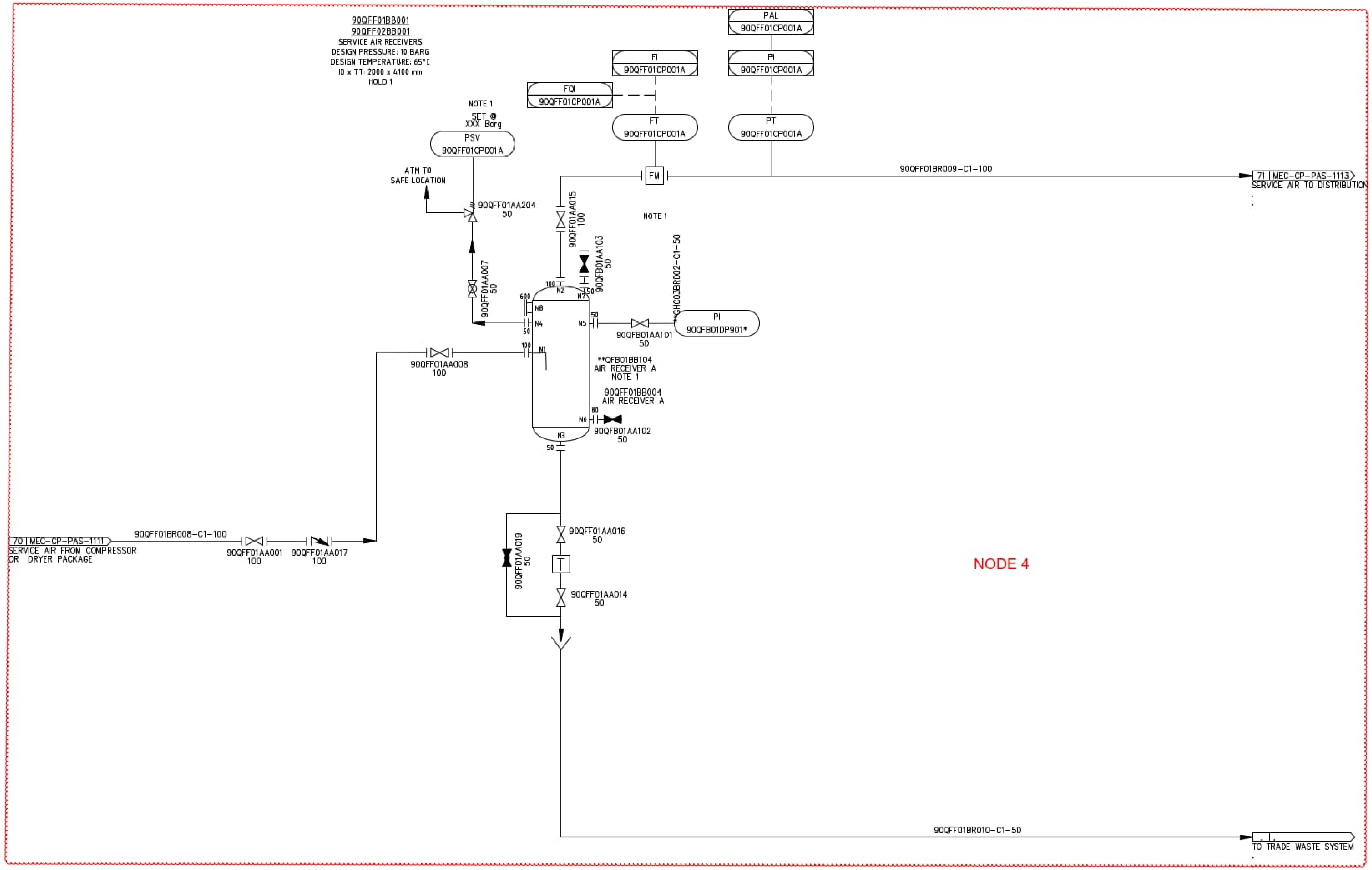
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-CP-PAS-DRG-1110
REV: B

DRAWN LAF 30.11.2021	DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021	DESIGN CHECKED BWT 30.11.2021
SCALE / WORK ORDER No	APPROVED CDT 30.11.2021
SECTION No/KKS QFF	A1 SHEET SIZE

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE AIR UNIT – AIR COMPRESSORS
SHEET 1

REV B SH 1 OF 1


90QFF02BR002-C1-100
69 | MEC-CP-PAS-1127
SERVICE AIR FROM COMPRESSOR OR DRYER PACKAGE
90QFF01AN001
SERVICE AIR COMPRESSOR / DRYER PACKAGE
90QFF01BR013-C1-100
THERMAL EXPANSION VALVE
90QFF01AA010
90QFF01BB003
LIQUID RECEIVER
63 | MEC-CP-PAS-1110
SERVICE AIR FROM COMPRESSOR
90QFF01BR003-C1-100
NOTE 1
**QFF01AC001
EVAPORATOR
90QFF01AH001
CONDENSER
90QFF01BB002
SUCTION ACCUMULATOR
M
90QFF01AN001
COMPRESSOR
90QFF02AA003
100
90QFF01BR008-C1-100
70 | MEC-CP-PAS-1112
SERVICE AIR TO SERVICE AIR RECEIVER
90QFF01AA012
100
NODE 3
NOTES:
1. PIPING BETWEEN THE COMPRESSOR DISCHARGE AND DRYER INLET SHALL HAVE AUTOMATIC CONDENSATE DRAINING FACILITIES AT ALL LOW POINTS.
HOLDS:
1. CAPACITY IS BASED ON PRODUCED SERVICE AIR. PRELIMINARY DATA FOR THE CAPACITY TO BE CONFIRMED BY VENDOR.
2. DETAIL INSIDE THE PACKAGES IS SCHEMATIC ONLY. DETAILED DESIGN SHALL BE DESIGNED, MANUFACTURED, PURCHASED AND FABRICATED INSIDE THE PACKAGES IN ACCORDANCE WITH ENGINEERING CODES AND STANDARDS DEFINED FOR THE PROJECT.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
ISSUED FOR INFORMATION ONLY
B AECOM 27.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-CP-PAS-DRG-1111
REV: B
DRAWN CAR 30.11.2021
DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021
DESIGN CHECKED BWT 30.11.2021
SCALE
WORK ORDER No
APPROVED CDT 30.11.2021
SECTION No/KKS QFF
A1 SHEET SIZE
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE AIR UNIT - AIR DRYERS
SHEET 1
B REV SH 1 OF 1



NOTES:
1. FLOW ORIFICE TYPE FLOWMETER.

HOLDS:
1. VENDOR SIZING OF SERVICE AIR RECEIVER TO BE CONFIRMED BASED ON RESULTS OF SERVICE AIR CONSUMPTION CALC.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

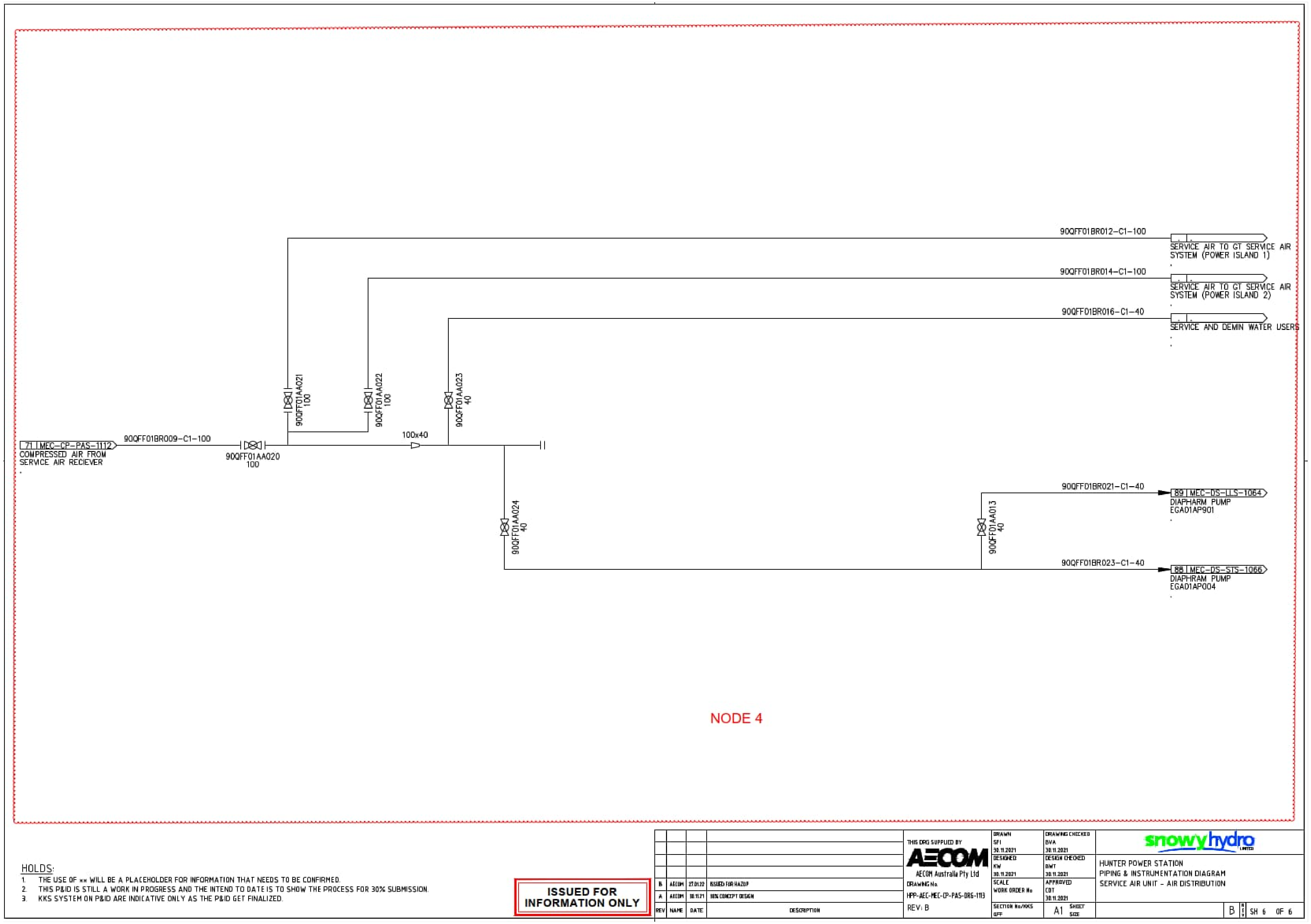
ISSUED FOR INFORMATION ONLY

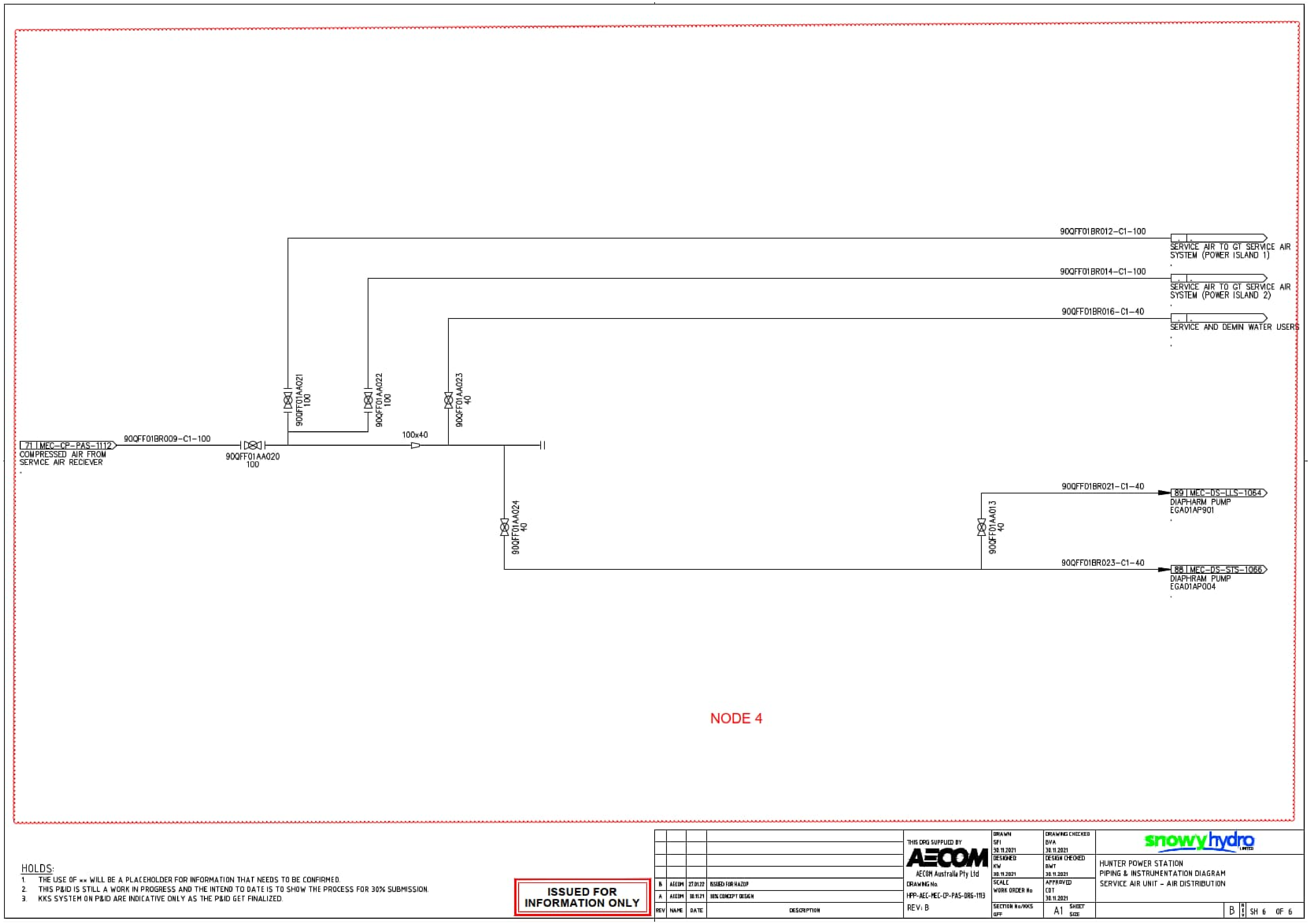
REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

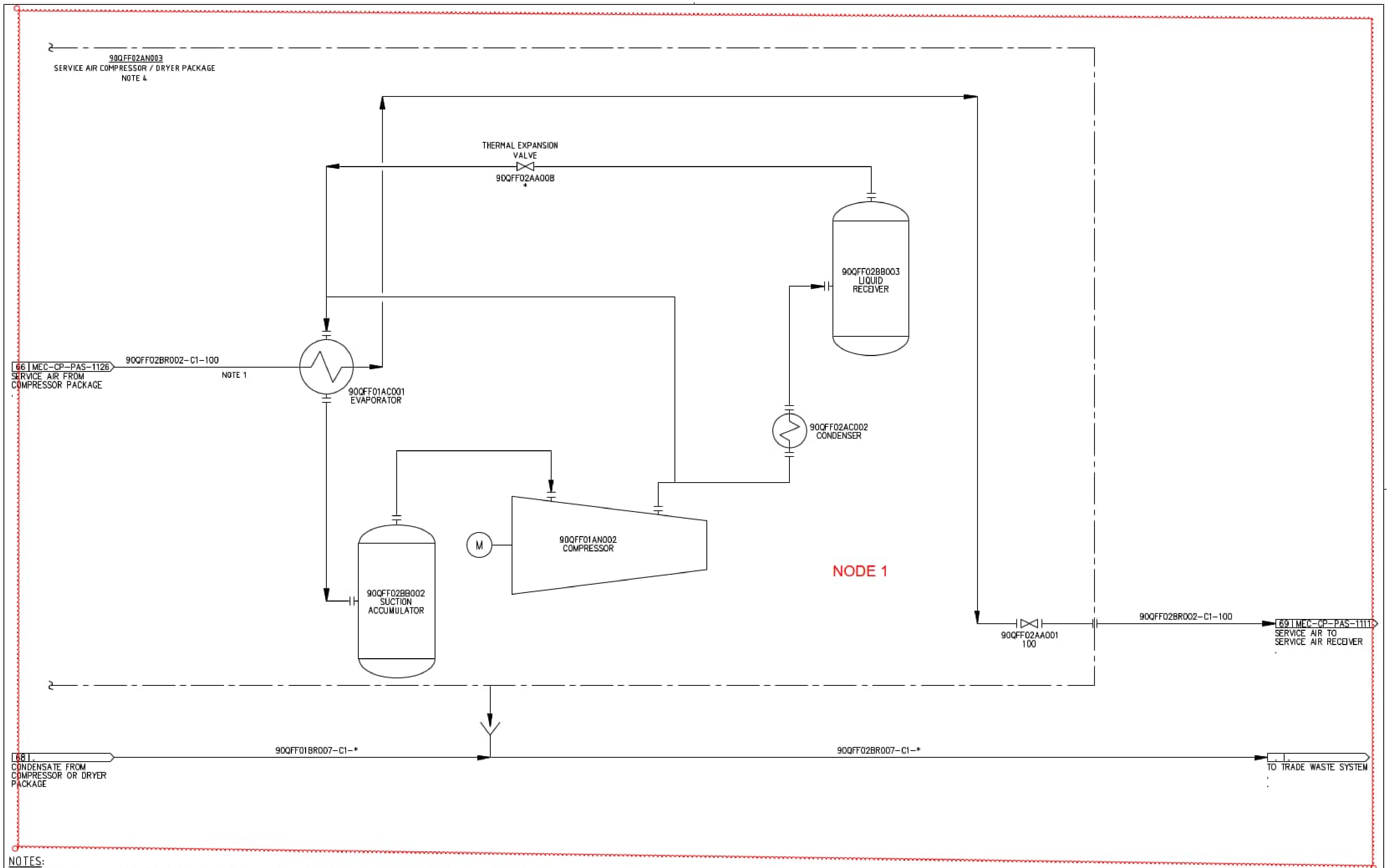
THIS DRG SUPPLIED BY
AECOM
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-CP-PAS-0RG-1112
REV: B

DRAWN SR 30.11.2021	DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021	DESIGN CHECKED BWT 30.11.2021
SCALE	APPROVED
WORK ORDER No	CDT 30.11.2021
SECTION No/KKS QFF	A1 SHEET SIZE

snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE AIR UNIT - AIR RECEIVER
B SH 1 OF 1


90QFF01BR012–C1–100
SERVICE AIR TO GT SERVICE AIR SYSTEM (POWER ISLAND 1)
90QFF01BR014–C1–100
SERVICE AIR TO GT SERVICE AIR SYSTEM (POWER ISLAND 2)
90QFF01BR016–C1–40
SERVICE AND DEMIN WATER USERS
90QFF01AA021 100
90QFF01AA022 100
90QFF01AA023 40
71 MEC–CP–PAS–1112
COMPRESSED AIR FROM SERVICE AIR RECIEVER
90QFF01BR009–C1–100
90QFF01AA020 100
100x40
90QFF01BR021–C1–40
89 MEC–DS–LLS–1064
DIAPHARM PUMP EGAD1AP901
90QFF01AA024 40
90QFF01AA013 40
90QFF01BR023–C1–40
88 MEC–DS–STS–1066
DIAPHRAM PUMP EGAD1AP004
NODE 4
HOLDS:
1. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
2. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
3. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
ISSUED FOR INFORMATION ONLY
B AECOM 27.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-CP-PAS-DRG-1113
REV: B
DRAWN SFI 30.11.2021
DESIGNED KW 30.11.2021
SCALE
WORK ORDER No
SECTION No/KKS QFF
DRAWING CHECKED BVA 30.11.2021
DESIGN CHECKED BWT 30.11.2021
APPROVED CDT 30.11.2021
A1 SHEET SIZE
snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE AIR UNIT – AIR DISTRIBUTION
B REV SH 6 OF 6


90QFF01BR012–C1–100
SERVICE AIR TO GT SERVICE AIR SYSTEM (POWER ISLAND 1)
90QFF01BR014–C1–100
SERVICE AIR TO GT SERVICE AIR SYSTEM (POWER ISLAND 2)
90QFF01BR016–C1–40
SERVICE AND DEMIN WATER USERS
90QFF01AA021 100
90QFF01AA022 100
90QFF01AA023 40
71 MEC–CP–PAS–1112
COMPRESSED AIR FROM SERVICE AIR RECIEVER
90QFF01BR009–C1–100
90QFF01AA020 100
100x40
90QFF01BR021–C1–40
89 MEC–DS–LLS–1064
DIAPHARM PUMP EGA01AP901
90QFF01AA024 40
90QFF01AA013 40
90QFF01BR023–C1–40
88 MEC–DS–STS–1066
DIAPHRAM PUMP EGA01AP004
NODE 4
HOLDS:
1. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
2. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
3. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
ISSUED FOR INFORMATION ONLY
B AECOM 27.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-CP-PAS-DRG-1113
REV: B
DRAWN SFI 30.11.2021
DESIGNED KW 30.11.2021
SCALE
WORK ORDER No
SECTION No/KKS QFF
DRAWING CHECKED BVA 30.11.2021
DESIGN CHECKED BWT 30.11.2021
APPROVED CDT 30.11.2021
A1 SHEET SIZE
snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE AIR UNIT – AIR DISTRIBUTION
B SH 6 OF 6



NOTES:

1. PIPING BETWEEN THE COMPRESSOR DISCHARGE AND DRYER INLET SHALL HAVE AUTOMATIC CONDENSATE DRAINING FACILITIES AT ALL LOW POINTS.
2. PART OF THE SAME SERVICE AIR DRYER PACKAGE FROM DRAWING: HPP-AEC-MEC-CP-PAS-DRG-1126.

HOLDS:

1. CAPACITY IS BASED ON PRODUCED SERVICE AIR. PRELIMINARY DATA FOR THE CAPACITY TO BE CONFIRMED BY VENDOR.
2. DETAIL INSIDE THE PACKAGES IS SCHEMATIC ONLY. DETAILED DESIGN SHALL BE DESIGNED, MANUFACTURED, PURCHASED AND FABRICATED INSIDE THE PACKAGES IN ACCORDANCE WITH ENGINEERING CODES AND STANDARDS DEFINED FOR THE PROJECT.
3. THE USE OF "*" WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-CP-PAS-DRG-1127
REV: B

DRAWN: CAR 30.11.2021	DRAWING CHECKED: BVA 30.11.2021
DESIGNED: KW 30.11.2021	DESIGN CHECKED: BWT 30.11.2021
SCALE / WORK ORDER No	APPROVED: CDT 30.11.2021
SECTION No/KKS: QFF	A1 SHEET SIZE

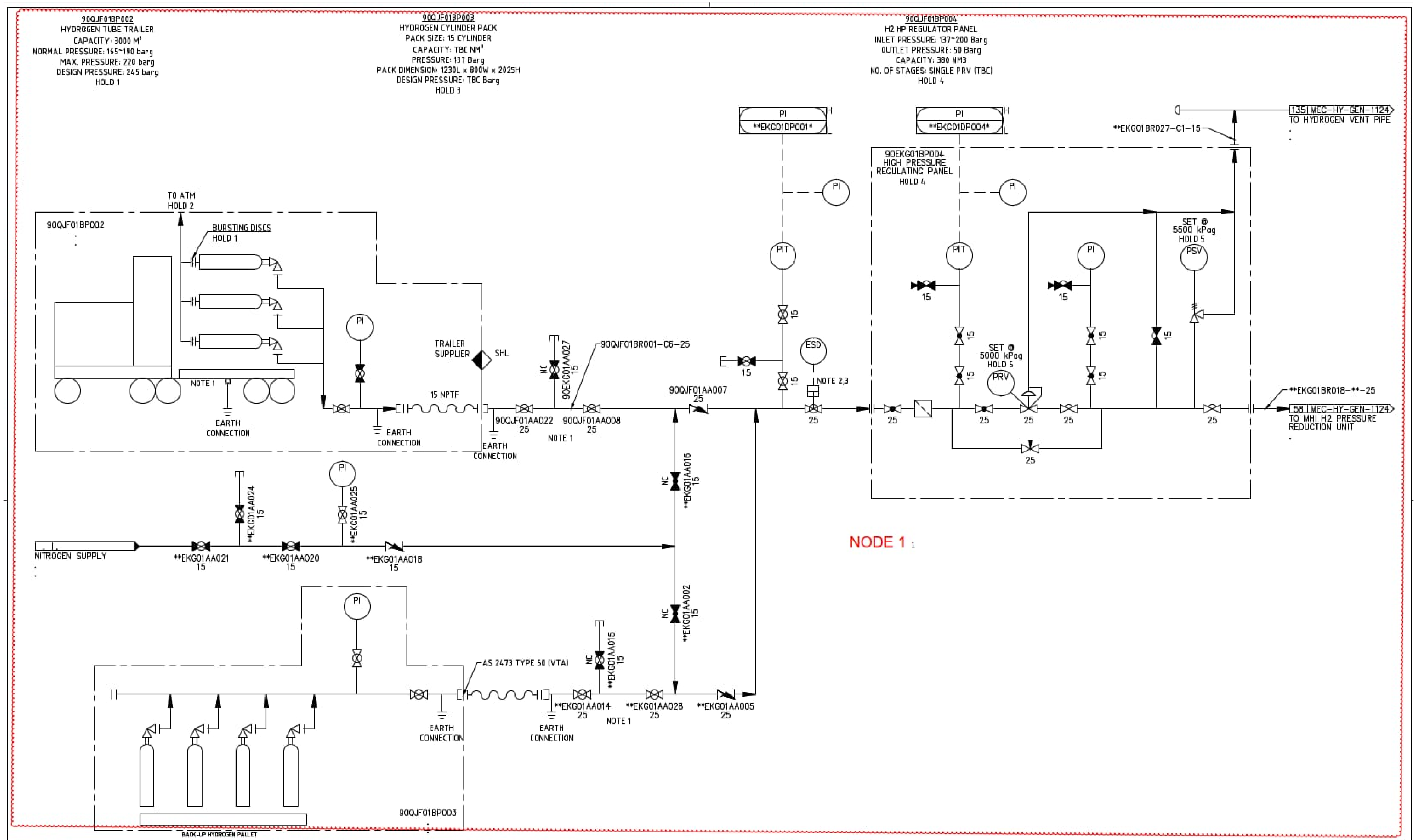
snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE AIR UNIT - AIR DRYERS
SHEET 2

B REV SH 4 OF 6

Appendix F

H2, CO2 & N2 Systems P&IDs Showing Nodes Applied in the HAZOP



NOTES:

1. VALVES ARE OPEN ONLY DURING GENERATOR RECHARGE VIA TRAILER OR H2 MAKE-UP THROUGH H2 BOTTLES.
2. EMERGENCY SHUTDOWN VALVE.
3. ALL VALVES TO BE FIRE SAFE.

HOLDS:

1. TRAILER DATA INCLUDING CAPACITY, SUPPLY AND DESIGN PRESSURE AND RUPTURE DISCS RELEASE RATE WILL BE FINALIZED WITH SUPPLIER.
2. DISCHARGE TO SAFE LOCATION, AT LEAST 3m ABOVE ADJACENT STRUCTURE AND BUILDINGS (TBC).
3. CYLINDER PACK DATA INCLUDING CAPACITY, SUPPLY AND DESIGN PRESSURE WILL BE FINISHED WITH SUPPLIER.
4. PRESSURE REDUCTION STAGES WILL BE FINALIZED BY CONTROL VALVE SUPPLIER.
5. ALL PSV AND PCV SET PRESSURES ARE HOLD AND WILL BE FINALISED WITH SUPPLIER.
6. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
7. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
8. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM – AECOM Australia Pty Ltd

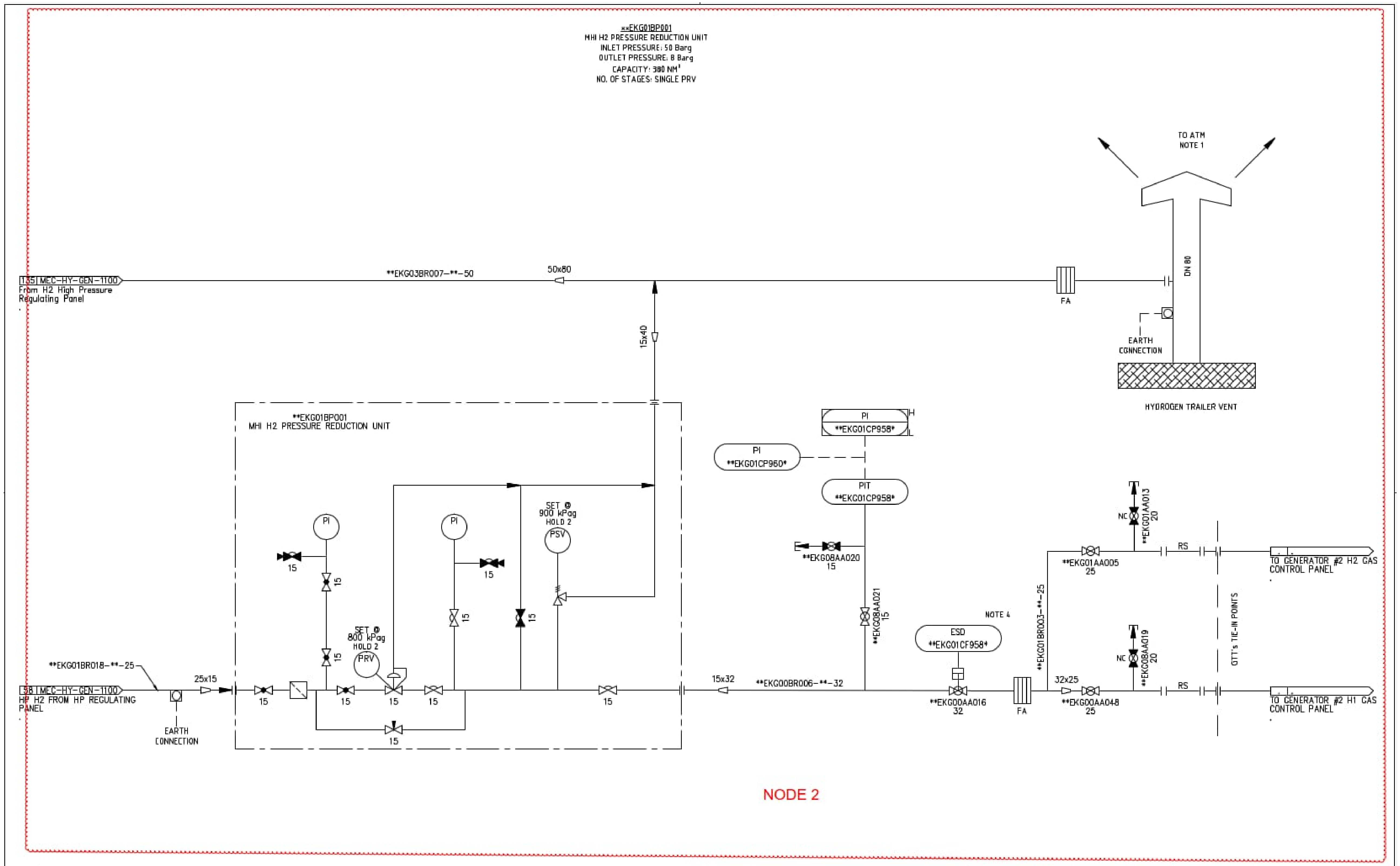
DRAWING No. HPP-AEC-MEC-HY-GEN-DRG-1100 REV: B

DRAWN: SR 30.11.2021 | DRAWING CHECKED: BVA 30.11.2021
DESIGNED: KW 30.11.2021 | DESIGN CHECKED: BWT 30.11.2021
SCALE / WORK ORDER No | APPROVED: CDT 30.11.2021
SECTION No/KKS DKG | A1 SHEET SIZE

snowy hydro

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
HYDROGEN FACILITY
TRAILER CYLINDER AND BACKUP BOTTLES - SHEET 1

B | SH 1 OF 1



NOTES:

1. ALL VALVES TO BE FIRE SAFE.
2. MHI H2 PRESSURE REDUCTION UNIT WILL BE SUPPLIED BY MITSUBISHI.

HOLDS:

1. DISCHARGE TO SAFE LOCATION, AT LEAST 3m ABOVE ADJACENT STRUCTURE AND BUILDINGS (TBC).
2. ALL PSV AND PCV SET PRESSURES ARE HOLD AND WILL BE FINALISED BY MITSUBISHI.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

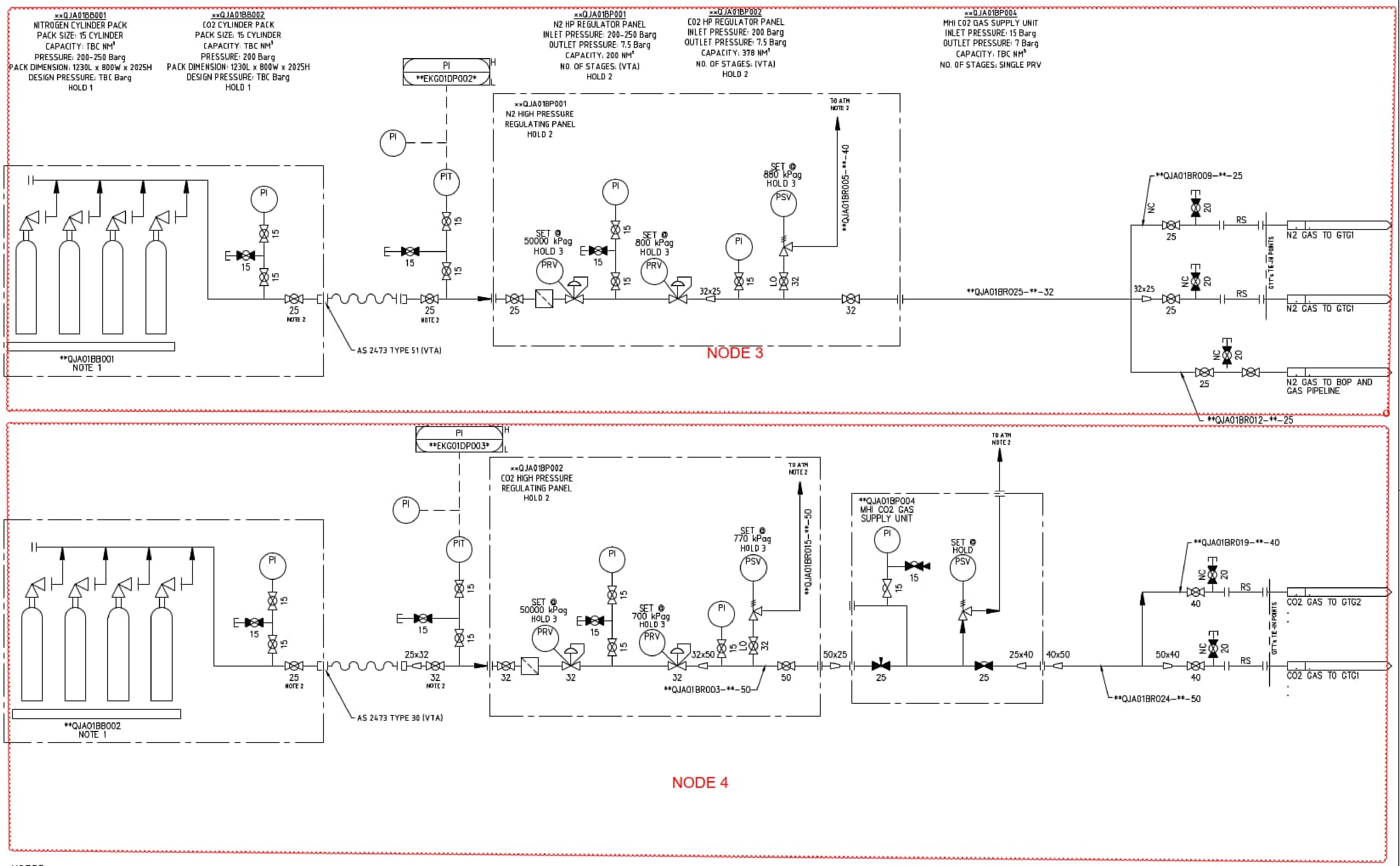
ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-HY-GEN-DRG-1124
REV: B

DRAWN SR 30.11.2021 | DRAWING CHECKED BVA 30.11.2021
DESIGNED KW 30.11.2021 | DESIGN CHECKED BWT 30.11.2021
SCALE | APPROVED CDT 30.11.2021
WORK ORDER No
SECTION No/KKS EKG | A1 SHEET SIZE

snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
HYDROGEN FACILITY
TRAILER CYLINDER AND BACKUP BOTTLES - SHEET 2
B REV SH 1 OF 1



NOTES:
1. VALVES ARE OPEN ONLY DURING PURGING OPERATION WHEN THERE IS DEMAND FOR.
2. DISCHARGE TO SAFE LOCATION.

HOLDS:
1. CYLINDER PACK DATA INCLUDING CAPACITY, SUPPLY AND DESIGN PRESSURE WILL BE FINALIZED WITH SUPPLIER.
2. PRESSURE REDUCTION STAGES WILL BE FINALIZED BY CONTROL VALVE SUPPLIER.
3. ALL PCV AND PSV SET POINTS ARE ON HOLD AND WILL BE FINALISED LATER.
4. THE USE OF ×× WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
5. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
6. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	21.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

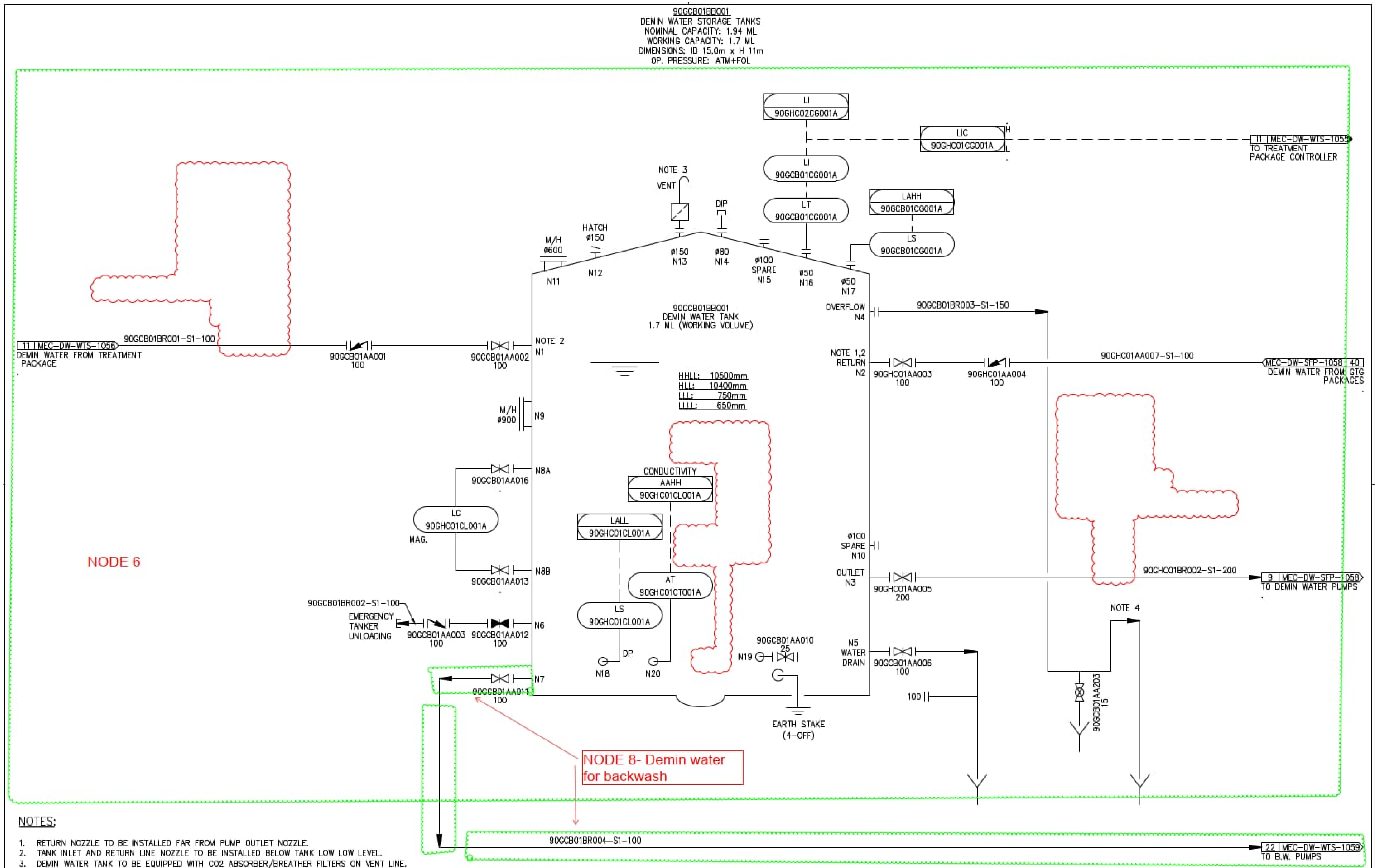
THIS DRG SUPPLIED BY AECOM — AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-HY-GEN-DRG-1102 — REV: B

DRAWN	RPP 30.11.2021	DRAWING CHECKED	BVA 30.11.2021
DESIGNED	KW 30.11.2021	DESIGN CHECKED	BWT 30.11.2021
SCALE		APPROVED	CDT 30.11.2021
WORK ORDER No			
SECTION No/KKS	QJA	SHEET SIZE	A1

snowy hydro
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
PROCESS GAS FACILITY
N2 AND CO2 PRESSURE REGULATOR PANELS
B SH 1 OF 1

Appendix G

Demin. Water System P&IDs Showing Nodes Applied in the HAZOP



NOTES:

1. RETURN NOZZLE TO BE INSTALLED FAR FROM PUMP OUTLET NOZZLE.
2. TANK INLET AND RETURN LINE NOZZLE TO BE INSTALLED BELOW TANK LOW LOW LEVEL.
3. DEMIN WATER TANK TO BE EQUIPPED WITH CO2 ABSORBER/BREATHER FILTERS ON VENT LINE.
4. SIPHON ARRANGEMENT SHOULD BE CONSIDERED FOR OVERFLOW LINE WITH MINIMUM 1m HEIGHT TO PREVENT AIR ENTRANCE TO THE DEMIN WATER TANK.

HOLDS:

1. CONSIDERATION TO APPLY WINTERIZATION FOR SMALL SIZE PIPE WILL BE FINALIZED LATER.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

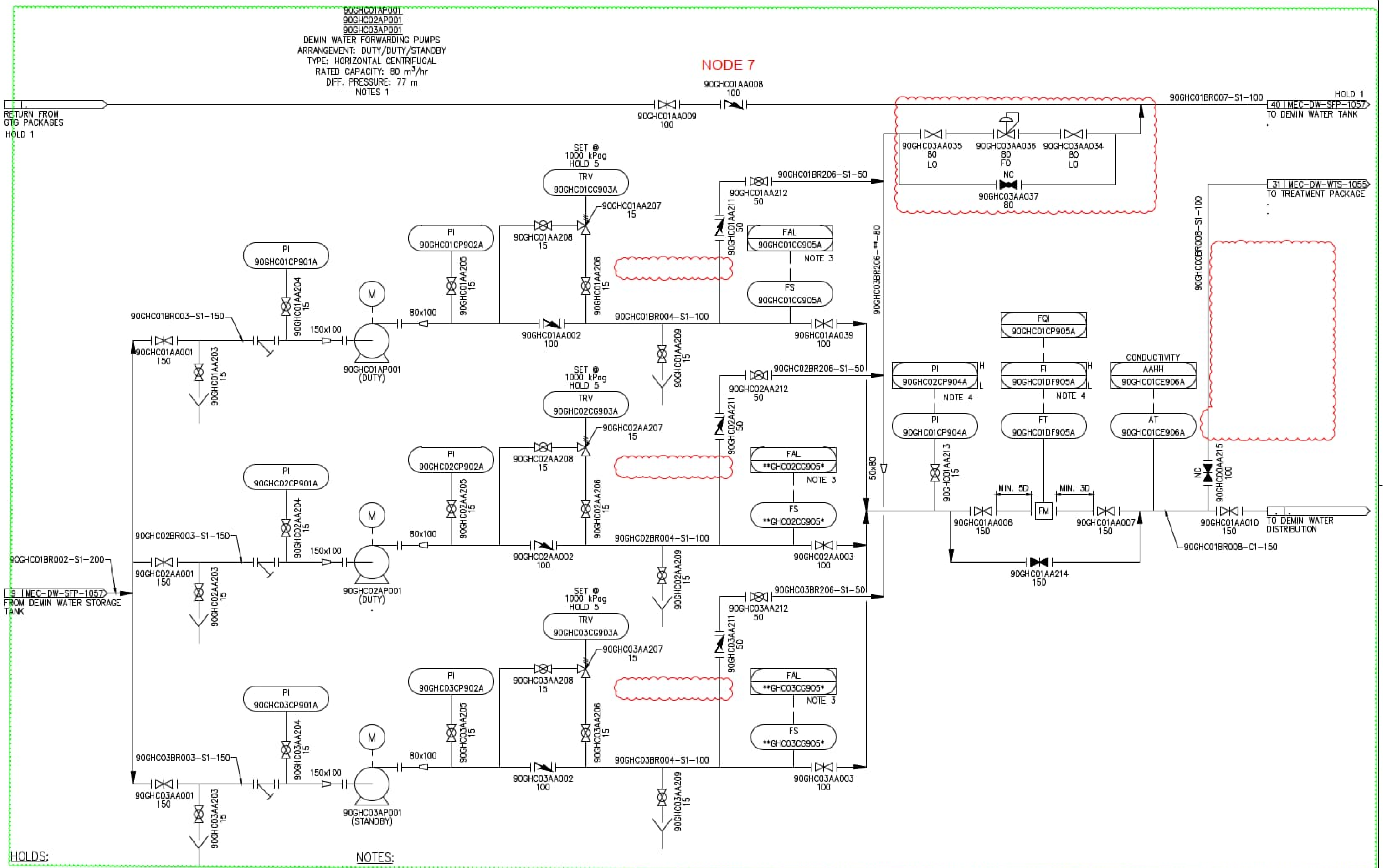
REV	NAME	DATE	DESCRIPTION
B	AECOM	28.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-DW-SFP-DRG-1057
REV: B

DRAWN LAF 28.01.2022	DRAWING CHECKED BVA 28.01.2022		
DESIGNED JD 28.01.2022	DESIGN CHECKED KW 28.01.2022		
SCALE	APPROVED CDT 28.01.2022		
WORK ORDER No			
SECTION No/KKS GHB / GHC	A1 SHEET SIZE	B	SH 1 OF 1

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DEMIN WATER - STORAGE TANK



HOLDS:

1. FILTERING REQUIREMENT ON RETURN LINE WILL BE FINALIZED LATER.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
5. ALL TRV SET PRESSURES ARE HOLD AND WILL BE FINALISED LATER.

NOTES:

1. DEMIN PUMP CAPACITY AND HEAD BASED ON MHI UTILITY LIST.
2. FLOW SWITCH WILL STOP THE PUMP IN CASE OF ACTIVATION WITH TIME DELAY.
3. PUMPS SEQUENCING SYSTEM WILL BE BASED ON SUPPLY LINE PRESSURE AND FLOW, LOW PRESSURE OR HIGH FLOW WILL START THE NEXT PUMP.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	28.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

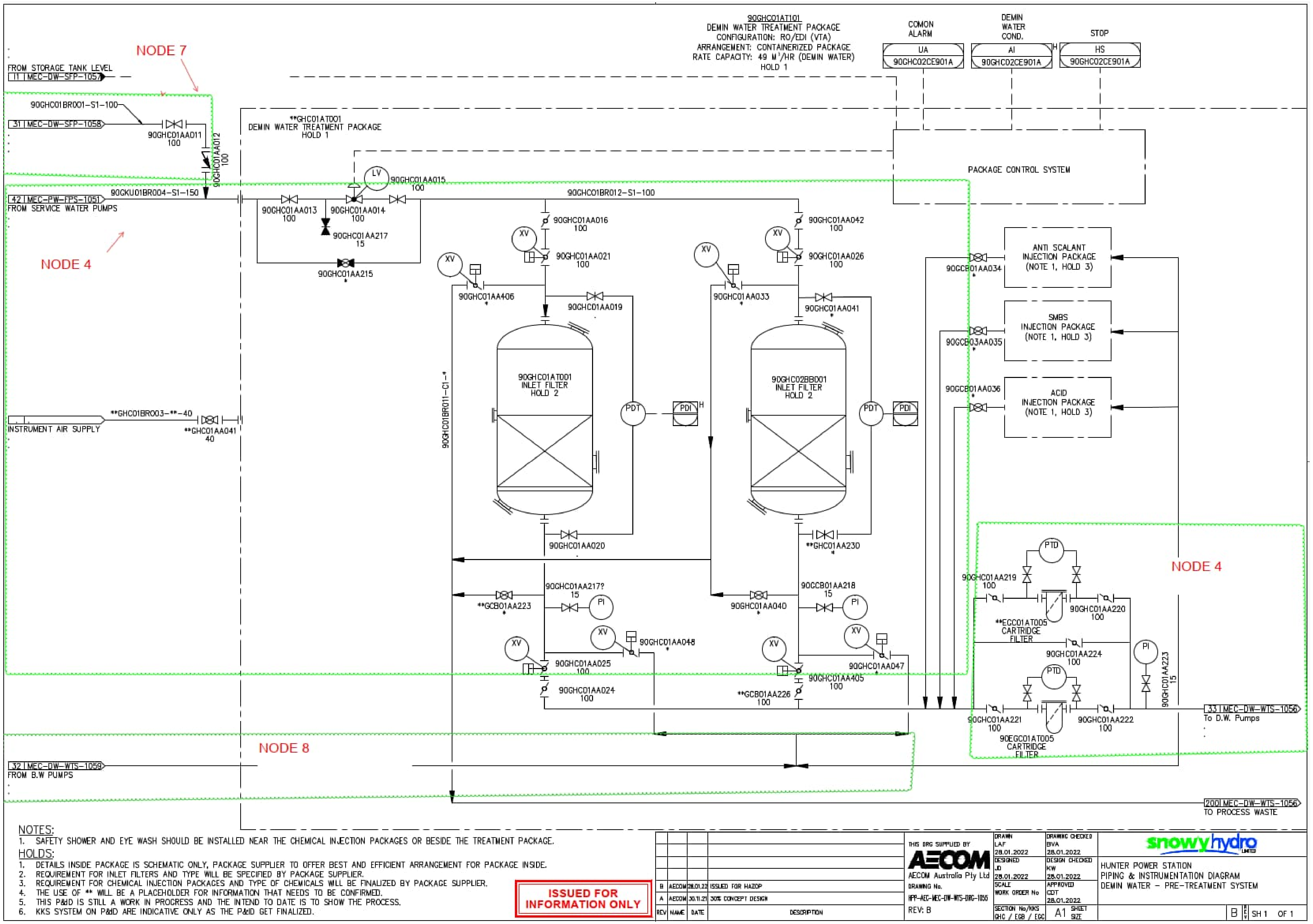
THIS DRG SUPPLIED BY AECOM — AECOM Australia Pty Ltd

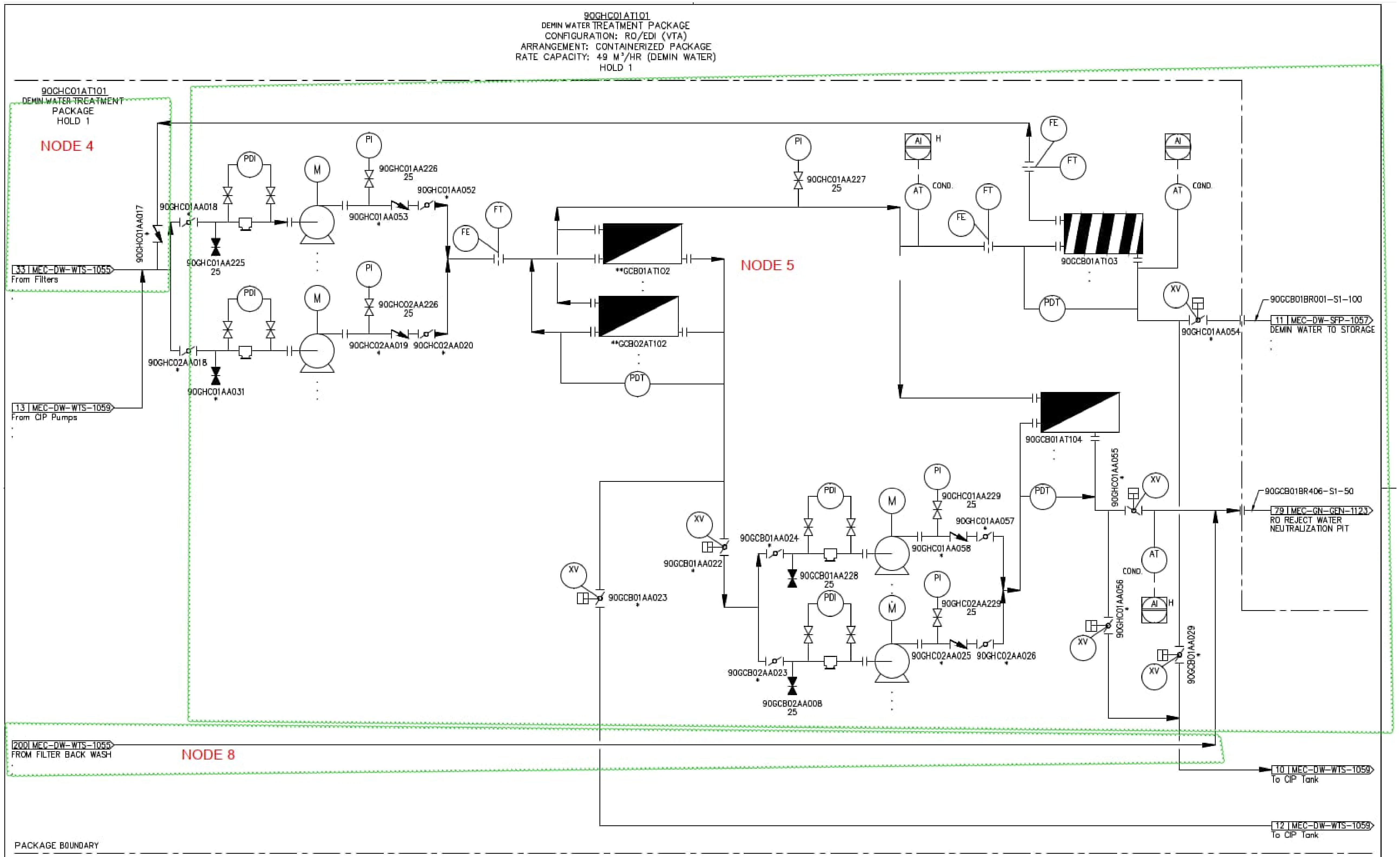
DRAWN: CAR 28.01.2022 | DRAWING CHECKED: BVA 28.01.2022
DESIGNED: JD 28.01.2022 | DESIGN CHECKED: KW 28.01.2022
SCALE | APPROVED: CDT 28.01.2022
WORK ORDER No
DRAWING No. HPP-AEC-MEC-DW-SFP-DRG-1058
REV: B
SECTION No/KKS: GHB / GHC | A1 SHEET SIZE

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DEMIN WATER – FORWARDING PUMPS

B | SH 1 OF 1


NODE 7
NODE 4
NODE 4
NODE 8
FROM STORAGE TANK LEVEL
11 MEC-DW-SFP-1057
90GHC01BR001-S1-100
31 MEC-DW-SFP-1058
90GHC01AA011
100
90GHC01AA012
100
90GKU01BR004-S1-150
42 MEC-PW-FPS-1051
FROM SERVICE WATER PUMPS
**GHC01AT001
DEMIN WATER TREATMENT PACKAGE
HOLD 1
90GHC01AT101
DEMIN WATER TREATMENT PACKAGE
CONFIGURATION: RO/EDI (VTA)
ARRANGEMENT: CONTAINERIZED PACKAGE
RATE CAPACITY: 49 M³/HR (DEMIN WATER)
HOLD 1
COMON ALARM
UA
90GHC02CE901A
DEMIN WATER COND.
AI
90GHC02CE901A
STOP
HS
90GHC02CE901A
PACKAGE CONTROL SYSTEM
LV
90GHC01AA015
100
90GHC01BR012-S1-100
90GHC01AA013
100
90GHC01AA014
100
90GHC01AA217
15
90GHC01AA215
90GHC01AA016
100
90GHC01AA021
100
90GHC01AA406
90GHC01AA019
90GHC01AT001
INLET FILTER
HOLD 2
90GHC02BB001
INLET FILTER
HOLD 2
90GHC01AA042
100
90GHC01AA026
100
90GHC01AA033
90GHC01AA041
PDT
PDI
90GHC01BR011-C1-*
GHC01BR003--40
INSTRUMENT AIR SUPPLY
**GHC01AA041
40
ANTI SCALANT
INJECTION PACKAGE
(NOTE 1, HOLD 3)
90GCB01AA034
SMBS
INJECTION PACKAGE
(NOTE 1, HOLD 3)
90GCB03AA035
ACID
INJECTION PACKAGE
(NOTE 1, HOLD 3)
90GCB01AA036
90GHC01AA020
**GHC01AA230
90GHC01AA217?
15
**GCB01AA223
PI
90GHC01AA040
90GCB01AA218
15
90GHC01AA048
90GHC01AA025
100
90GHC01AA024
100
90GHC01AA047
90GHC01AA405
100
**GCB01AA226
100
PTD
90GHC01AA219
100
90GHC01AA220
100
**EGC01AT005
CARTRIDGE
FILTER
90GHC01AA224
100
90GHC01AA223
15
90GHC01AA221
100
90EGC01AT005
CARTRIDGE
FILTER
90GHC01AA222
100
33 MEC-DW-WTS-1056
To D.W. Pumps
32 MEC-DW-WTS-1059
FROM B.W PUMPS
200 MEC-DW-WTS-1056
TO PROCESS WASTE
NOTES:
1. SAFETY SHOWER AND EYE WASH SHOULD BE INSTALLED NEAR THE CHEMICAL INJECTION PACKAGES OR BESIDE THE TREATMENT PACKAGE.
HOLDS:
1. DETAILS INSIDE PACKAGE IS SCHEMATIC ONLY, PACKAGE SUPPLIER TO OFFER BEST AND EFFICIENT ARRANGEMENT FOR PACKAGE INSIDE.
2. REQUIREMENT FOR INLET FILTERS AND TYPE WILL BE SPECIFIED BY PACKAGE SUPPLIER.
3. REQUIREMENT FOR CHEMICAL INJECTION PACKAGES AND TYPE OF CHEMICALS WILL BE FINALIZED BY PACKAGE SUPPLIER.
4. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
5. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS.
6. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
ISSUED FOR INFORMATION ONLY
B AECOM 28.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-DW-WTS-DRG-1056
REV: B
DRAWN LAF 28.01.2022
DRAWING CHECKED BVA 28.01.2022
DESIGNED LD 28.01.2022
DESIGN CHECKED KW 28.01.2022
SCALE
APPROVED
WORK ORDER No
CDT 28.01.2022
SECTION No/KKS GHC / EGB / EGC
A1 SHEET SIZE
snowy hydro LIMITED
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DEMIN WATER - PRE-TREATMENT SYSTEM
B SH 1 OF 1



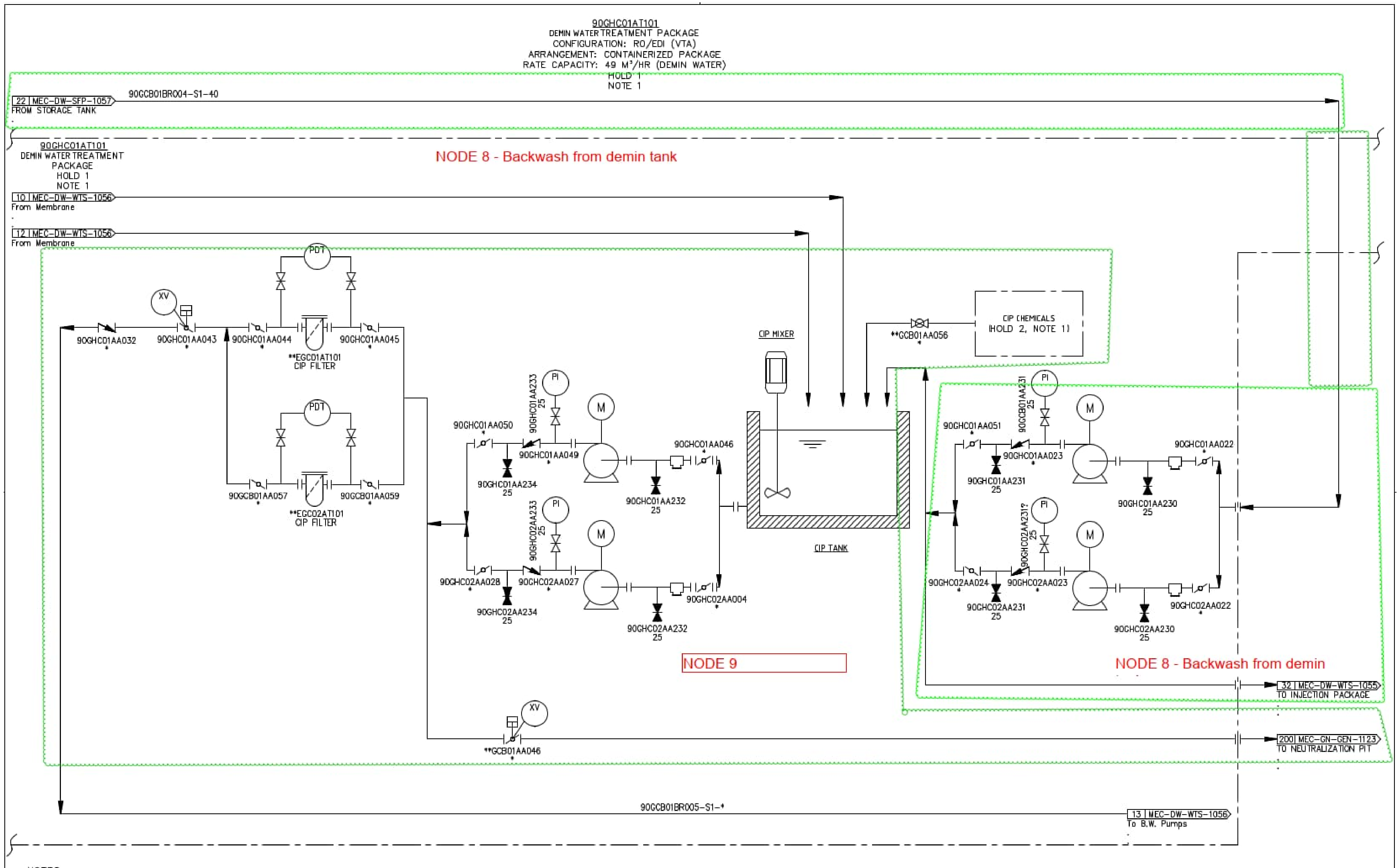
HOLDS:

1. DETAILS INSIDE PACKAGE IS SCHEMATIC ONLY, PACKAGE SUPPLIER TO OFFER BEST AND EFFICIENT ARRANGEMENT FOR PACKAGE INSIDE.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	28.01.22	ISSUED FOR HAZOP
A	AECOM	18.11.21	30% CONCEPT DESIGN

THIS DWG SUPPLIED BY AECOM — AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-DW-WTS-DRG-1056 REV: B
DRAWN CAR 28.01.2022 — DRAWING CHECKED BVA 28.01.2022
DESIGNED JD 28.01.2022 — DESIGN CHECKED KW 28.01.2022
SCALE — APPROVED CDT 28.01.2022
WORK ORDER No — SECTION No/KKS EGA / GHC / GCB — A1 SHEET SIZE
snowy hydro
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DEMIN WATER - TREATMENT SYSTEM
B SH 1 OF 1



NOTES:

1. SAFETY SHOWER AND EYE WASH SHOULD BE INSTALLED NEAR THE CHEMICAL INJECTION PACKAGES.

HOLDS:

1. DETAILS INSIDE PACKAGE IS SCHEMATIC ONLY, PACKAGE SUPPLIER TO OFFER BEST AND EFFICIENT ARRANGEMENT FOR PACKAGE INSIDE.
2. REQUIREMENT FOR INLET FILTERS AND TYPE WILL BE SPECIFIED BY PACKAGE SUPPLIER.
3. REQUIREMENT FOR CHEMICAL INJECTION PACKAGES AND TYPE OF CHEMICALS WILL BE FINALIZED BY PACKAGE SUPPLIER.
4. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
5. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
6. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

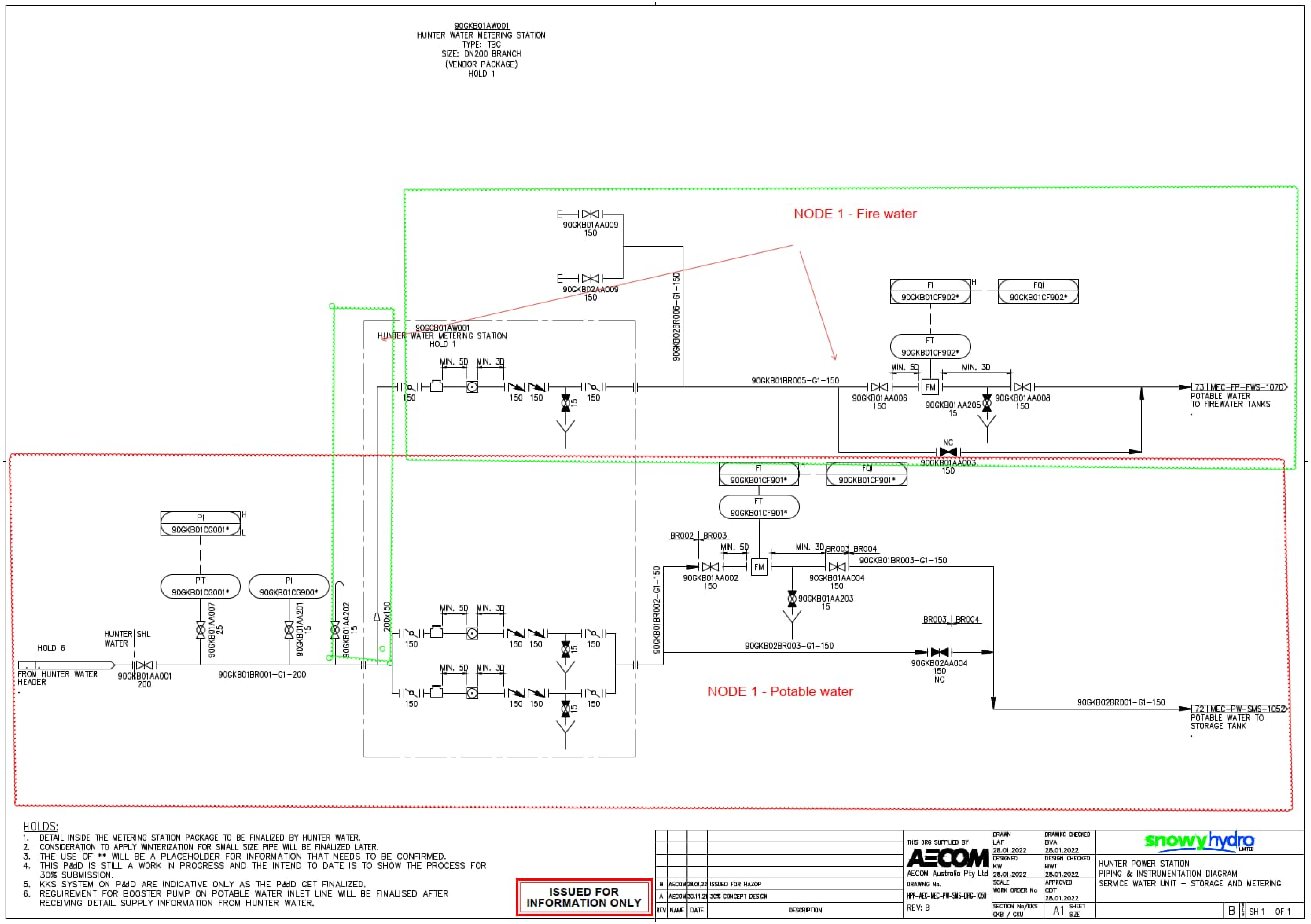
ISSUED FOR INFORMATION ONLY

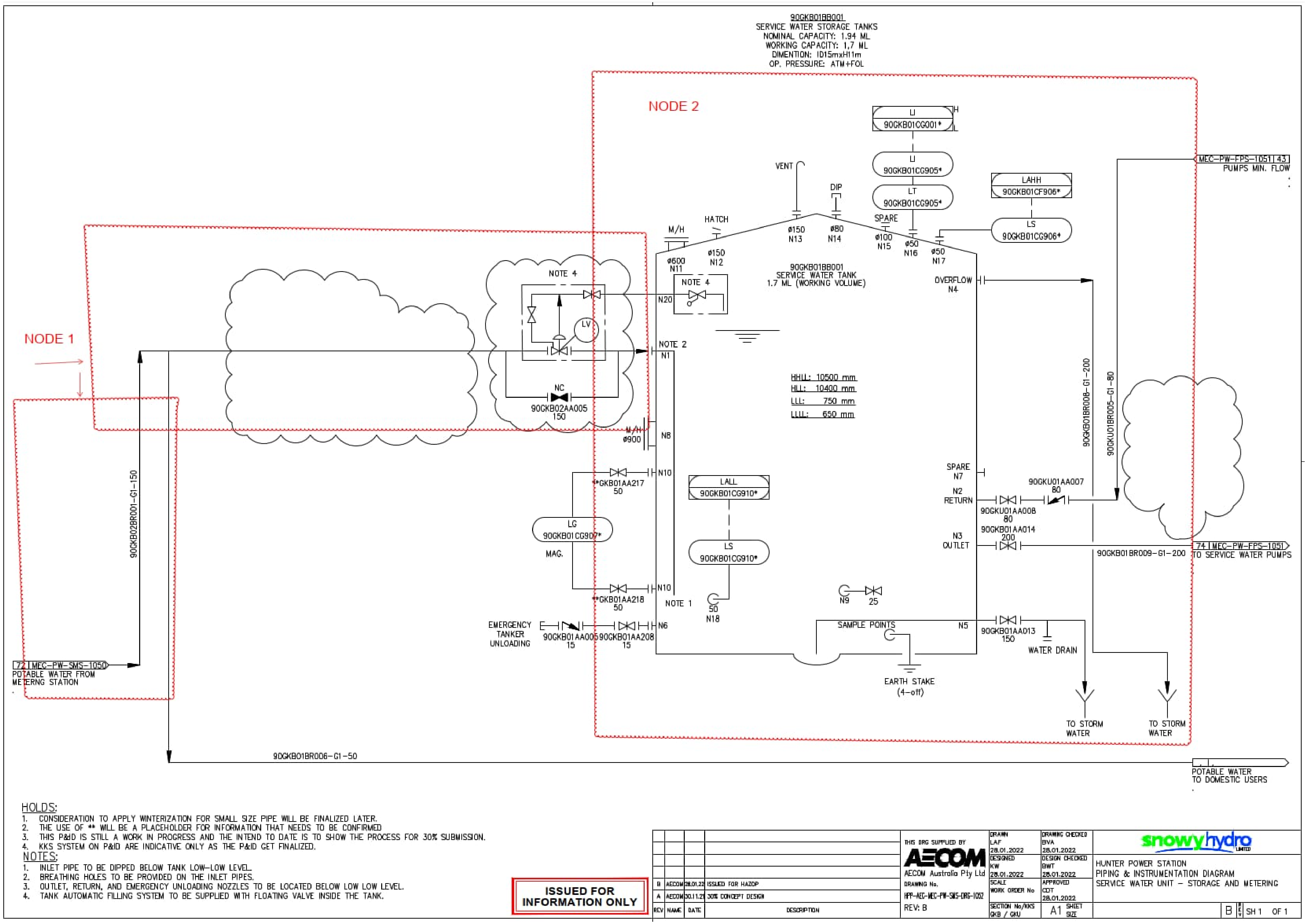
REV	NAME	DATE	DESCRIPTION
B	AECOM	28.01.22	ISSUED FOR HAZOP
A	AECOM	18.11.21	30% CONCEPT DESIGN

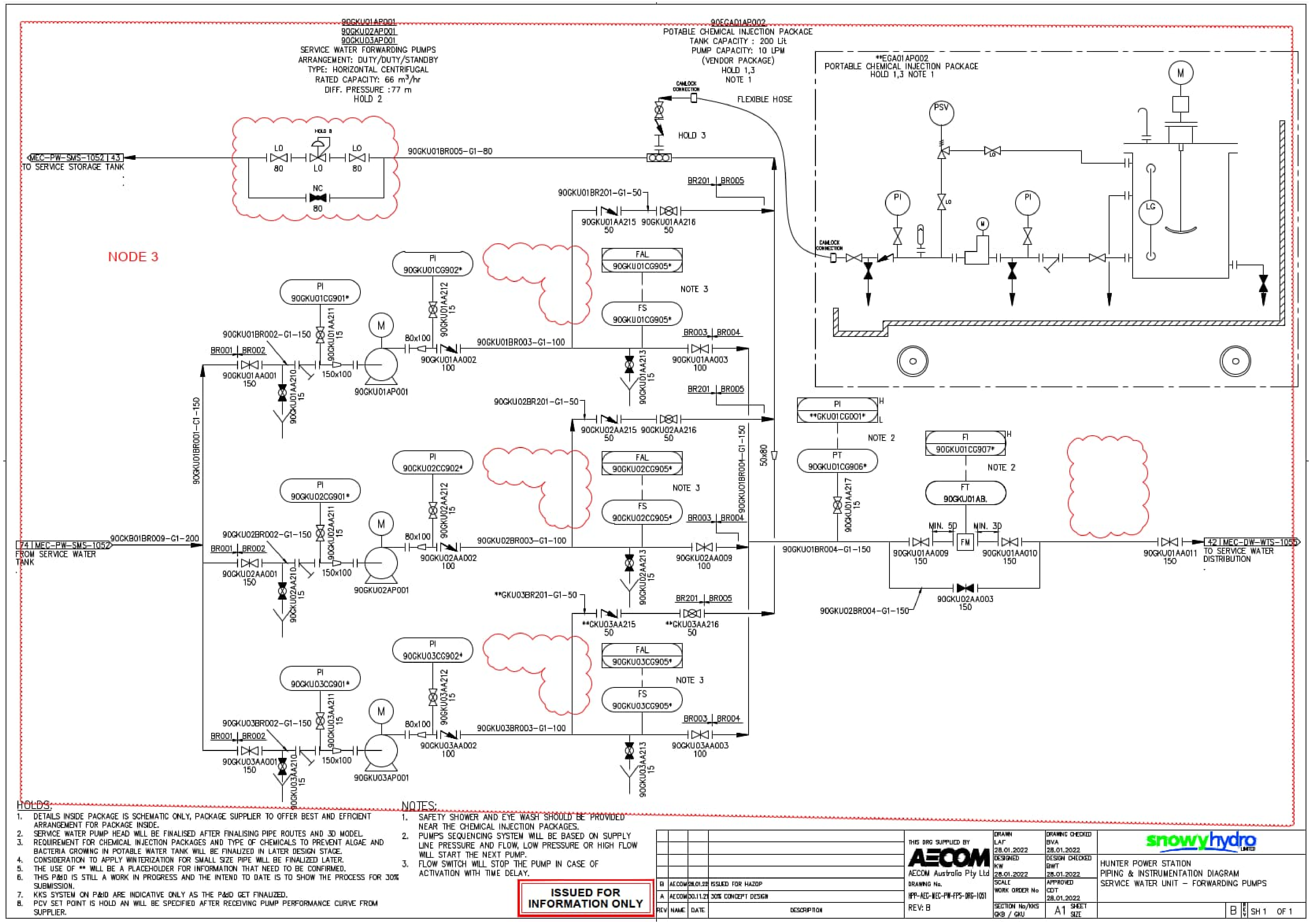
THIS DRG SUPPLIED BY AECOM Australia Pty Ltd
DRAWN CAR 28.01.2022 | DRAWING CHECKED BVA 28.01.2022
DESIGNED JO 28.01.2022 | DESIGN CHECKED KW 28.01.2022
APPROVED CDT 28.01.2022
DRAWING No HPP-AEC-MEC-DW-WTS-DRG-1059 REV: B
SIZE A1
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
DEMIN WATER - TREATMENT SYSTEM
B SH 1 OF 1

Appendix H

Water System P&IDs Showing Nodes Applied in the HAZOP

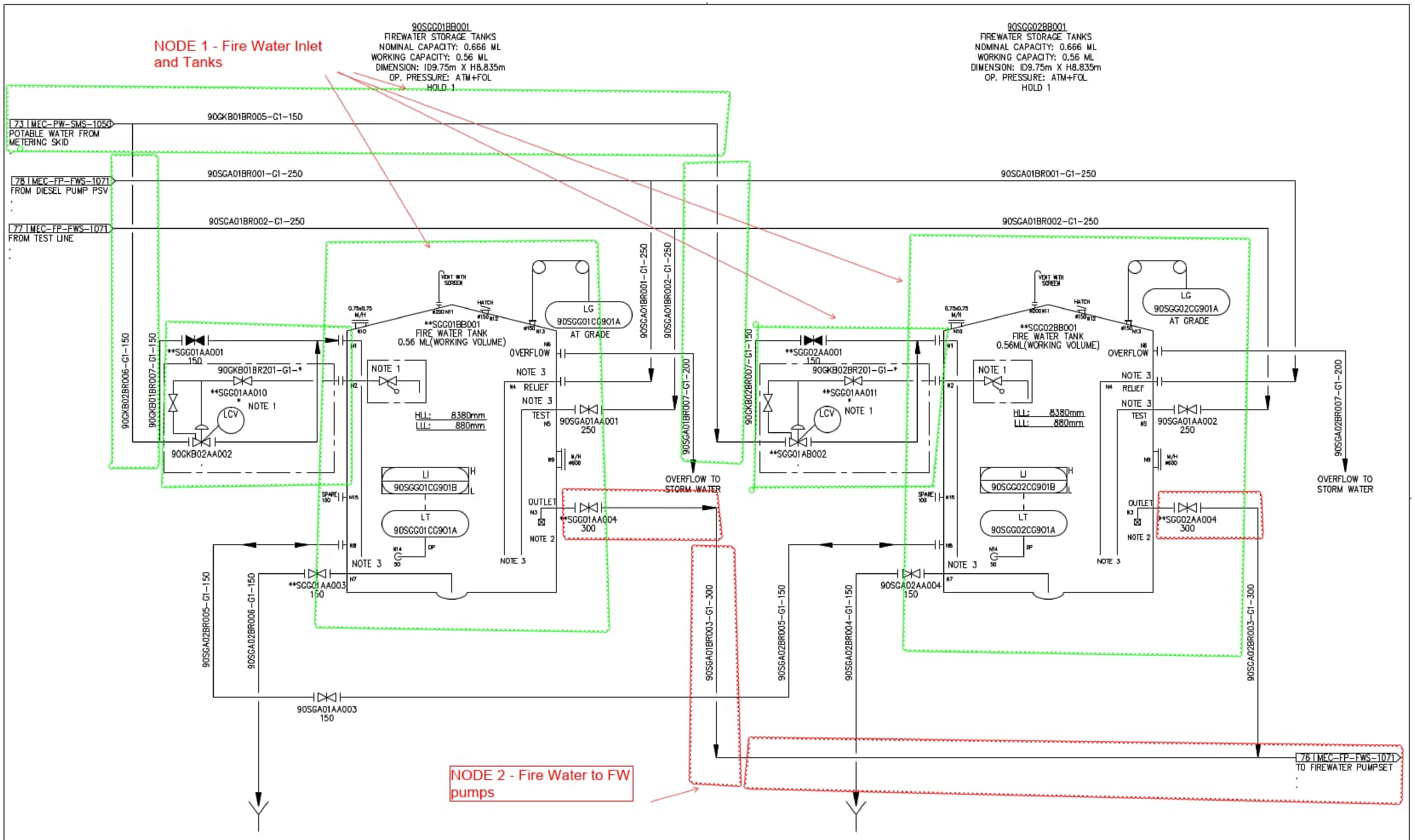

90GKB01AW001
HUNTER WATER METERING STATION
TYPE: TBC
SIZE: DN200 BRANCH
(VENDOR PACKAGE)
HOLD 1
NODE 1 - Fire water
NODE 1 - Potable water
90GKB01AA009 150
90GKB02AA009 150
90GKB02BR006-G1-150
90GKB01BR005-G1-150
90GKB01CF902*
FI
FQI
FT
MIN. 5D
MIN. 3D
90GKB01AA006 150
90GKB01AA205 15
90GKB01AA008 150
90GKB01AA003 150
NC
73 | MEC-FP-FWS-1070
POTABLE WATER TO FIREWATER TANKS
90GKB01CF901*
90GKB01AA002 150
90GKB01AA004 150
90GKB01AA203 15
90GKB01BR003-G1-150
90GKB02BR003-G1-150
90GKB02AA004 150 NC
90GKB02BR001-G1-150
72 | MEC-PW-SMS-1052
POTABLE WATER TO STORAGE TANK
90GKB01BR002-G1-150
BR002 | BR003
BR003 | BR004
PI
PT
90GKB01CG001*
90GKB01CG900*
90GKB01AA007 25
90GKB01AA201 15
90GKB01AA202 15
HOLD 6
FROM HUNTER WATER HEADER
HUNTER | SHL WATER
90GKB01AA001 200
90GKB01BR001-G1-200
200x150
HOLDS:
1. DETAIL INSIDE THE METERING STATION PACKAGE TO BE FINALIZED BY HUNTER WATER.
2. CONSIDERATION TO APPLY WINTERIZATION FOR SMALL SIZE PIPE WILL BE FINALIZED LATER.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
6. REGUIREMENT FOR BOOSTER PUMP ON POTABLE WATER INLET LINE WILL BE FINALISED AFTER RECEIVING DETAIL SUPPLY INFORMATION FROM HUNTER WATER.
ISSUED FOR INFORMATION ONLY
B AECOM 28.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-PW-SMS-DRG-1050
REV: B
DRAWN LAF 28.01.2022
DESIGNED KW 28.01.2022
DRAWING CHECKED BVA 28.01.2022
DESIGN CHECKED BWT 28.01.2022
APPROVED CDT 28.01.2022
SCALE
WORK ORDER No
SECTION No/KKS QKB / QKU
A1 SHEET SIZE
snowy hydro
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE WATER UNIT - STORAGE AND METERING
B SH 1 OF 1


90GKB01BB001
SERVICE WATER STORAGE TANKS
NOMINAL CAPACITY: 1.94 ML
WORKING CAPACITY: 1.7 ML
DIMENTION: ID15mxH11m
OP. PRESSURE: ATM+FOL
NODE 2
NODE 1
90GKB01BB001
SERVICE WATER TANK
1.7 ML (WORKING VOLUME)
HHLL: 10500 mm
HLL: 10400 mm
LLL: 750 mm
LLLL: 650 mm
EMERGENCY TANKER UNLOADING
72 MEC-PW-SMS-1050 POTABLE WATER FROM METERING STATION
74 MEC-PW-FPS-1051 TO SERVICE WATER PUMPS
MEC-PW-FPS-1051 43 PUMPS MIN. FLOW
POTABLE WATER TO DOMESTIC USERS
TO STORM WATER
EARTH STAKE (4-off)
HOLDS:
1. CONSIDERATION TO APPLY WINTERIZATION FOR SMALL SIZE PIPE WILL BE FINALIZED LATER.
2. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED
3. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
4. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
NOTES:
1. INLET PIPE TO BE DIPPED BELOW TANK LOW-LOW LEVEL.
2. BREATHING HOLES TO BE PROVIDED ON THE INLET PIPES.
3. OUTLET, RETURN, AND EMERGENCY UNLOADING NOZZLES TO BE LOCATED BELOW LOW LOW LEVEL.
4. TANK AUTOMATIC FILLING SYSTEM TO BE SUPPLIED WITH FLOATING VALVE INSIDE THE TANK.
ISSUED FOR INFORMATION ONLY
B AECOM 28.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
AECOM Australia Pty Ltd
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE WATER UNIT - STORAGE AND METERING
snowy hydro


90GKU01AP001
90GKU02AP001
90GKU03AP001
SERVICE WATER FORWARDING PUMPS
ARRANGEMENT: DUTY/DUTY/STANDBY
TYPE: HORIZONTAL CENTRIFUGAL
RATED CAPACITY: 66 m³/hr
DIFF. PRESSURE :77 m
HOLD 2
90EGA01AP002
POTABLE CHEMICAL INJECTION PACKAGE
TANK CAPACITY : 200 Lit
PUMP CAPACITY: 10 LPM
(VENDOR PACKAGE)
HOLD 1,3
NOTE 1
**EGA01AP002
PORTABLE CHEMICAL INJECTION PACKAGE
HOLD 1,3 NOTE 1
FLEXIBLE HOSE
HOLD 3
NODE 3
MEC-PW-SMS-1052 43
TO SERVICE STORAGE TANK
90GKU01BR005-G1-80
90GKU01BR201-G1-50
90GKU01AA215 50
90GKU01AA216 50
90GKU01BR002-G1-150
90GKU01BR003-G1-100
90GKU01AA001 150
90GKU01AA002 100
90GKU01AA003 100
90GKU01AP001
90GKU01BR001-G1-150
90GKU02BR201-G1-50
90GKU02AA215 50
90GKU02AA216 50
90GKU02BR002-G1-150
90GKU02BR003-G1-100
90GKU02AA001 150
90GKU02AA002 100
90GKU02AA009 100
90GKU02AP001
**GKU03BR201-G1-50
**GKU03AA215 50
**GKU03AA216 50
90GKU03BR002-G1-150
90GKU03BR003-G1-100
90GKU03AA001 150
90GKU03AA002 100
90GKU03AA003 100
90GKU03AP001
74 MEC-PW-SMS-1052
90GKB01BR009-G1-200
FROM SERVICE WATER TANK
90GKU01BR004-G1-150
90GKU02BR004-G1-150
90GKU01AA009 150
90GKU01AA010 150
90GKU02AA003 150
90GKU01AA011 150
42 MEC-DW-WTS-1055
TO SERVICE WATER DISTRIBUTION
**GKU01CG001*
90GKU01CG906*
90GKU01CG907*
90GKU01AB.
NOTE 2
NOTE 3
HOLDS:
1. DETAILS INSIDE PACKAGE IS SCHEMATIC ONLY, PACKAGE SUPPLIER TO OFFER BEST AND EFFICIENT ARRANGEMENT FOR PACKAGE INSIDE.
2. SERVICE WATER PUMP HEAD WILL BE FINALISED AFTER FINALISING PIPE ROUTES AND 3D MODEL.
3. REQUIREMENT FOR CHEMICAL INJECTION PACKAGES AND TYPE OF CHEMICALS TO PREVENT ALGAE AND BACTERIA GROWING IN POTABLE WATER TANK WILL BE FINALIZED IN LATER DESIGN STAGE.
4. CONSIDERATION TO APPLY WINTERIZATION FOR SMALL SIZE PIPE WILL BE FINALIZED LATER.
5. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEED TO BE CONFIRMED.
6. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
7. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
8. PCV SET POINT IS HOLD AN WILL BE SPECIFIED AFTER RECEIVING PUMP PERFORMANCE CURVE FROM SUPPLIER.
NOTES:
1. SAFETY SHOWER AND EYE WASH SHOULD BE PROVIDED NEAR THE CHEMICAL INJECTION PACKAGES.
2. PUMPS SEQUENCING SYSTEM WILL BE BASED ON SUPPLY LINE PRESSURE AND FLOW, LOW PRESSURE OR HIGH FLOW WILL START THE NEXT PUMP.
3. FLOW SWITCH WILL STOP THE PUMP IN CASE OF ACTIVATION WITH TIME DELAY.
ISSUED FOR INFORMATION ONLY
B AECOM 28.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-PW-FPS-DRG-1051
REV: B
DRAWN LAF 28.01.2022
DRAWING CHECKED BVA 28.01.2022
DESIGNED KW 28.01.2022
DESIGN CHECKED BWT 28.01.2022
SCALE
WORK ORDER No
APPROVED CDT 28.01.2022
SECTION No/KKS GKB / GKU
A1 SHEET SIZE
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
SERVICE WATER UNIT – FORWARDING PUMPS
B REV SH 1 OF 1

Appendix I

Fire Water System P&IDs Showing Nodes Applied in the HAZOP



NOTES:

1. TANK AUTOMATIC FILLING SYSTEM WITH MANUAL BYPASS TO BE INSTALL ON INLET LINE AND LEVEL CONTROL VALVE WITH ALL ACCESSORIES AND FLOAT VALVE TO BE PROVIDED BY SUPPLIER.
2. VORTEX PLATE SHALL BE INTALLED AT ENTRANCE OF OUTLET NOZZLE.
3. INLET AND RETURN PIPES TO BE DIPPED BELOW TANK OUTLET NOZZLE, PROVIDE BREATHING HOLES ON TOP OF THE LINES.

HOLDS:

1. TANKS CAPACITY WILL BE FINALIZED AFTER COMPLETION OF FIRE SAFETY STUDY.
2. TANK NOZZLE SIZES, SPECIALLY VENT, LEVEL GAUGE, FLOAT VALVE AND MANHOLES TO BE FINALISED BY TANK MANUFACTURER
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	28.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM Australia Pty Ltd

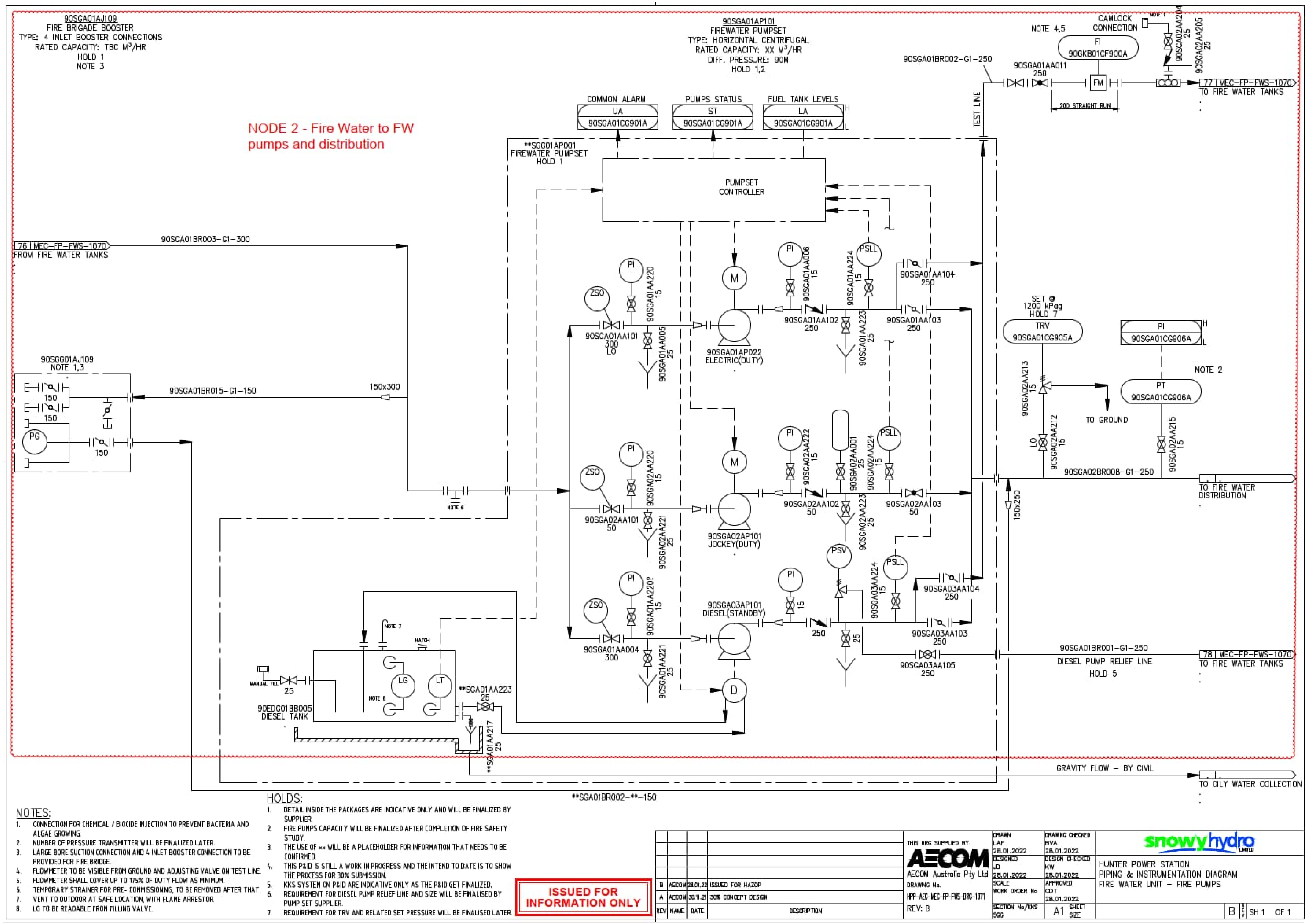
DRAWING No. HPP-AEC-MEC-FP-FWS-DRG-1070 REV: B

DRAWN LAF 28.01.2022	DRAWING CHECKED BVA 28.01.2022
DESIGNED JD 28.01.2022	DESIGN CHECKED KW 28.01.2022
SCALE	APPROVED CDT 28.01.2022
WORK ORDER No	
SECTION No/KKS SGG	A1 SHEET SIZE

snowy hydro LIMITED

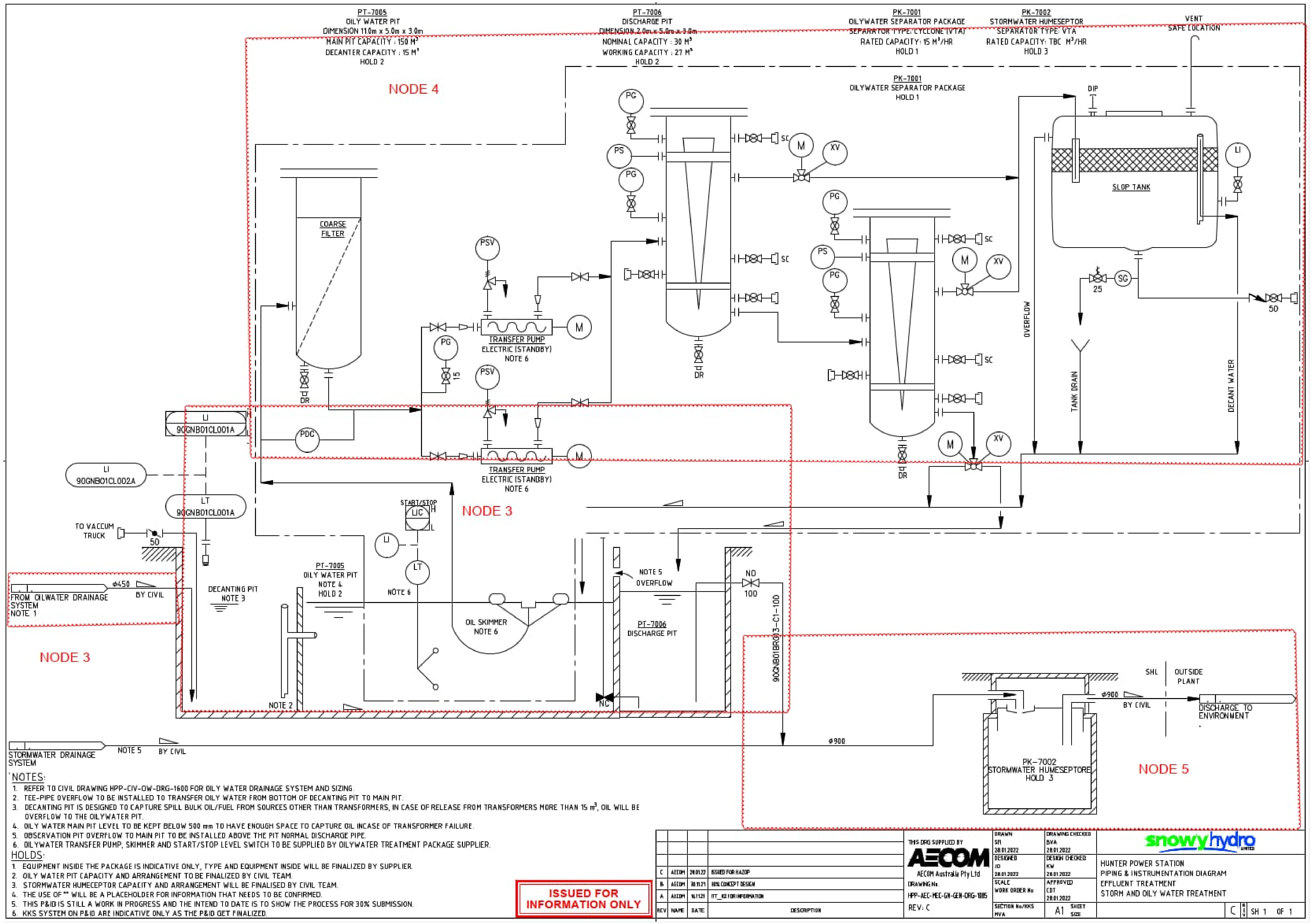
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
FIRE WATER UNIT – STORAGE TANKS

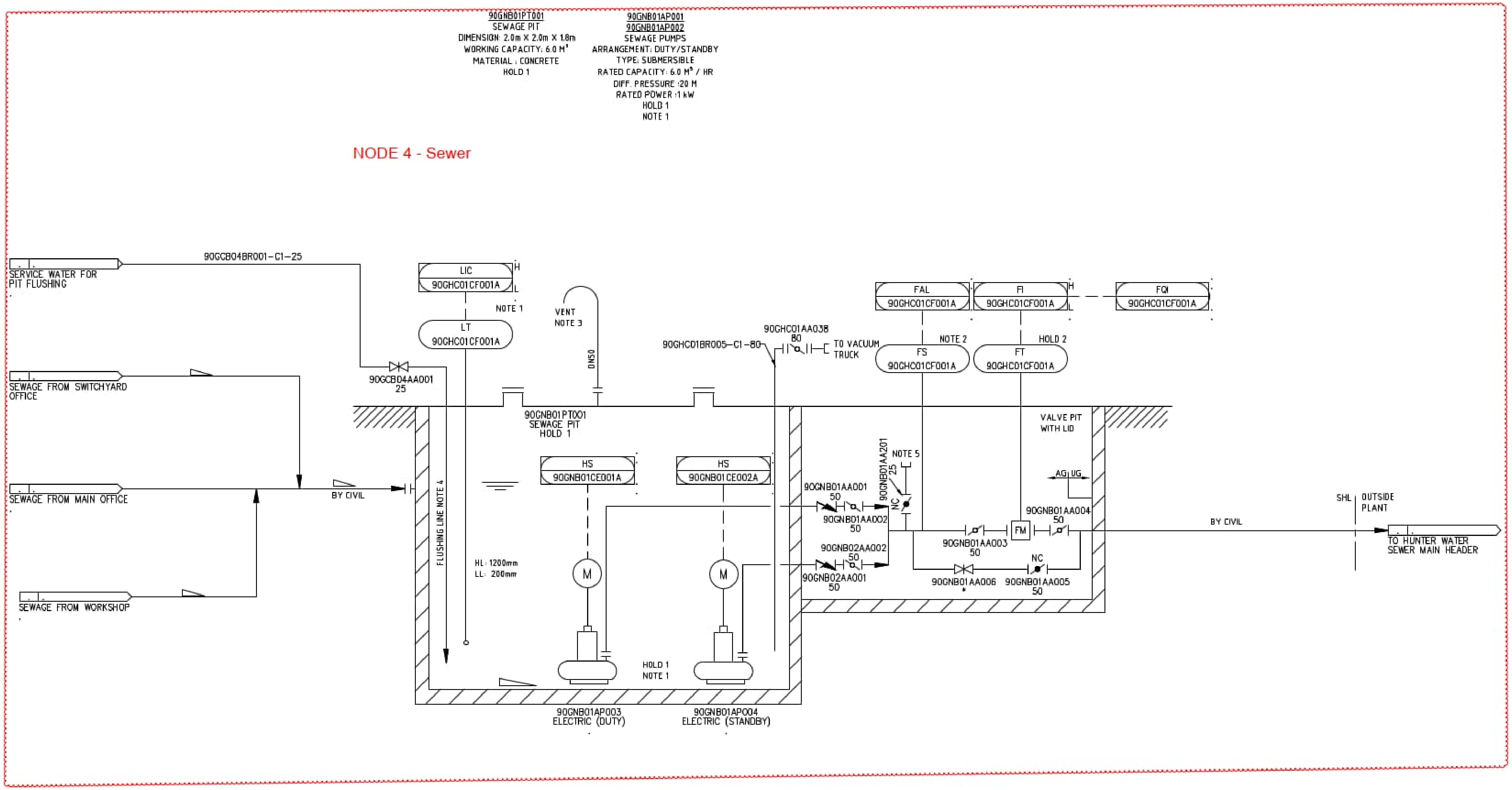
B SH 1 OF 1


NODE 2 - Fire Water to FW pumps and distribution
90SGA01AJ109
FIRE BRIGADE BOOSTER
TYPE: 4 INLET BOOSTER CONNECTIONS
RATED CAPACITY: TBC M³/HR
HOLD 1
NOTE 3
90SGA01AP101
FIREWATER PUMPSET
TYPE: HORIZONTAL CENTRIFUGAL
RATED CAPACITY: XX M³/HR
DIFF. PRESSURE: 90M
HOLD 1,2
COMMON ALARM
PUMPS STATUS
FUEL TANK LEVELS
90SGA01CG901A
**SGG01AP001
FIREWATER PUMPSET
HOLD 1
PUMPSET CONTROLLER
76 MEC-FP-FWS-1070
FROM FIRE WATER TANKS
90SGA01BR003-G1-300
90SGG01AJ109
NOTE 1,3
90SGA01BR015-G1-150
150x300
90SGA01AP022
ELECTRIC(DUTY)
90SGA02AP101
JOCKEY(DUTY)
90SGA03AP101
DIESEL(STANDBY)
90EDG01BB005
DIESEL TANK
MANUAL FILL
90SGA01BR002-G1-250
90SGA01AA011
CAMLOCK CONNECTION
NOTE 4,5
90GKB01CF900A
20D STRAIGHT RUN
TEST LINE
77 MEC-FP-FWS-1070
TO FIRE WATER TANKS
SET @ 1200 kPag
HOLD 7
TRV
90SGA01CG905A
90SGA01CG906A
NOTE 2
TO GROUND
90SGA02BR008-G1-250
TO FIRE WATER DISTRIBUTION
90SGA01BR001-G1-250
DIESEL PUMP RELIEF LINE
HOLD 5
78 MEC-FP-FWS-1070
TO FIRE WATER TANKS
GRAVITY FLOW - BY CIVIL
TO OILY WATER COLLECTION
SGA01BR002--150
NOTES:
1. CONNECTION FOR CHEMICAL / BIOCIDE INJECTION TO PREVENT BACTERIA AND ALGAE GROWING.
2. NUMBER OF PRESSURE TRANSMITTER WILL BE FINALIZED LATER.
3. LARGE BORE SUCTION CONNECTION AND 4 INLET BOOSTER CONNECTION TO BE PROVIDED FOR FIRE BRIDGE.
4. FLOWMETER TO BE VISIBLE FROM GROUND AND ADJUSTING VALVE ON TEST LINE.
5. FLOWMETER SHALL COVER UP TO 175% OF DUTY FLOW AS MINIMUM.
6. TEMPORARY STRAINER FOR PRE- COMMISSIONING, TO BE REMOVED AFTER THAT.
7. VENT TO OUTDOOR AT SAFE LOCATION, WITH FLAME ARRESTOR.
8. LG TO BE READABLE FROM FILLING VALVE.
HOLDS:
1. DETAIL INSIDE THE PACKAGES ARE INDICATIVE ONLY AND WILL BE FINALIZED BY SUPPLIER.
2. FIRE PUMPS CAPACITY WILL BE FINALIZED AFTER COMPLETION OF FIRE SAFETY STUDY.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
6. REQUIREMENT FOR DIESEL PUMP RELIEF LINE AND SIZE WILL BE FINALISED BY PUMP SET SUPPLIER.
7. REQUIREMENT FOR TRV AND RELATED SET PRESSURE WILL BE FINALISED LATER.
ISSUED FOR INFORMATION ONLY
B AECOM 28.01.22 ISSUED FOR HAZOP
A AECOM 30.11.21 30% CONCEPT DESIGN
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-FP-FWS-DRG-1071
REV: B
DRAWN LAF 28.01.2022
DESIGNED JD 28.01.2022
SCALE
WORK ORDER No
SECTION No/KKS SGG
DRAWING CHECKED BVA 28.01.2022
DESIGN CHECKED KW 28.01.2022
APPROVED CDT 28.01.2022
A1 SHEET SIZE
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
FIRE WATER UNIT - FIRE PUMPS
B SH 1 OF 1

Appendix J

Effluent Treatment System P&IDs Showing Nodes Applied in the HAZOP


PT-7005
OILY WATER PIT
DIMENSION 11.0m x 5.0m x 3.0m
MAIN PIT CAPACITY : 150 M³
DECANTER CAPACITY : 15 M³
HOLD 2
PT-7006
DISCHARGE PIT
DIMENSION 2.0m x 5.0m x 3.0m
NOMINAL CAPACITY : 30 M³
WORKING CAPACITY : 27 M³
HOLD 2
PK-7001
OILYWATER SEPARATOR PACKAGE
SEPARATOR TYPE: CYCLONE (VTA)
RATED CAPACITY: 15 M³/HR
HOLD 1
PK-7002
STORMWATER HUMESEPTOR
SEPARATOR TYPE: VTA
RATED CAPACITY: TBC M³/HR
HOLD 3
VENT
SAFE LOCATION
NODE 4
PK-7001
OILYWATER SEPARATOR PACKAGE
HOLD 1
DIP
SLOP TANK
COARSE FILTER
TRANSFER PUMP
ELECTRIC (STANDBY)
NOTE 6
TRANSFER PUMP
ELECTRIC (STANDBY)
NOTE 6
OVERFLOW
TANK DRAIN
DECANT WATER
LI
90GNB01CL001A
LI
90GNB01CL002A
LT
90GNB01CL001A
TO VACCUM TRUCK
NODE 3
START/STOP
LIC
FROM OILWATER DRAINAGE SYSTEM
NOTE 1
BY CIVIL
DECANTING PIT
NOTE 3
PT-7005
OILY WATER PIT
NOTE 4
HOLD 2
NOTE 6
OIL SKIMMER
NOTE 6
NOTE 5
OVERFLOW
PT-7006
DISCHARGE PIT
NOTE 2
90GNB01BR003-C1-100
NODE 3
SHL
OUTSIDE PLANT
BY CIVIL
DISCHARGE TO ENVIRONMENT
PK-7002
STORMWATER HUMESEPTORE
HOLD 3
NODE 5
STORMWATER DRAINAGE SYSTEM
NOTE 5
BY CIVIL
NOTES:
1. REFER TO CIVIL DRAWING HPP-CIV-OW-DRG-1600 FOR OILY WATER DRAINAGE SYSTEM AND SIZING.
2. TEE-PIPE OVERFLOW TO BE INSTALLED TO TRANSFER OILY WATER FROM BOTTOM OF DECANTING PIT TO MAIN PIT.
3. DECANTING PIT IS DESIGNED TO CAPTURE SPILL BULK OIL/FUEL FROM SOURCES OTHER THAN TRANSFORMERS, IN CASE OF RELEASE FROM TRANSFORMERS MORE THAN 15 m³, OIL WILL BE OVERFLOW TO THE OILYWATER PIT.
4. OILY WATER MAIN PIT LEVEL TO BE KEPT BELOW 500 mm TO HAVE ENOUGH SPACE TO CAPTURE OIL INCASE OF TRANSFORMER FAILURE.
5. OBSERVATION PIT OVERFLOW TO MAIN PIT TO BE INSTALLED ABOVE THE PIT NORMAL DISCHARGE PIPE.
6. OILYWATER TRANSFER PUMP, SKIMMER AND START/STOP LEVEL SWITCH TO BE SUPPLIED BY OILYWATER TREATMENT PACKAGE SUPPLIER.
HOLDS:
1. EQUIPMENT INSIDE THE PACKAGE IS INDICATIVE ONLY, TYPE AND EQUIPMENT INSIDE WILL BE FINALIZED BY SUPPLIER.
2. OILY WATER PIT CAPACITY AND ARRANGEMENT TO BE FINALIZED BY CIVIL TEAM.
3. STORMWATER HUMECEPTOR CAPACITY AND ARRANGEMENT WILL BE FINALISED BY CIVIL TEAM.
4. THE USE OF "" WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
5. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
6. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.
ISSUED FOR INFORMATION ONLY
C AECOM 28.01.22 ISSUED FOR HAZOP
B AECOM 30.11.21 30% CONCEPT DESIGN
A AECOM 16.11.21 ITT_02 FOR INFORMATION
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-GN-GEN-DRG-1005
REV: C
DRAWN SR 28.01.2022
DRAWING CHECKED BVA 28.01.2022
DESIGNED JD 28.01.2022
DESIGN CHECKED KW 28.01.2022
SCALE
WORK ORDER No
APPROVED CDT 28.01.2022
SECTION No/KKS MVA
A1 SHEET SIZE
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
EFFLUENT TREATMENT
STORM AND OILY WATER TREATMENT
C
SH 1 OF 1



HOLDS:

1. PUMP OPERATION IS INTERMITTENT, START IN HIGH LEVEL TO EMPTY THE PIT AND THEN STOP IN LOW LEVEL.
2. NO FLOW WILL STOP THE OPERATING PUMP.
3. VENT TO SAFE LOCATION, VENT TO BE EQUIPPED WITH ODOR FILTER.
4. SEWAGE PIT TO BE FLUSHED WITH WATER AND PUMPED OUT EVERY 3 DAYS WHEN FACILITY IS UNMANNED.
5. UTILITY CONNECTION FOR LINE FLUSHING.

NOTES:

1. SEWAGE PIT AND TRANSFER PUMP WILL BE REQUIRED IF GRAVITY FLOW FROM SITE TO HUNTER SEWAGE SYSTEM IS NOT POSSIBLE. TO BE FINALIZED BY CIVIL TEAM.
2. REQUIREMENT FOR METERING WILL BE FINALIZED BY HUNTER WATER.
3. THE USE OF "" WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
C	AECOM	28.01.22	ISSUED FOR HAZOP
B	AECOM	30.11.21	30% CONCEPT DESIGN
A	AECOM	16.11.21	ITT_R2 FOR INFORMATION

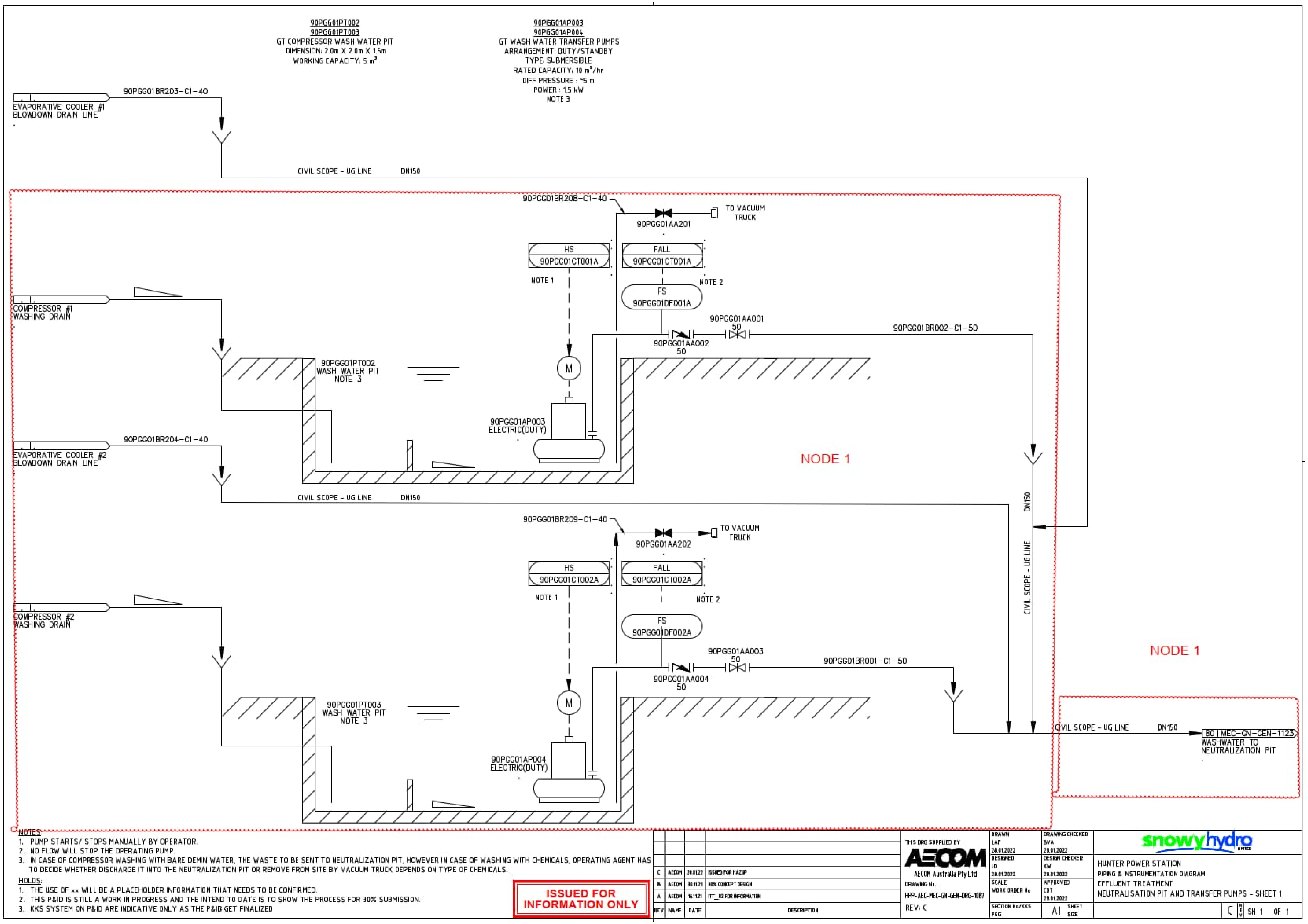
THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-GN-GEN-DRG-1086
REV: C

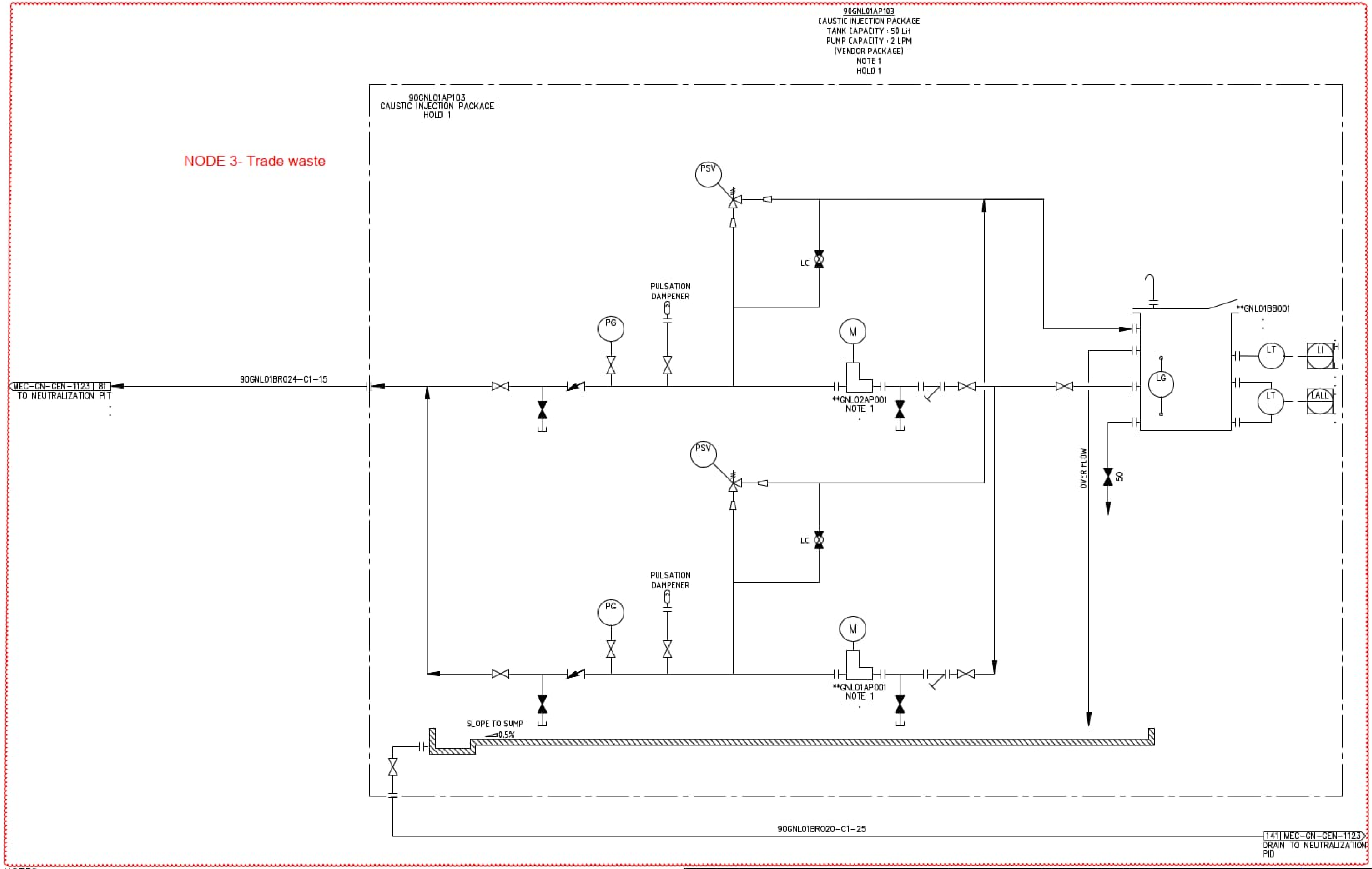
DRAWN CAR 28.01.2022	DRAWING CHECKED BVA 28.01.2022
DESIGNED JD 28.01.2022	DESIGN CHECKED KW 28.01.2022
SCALE WORK ORDER No	APPROVED CDT 28.01.2022
SECTION No/KKS GNB	A1 SHEET SIZE

snowy hydro LIMITED

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
EFFLUENT TREATMENT
SEWER TRANSFER PIT AND PUMPS

C REV SH 1 OF 1


90PGG01PT002
90PGG01PT003
GT COMPRESSOR WASH WATER PIT
DIMENSION: 2.0m X 2.0m X 1.5m
WORKING CAPACITY: 5 m³
90PGG01AP003
90PGG01AP004
GT WASH WATER TRANSFER PUMPS
ARRANGEMENT: DUTY/STANDBY
TYPE: SUBMERSIBLE
RATED CAPACITY: 10 m³/hr
DIFF PRESSURE : ~5 m
POWER : 1.5 kW
NOTE 3
90PGG01BR203-C1-40
EVAPORATIVE COOLER #1 BLOWDOWN DRAIN LINE
CIVIL SCOPE - UG LINE
DN150
90PGG01BR208-C1-40
TO VACUUM TRUCK
90PGG01AA201
HS
90PGG01CT001A
FALL
90PGG01CT001A
NOTE 1
NOTE 2
FS
90PGG01DF001A
90PGG01AA001
50
90PGG01BR002-C1-50
90PGG01AA002
50
COMPRESSOR #1 WASHING DRAIN
90PGG01PT002
WASH WATER PIT
NOTE 3
M
90PGG01AP003
ELECTRIC(DUTY)
NODE 1
90PGG01BR204-C1-40
EVAPORATIVE COOLER #2 BLOWDOWN DRAIN LINE
CIVIL SCOPE - UG LINE
DN150
DN150
90PGG01BR209-C1-40
TO VACUUM TRUCK
90PGG01AA202
HS
90PGG01CT002A
FALL
90PGG01CT002A
NOTE 1
NOTE 2
CIVIL SCOPE - UG LINE
FS
90PGG01DF002A
COMPRESSOR #2 WASHING DRAIN
90PGG01AA003
50
90PGG01BR001-C1-50
NODE 1
90PGG01AA004
50
90PGG01PT003
WASH WATER PIT
NOTE 3
M
90PGG01AP004
ELECTRIC(DUTY)
CIVIL SCOPE - UG LINE
DN150
801 MEC-GN-GEN-1123
WASHWATER TO NEUTRALIZATION PIT
NOTES:
1. PUMP STARTS/ STOPS MANUALLY BY OPERATOR.
2. NO FLOW WILL STOP THE OPERATING PUMP.
3. IN CASE OF COMPRESSOR WASHING WITH BARE DEMIN WATER, THE WASTE TO BE SENT TO NEUTRALIZATION PIT, HOWEVER IN CASE OF WASHING WITH CHEMICALS, OPERATING AGENT HAS TO DECIDE WHETHER DISCHARGE IT INTO THE NEUTRALIZATION PIT OR REMOVE FROM SITE BY VACUUM TRUCK DEPENDS ON TYPE OF CHEMICALS.
HOLDS:
1. THE USE OF ** WILL BE A PLACEHOLDER INFORMATION THAT NEEDS TO BE CONFIRMED.
2. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
3. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED
ISSUED FOR INFORMATION ONLY
C AECOM 28.01.22 ISSUED FOR HAZOP
B AECOM 30.11.21 30% CONCEPT DESIGN
A AECOM 16.11.21 IFT_R2 FOR INFORMATION
REV NAME DATE DESCRIPTION
THIS DRG SUPPLIED BY
AECOM Australia Pty Ltd
DRAWING No.
HPP-AEC-MEC-GN-GEN-DRG-1087
REV: C
DRAWN LAF 28.01.2022
DRAWING CHECKED BVA 28.01.2022
DESIGNED JD 28.01.2022
DESIGN CHECKED KW 28.01.2022
SCALE
WORK ORDER No
APPROVED CDT 28.01.2022
SECTION No/KKS PGG
A1 SHEET SIZE
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
EFFLUENT TREATMENT
NEUTRALISATION PIT AND TRANSFER PUMPS - SHEET 1
C REV SH 1 OF 1



NOTES:
1. CAUSTIC INJECTION PUMP TO BE STARTED WHEN PH BELOW 6.5 AND THEN WILL STOP WHEN PH BACK TO ABOVE 7.

HOLDS:
1. DETAILS INSIDE PACKAGE IS SCHEMATIC ONLY, PACKAGE SUPPLIER TO OFFER BEST AND EFFICIENT ARRANGEMENT FOR PACKAGE INSIDE, DILUTED CAUSTIC TO BE USED FOR PH ADJUSTMENT
2. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
3. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

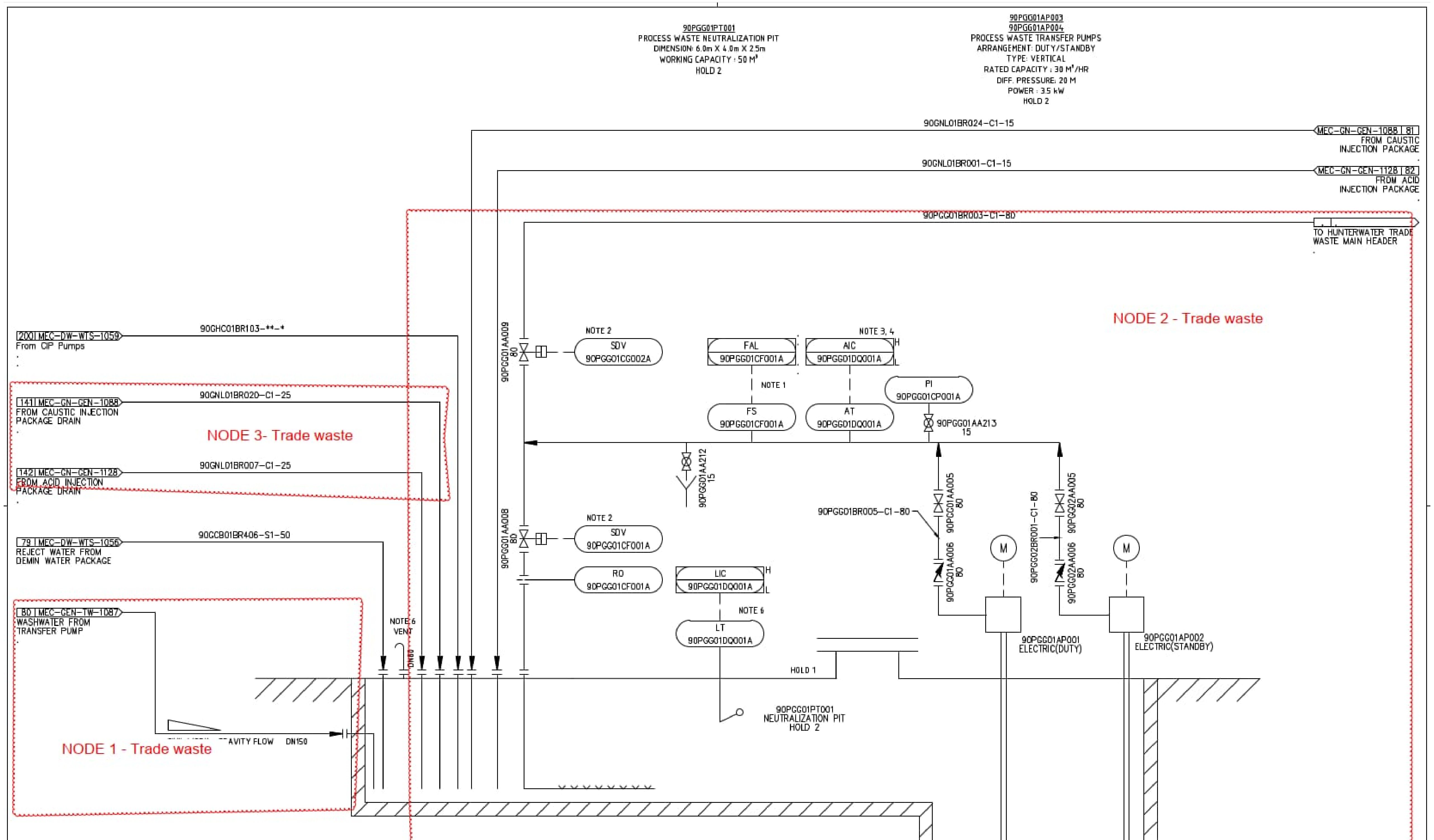
REV	NAME	DATE	DESCRIPTION
C	AECOM	28.01.22	ISSUED FOR HAZOP
B	AECOM	08.11.21	10% CONCEPT DESIGN
A	AECOM	16.11.21	ITT_R2 FOR INFORMATION

THIS DRG SUPPLIED BY
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-GN-GEN-DRG-1008
REV: C

DRAWN: SR 28.01.2022	DRAWING CHECKED: BVA 28.01.2022
DESIGNED: JD 28.01.2022	DESIGN CHECKED: KW 28.01.2022
SCALE / WORK ORDER No	APPROVED: CDT 28.01.2022
SECTION No/KKS: GNL	SHEET SIZE: A1

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
EFFLUENT TREATMENT
PH ADJUSTMENT INJECTION PACKAGES - SHEET 1

REV C SH 1 OF 1



NOTES:
1. NO FLOW WILL STOP THE OPERATING PUMP.
2. IN CASE OF PH HIGHER THAN 10 OR LOWER THAN 6.5, RECYCLE VALVE TO BE OPENED AND TRANSFER VALVE TO BE CLOSED AND FOR PH BETWEEN 6.5 AND 10, RECYCLE VALVE WILL BE OPEN TO TRANSFER THE WASTE TO HUNTER WATER TRADE WASTE.
3. PH ABOVE 10 WILL START THE ACID INJECTION PUMP, AND WILL STOP ONCE PH BACK TO BELOW 9.5.
4. PH BELOW 6.5 WILL START THE CAUSTIC INJECTION PUMP, AND WILL STOP ONCE PH BACK TO ABOVE 7.
5. VENT TO SAFE LOCATION.
6. TRANSFER PUMP WILL START WITH HIGH LEVEL SIGNAL AND STOP WITH LOW LEVEL.

HOLDS:
1. REQUIREMENT FOR COVER ON NEUTRALIZATION PIT IS ON HOLD.
2. NEUTRALIZATION PIT AND TRANSFER PUMP CAPACITY ARE SIZES BASED ON MHI UTILITY AND WASTE LIST AND RECEIVED PRELIMINARY INFORMATION FROM DEMIN WATER TREATMENT PACKAGE SUPPLIERS AND BOTH ARE SUBJECT TO CHANGE.
3. THE USE OF ** WILL BE A PLACEHOLDER INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	28.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM
AECOM Australia Pty Ltd
DRAWING No. HPP-AEC-MEC-GN-GEN-DRG-1123
REV: B

DRAWN LAF 28.01.2022	DRAWING CHECKED BVA 28.01.2022
DESIGNED JD 28.01.2022	DESIGN CHECKED KW 28.01.2022
SCALE / WORK ORDER No	APPROVED CDT 28.01.2022
SECTION No/KKS GNL / PGG	A1 SHEET SIZE

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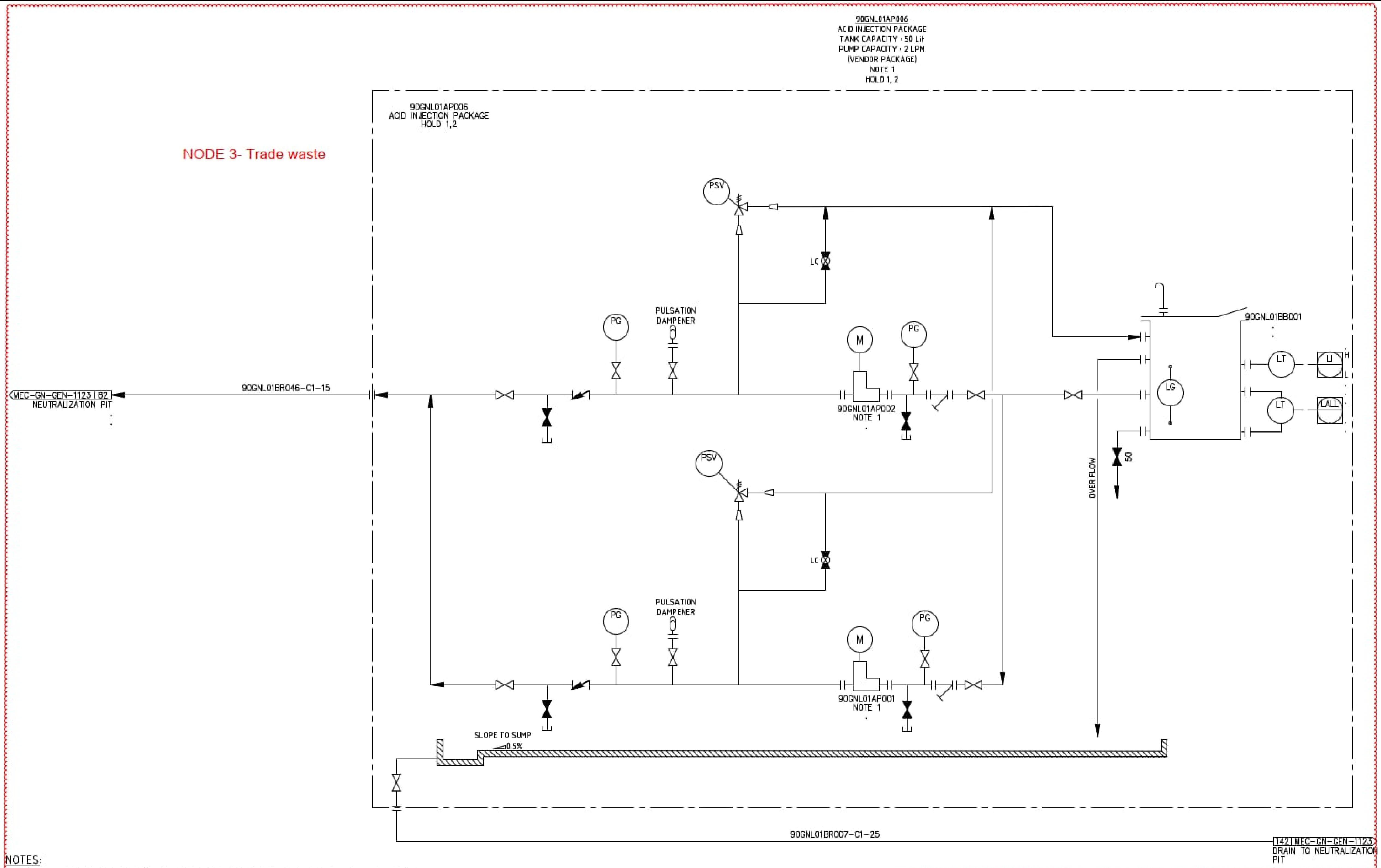
HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
EFFLUENT TREATMENT
NEUTRALISATION PIT AND TRANSFER PUMPS - SHEET 2
B REV SH 1 OF 1



NOTES:

1. ACID INJECTION PUMP TO BE STARTED WHEN PH ABOVE 10 AND THEN WILL STOP WHEN PH BACK TO BELOW 9.5.

HOLDS:

1. DETAILS INSIDE PACKAGE IS SCHEMATIC ONLY, PACKAGE SUPPLIER TO OFFER BEST AND EFFICIENT ARRANGEMENT FOR PACKAGE INSIDE.
2. TYPE OF ACID WILL BE FINALIZED BY PACKAGE SUPPLIER CONSIDERING HEALTH AND SAFETY ISSUES.
3. THE USE OF ** WILL BE A PLACEHOLDER FOR INFORMATION THAT NEEDS TO BE CONFIRMED.
4. THIS P&ID IS STILL A WORK IN PROGRESS AND THE INTEND TO DATE IS TO SHOW THE PROCESS FOR 30% SUBMISSION.
5. KKS SYSTEM ON P&ID ARE INDICATIVE ONLY AS THE P&ID GET FINALIZED.

ISSUED FOR INFORMATION ONLY

REV	NAME	DATE	DESCRIPTION
B	AECOM	28.01.22	ISSUED FOR HAZOP
A	AECOM	30.11.21	30% CONCEPT DESIGN

THIS DRG SUPPLIED BY AECOM Australia Pty Ltd	DRAWN SR 28.01.2022	DRAWING CHECKED BVA 28.01.2022
DRAWING No. HPP-AEC-MEC-GN-GEN-DRG-1128	DESIGNED JD 28.01.2022	DESIGN CHECKED KW 28.01.2022
REV: B	SCALE / WORK ORDER No	APPROVED CDT 28.01.2022
	SECTION No/KKS GNL	SHEET SIZE A1

HUNTER POWER STATION
PIPING & INSTRUMENTATION DIAGRAM
EFFLUENT TREATMENT
PH ADJUSTMENT INJECTION PACKAGES - SHEET 2

REV B SH 1 OF 1

Appendix E

HAZOP Recommendations Completion Schedule by Project Phase

Where a recommendation and action has been made, the project sequence for its resolution is indicated in the HAZOP study record according to the following four project implementation phases in order of priority:

- Phase 1 - Prior to Design Completion and Construction
- Phase 2 - Prior to Commissioning
- Phase 3 - Prior to Handover for Beneficial Operation
- Phase 4 - Within 12 months of Beneficial Operation

Design Area	System or Sub-System	Finding Ref No:	Recommendations	Owner	Required Completion Phase
Power Island	1 - Fuel Oil - High pressure Pump	3	Confirm forwarding pump deadhead pressure and prv	SNOWY HYDRO	1
Power Island	1 - Fuel Oil - High pressure Pump	4	Review bunding requirements around FO pumps	SNOWY HYDRO	1
Power Island	1 - Fuel Oil - High pressure Pump	5	Confirm $ cost per unit trip / 1 hr outage	SNOWY HYDRO	1
Power Island	1 - Fuel Oil - High pressure Pump	6	All ball valves to be lockable	SNOWY HYDRO	1
Power Island	1 - Fuel Oil - High pressure Pump	7	SHL to review who supplies instrumentation at MHI interfaces	SNOWY HYDRO	1
Power Island	1 - Fuel Oil - High pressure Pump	12	AECOM to consider heat tracing for FO dwg 2of 5. Start up temperature should be 11 deg C. Alternative may be an enclosure for the pump and piping	SNOWY HYDRO	1
Power Island	2 - Fuel Oil - Manifold pressure control	36	The screw pump has no min flow bypass return line. The HP pump only starts when burners are to be lit. When no burner flow the manifold pressure control valve acts as the min flow control. MHI to confirm forwarding pump flow rate through HP screw pump when shutdown	MHI	1
Power Island	5 - Fuel Oil - Flow divider	95	MHI manual ball valves should all be lockable	SNOWY HYDRO	1
Power Island	6 - Fuel Oil - Burners	124, 517, 565	Pantac to review blade path flameout voting logic. One or multiple burners, adjacent burners, single or duplex t/c. No optical flame detectors	SNOWY HYDRO	2
Power Island	6 - Fuel Oil - Burners	127	MHI to advise combustion frequency sensor criticality. Commissioning tool or protection	MHI	2
Power Island	6 - Fuel Oil - Burners	129	SHL investigating additional diesel fuel quality reports	SNOWY HYDRO	2
Power Island	7 - Fuel Oil - Drain tank	144	MHI to confirm if there is a drain tank Hi level start permissive. Unit won’t start with high level	MHI	1
Power Island	7 - Fuel Oil - Drain tank	147	SHL to confirm with operations to see if small lines have been problematic with non-return valves failing / passing	SNOWY HYDRO	1
Power Island	7 - Fuel Oil - Drain tank	148	AECOM to consider drain pit discharge hi alarm to start pump and hi hi to alarm to remote operations	AECOM	1
Power Island	7 - Fuel Oil - Drain tank	149	AECOM Fuel oil discharge to oily water pit detection to be considered in design	AECOM	1
Power Island	8 - Fuel Oil - Water injection	159	MHI to confirm at what load level water injection is enabled. Also when water injection is not correct the unit would go to run back load, where water injection is turned off.	MHI	1
Power Island	8 - Fuel Oil - Water injection	160	SHL to confirm action required when water injection is off, i.e. valley will try to restart water injection 3 times and max operating time without water injection is 15 minutes. Automatic shutdown required, tbc and advise to MHI or add into station controls	SNOWY HYDRO	2
Power Island	8 - Fuel Oil - Water injection	161	Oily water pit to be covered with rain shelter	AECOM	1
Power Island	8 - Fuel Oil - Water injection	169	AECOM to consider valve failure, excessive flow to oily water pit overflow during runback time. Flow balance required. MHI to advise oily water flow rate and volumes expected during normal operating conditions and if one of the drain valves fails open, MBN13AA735,AA736,AA737 based on SHL RFI document	AECOM	1
Power Island	8 - Fuel Oil - Water injection	170	Water injection flow transmitter is a single point of failure which would cause diesel outage, so it is critical for operation. Redundancy for valve control per fuel oil control should be considered. MBU02CP531.	SNOWY HYDRO	1
Power Island	8 - Fuel Oil - Water injection	171	Single point of failure mode analysis should be completed at a suitable time. SHL internal item	SNOWY HYDRO	3
Power Island	8 - Fuel Oil - Water injection	172	Outage, run back, emergency trip restart time cost analysis required for Risk Assessment decision around device fault tolerance, i.e. trip or 1 hours outage = 800k (330MW x 2500MW/Hr x 1 hr), additional instrument = 20k installed	SNOWY HYDRO	1

Design Area	System or Sub-System	Finding Ref No:	Recommendations	Owner	Required Completion Phase
Power Island	9 - Fuel Oil - Purge credit block valves	184	Purge credit details are not well understood by Operations. There is a manual, Operating Procedure(S4-96597), that describes it in more detail. Type B compliance, intermittent or continuous turning and start and re-purge credit are all good questions. Potentially every 8 days the unit needs repurging, which can lead to more blade wear (wobbling in root) and starter problems. This item to be revisited by Operations with MHI detail input.	SNOWY HYDRO	3
Power Island	9 - Fuel Oil - Purge credit block valves	191	MHI to review if fuel oil from the fuel oil purge credit can go to the tank not the pit as it is clean fuel. Environmental credit	SNOWY HYDRO	1
Power Island	9 - Fuel Oil - Purge credit block valves	192	Fuel oil purge credit valves only have a single limit switch, preference for both open and closed indication, all valves (block, drain, N2). AECOM supply these valves	SNOWY HYDRO	1
Power Island	11 - Fuel Gas - Supply pressure control	216	MHI to check logic. Gas vent valve out of position during operation should be a trip. Redundant limit switches may be.	MHI	2
Power Island	11 - Fuel Gas - Supply pressure control	217	AECOM should review vent valve position failure actions	AECOM	2
Power Island	11 - Fuel Gas - Supply pressure control	218	AECOM to review appliance manual isolation valve per AS3814 requirements within 5m of the appliance. Paul van Dyk to confirm AS3814 clause requirements	SNOWY HYDRO	1
Power Island	11 - Fuel Gas - Supply pressure control	219	Tapping points for pressure testing / leak testing valves not shown on P&ID. Additional testing points may be required. SHL to review based on length of pipework and valve locations.	MHI	1
Power Island	11 - Fuel Gas - Supply pressure control 17 - Fuel Gas - GT sweep (purge air)	223, 350	MHI to review AS3814 section 2.13 requirement for sufficient test points to verify the integrity of shutoff valve / train.	MHI	1
Power Island	12 - Fuel Gas - Flow control	231	RFI for the purpose of the HAZOP the main question, is there a single point of failure (DPT) and what would be consequence of a critical time pressure excursion explosion. Is DPT control or protection, refer control description fig 2.9.1	MHI	1
Power Island	15 - Fuel Gas - Combustor drain valves	301	MHI to confirm temperature rating of pipework after MBA01AA704, burner drain valve. Rating drops from 525 to 60 Celsius	MHI	1
Power Island	15 - Fuel Gas - Combustor drain valves	304, 871, 878	Water wash procedure has many manual valves which could potentially lead to false start by flooded combustion chamber and subsequently detergent flow into the oil water pit. SHL to develop a water wash procedure with 2 operators to cross check. Water washing drain header could also have small amounts of diesel residue from liquid fuel false start.	SNOWY HYDRO	3
Power Island	18 - Fuel Gas - Flow meter	368	Commissioning spool required for flow meter, that will need to be removed for pipe blow down activities. Mark up P&ID	AECOM	2
Power Island	19 - Fuel Gas - Filter and purge credit	397	Add instrument tapping point for Nitrogen entry for valve leak testing, with smaller volume than upstream line	AECOM	1
Power Island	20 - Fuel Gas - Calorie meter	403	Calorie meter. 1. Cal gas bottles only have single regulator and no relief valve. Potential single point of failure. Is meter rated for cal gas pressure. 2. If reg fails, is it possible to reverse flow cal gas into the gas line? 3. Why is there a flow meter in the vent line?	MHI	1
Power Island	21 - Air & Flue Gas - Seal air	432	All ball valves to be lockable. Evan to confirm who is responsible for providing the pad locking system for all the manual isolation valves and to ensure the valves have lock tabs, refer also action item 4. Also send sample photos to MHI. The requirement is in the tender specification section 2.3	SNOWY HYDRO	1
Power Island	24 - Air & Flue Gas - GT HP Bleed valve	506	MHI to confirm failure mode of IGV, i.e. fail last position, fail ramp closed on loss of control oil or power?	MHI	2
Power Island	25 - Air & Flue Gas - Inlet duct flow 27 - Air & Flue Gas - Combustor and Exhaust	515, 563	2oo3 trip voting degradation to be reviewed on a trip by trip basis by SHL, 2oo3, 1oo2 or 2oo2 and 1oo1 = trip or run?	SNOWY HYDRO	2

Design Area	System or Sub-System	Finding Ref No:	Recommendations	Owner	Required Completion Phase
Power Island	29 - Lube Oil - Tank, pumps, prv	608	DC Lube oil pump to be tested prior or after each start to prove functionality. Replacing MBV01CP304 DC lube oil pressure gauge with a transmitter would facilitate fast auto test sequence. Requirements to be confirmed by SHL	SNOWY HYDRO	1
Power Island	30 - Lube Oil - GT bearings 50 - Generator - Lube oil system	633, 1060	SHL to review high temperature alarm shutdown requirements for Hunter. Remote operator may not react in time.	SNOWY HYDRO	2
Power Island	30 - Lube Oil - GT bearings	646	SHL may request additional oil sampling point downstream of the bearings (generator and turbine). MHI to review installation requirements and advise accordingly	MHI	1
Power Island	34 - Control Oil - Tank, pumps, temp control	724	There is a wall in the oil tank which may create different tank levels, design to be confirmed by MHI	MHI	1
Power Island	35 - Control Oil - Fuel valve position control	753	Fuel gas and Fuel Oil control oil dump valves are single point of failure and common cause fraction is high. Is this allowed per the standard. Valves should failsafe and individually actuated?? PVD to review in detail as part of AS3814 compliance	SNOWY HYDRO	1
Power Island	36 - Control Oil - Fuel valve trip solenoids & Inlet Guide Vanes	774	Control oil dump circuits to be reviewed against SIL requirements and AS3814 compliance	SNOWY HYDRO	1
Power Island	37 - Package Enclosure Ventilation	791	Note AECOM responsible for Fire protection of the Balance of Plant equipment such as lube oil package, fuel oil pump / valve systems and how that system is interlock or integrated into the plant DCS or MHI GT controls. AECOM is design stage now. Fire safety study is well advanced MHI fire and gas detection limited to GT enclosure and Fuel Gas valve systems. SHL to review final design proposal	SNOWY HYDRO	1
Power Island	37 - Package Enclosure Ventilation	792	Door tracking isolating the CO2 if someone enters the GT is to be confirmed by vendor and reviewed by SHL	SNOWY HYDRO	1
Power Island	38 - Air & Flue Gas - Inlet filter	805	Ambient conditions -5 C to +45 C. Anti-icing system was considered in the tender specification but MHI advised at that time it is not required. MHI to revisit the study and reconfirm anti-icing is not required.	MHI	1
Power Island	42 - Evaporative Cooler - pump and tank unit	887	Valve numbers and instrument numbers and line sizes are not shown on the drawing. Return valve is shown as control valve but is actually a manual lockable isolation valve	MHI	3
Power Island	42 - Evaporative Cooler - pump and tank unit	893	Evap tank water is potable water. Should overflow or draining be discharged to Trade Waste or Storm Water. AECOM to review and design accordingly	AECOM	1
Power Island	42 - Evaporative Cooler - pump and tank unit	899	Evap tank has no sample point. MHI to review option to supply	MHI	1
Power Island	44 - Generator cooling water	928	MELCO interface details required for AECOM water services. Water pressure recently increased to 7.5 Bar. AECOM to advise MELCO final supply pressure. MELCO cooler to be designed accordingly	AECOM	1
Power Island	44 - Generator cooling water	932	MELCO to provide full list of generator protection settings, trips complete with alarms, auto shutdown and run backs	MELCO	2
Power Island	45 - Generator CO2 gas supply	951	Manual purging requires strict procedure with 2 people to cross check to confirm successful purge	SNOWY HYDRO	2
Power Island	45 - Generator CO2 gas supply	950	CO2 site capacity to be assessed against minimum volume required for a successful purge times a safety factor. Potential bottle leak reduces capacity. Is adequate monitoring installed, flow pressure bottle weight	AECOM	1
Power Island	45 - Generator CO2 gas supply 53 - Generator - DC seal oil system	957, 1128	Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. MHI incorporate in design, logic to action valve	MHI	1
Power Island	45 - Generator CO2 gas supply	958	Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. AECOM to incorporate automate CO2 supply to the units	AECOM	1
Power Island	46 - Generator H2 gas supply	970	Unit H2 flow meter can be used for make up flow monitoring, leak and PRV lifting detection. SHL to review	SNOWY HYDRO	2

Design Area	System or Sub-System	Finding Ref No:	Recommendations	Owner	Required Completion Phase
Power Island	46 - Generator H2 gas supply	983	AECOM to review H2 pipework for dissimilar metals. MELCO supply all 304 stainless. Potential corrosion and Haz area issue	AECOM	1
Power Island	47 - Generator CO2	1004	CO2 line has no filter or strainer. It is rarely used which could create fouling issues. MELCO to consider and quote option	MELCO	1
Power Island	48 - Generator H2	1013	MELCO to review automating the Hydrogen make up valve as the site is normally not manned.	MELCO	1
Power Island	48 - Generator H2	1014	Hydrogen pressure transmitter PT1 is potentially a single point of failure for an unmanned site. MHI to confirm signal failure response	MHI	2
Power Island	48 - Generator H2	1026	Dew point monitoring is currently not part of the scope. SHL to request a quotation from MDI to add dew point monitoring	SNOWY HYDRO	1
Power Island	48 - Generator H2	1022	MELCO to confirm what happens to the purity meter if CV-1 fails and flow is too low or no flow or needle valve set incorrectly. Hydrogen purity is important for purging requirements	MHI	2
Power Island	48 - Generator H2	1029	SHL to develop written procedure for sampling purity with portable analyser to confirm main analyser reading is correct. Drain sampling and valve switching is manual to select top or bottom of the generator sampling. Note sampling drain point is within hazardous area	SNOWY HYDRO	2
Power Island	48 - Generator H2	1017	Site wide review of field mounted instrumentation junction boxes and field panels required. These are normally fitted with heaters to prevent condensation	SNOWY HYDRO	1
Power Island	48 - Generator H2	1018	MHI to supply instrumentation datasheets for action item 66. To confirm field instrumentation ratings, i.e. +5 - +45 non- condensing??	MHI	1
Power Island	48 - Generator H2	1020	AECOM to study hydrogen detection requirements for this open area plant area and that location is under exciter which probably has cooling fans that could draw H2 into enclosure	AECOM	1
Power Island	48 - Generator H2	1024	MELCO to add check valve before CO2 manual isolation valve	MELCO	1
Power Island	49 - Generator H2 drying system	1045	Hydrogen dryer blower intake is open to atmosphere and in close proximity to the Operator swinging the 3-ways valves. Incorrect procedure (monthly) or Operator error would vent Hydrogen out of air intake. Operator exposure to fire / explosion (static). Design review required. Air intake pipe to safe area to seal system or automated double block and bleed per combustion standard	SNOWY HYDRO	1
Power Island	49 - Generator H2 drying system	1040, 1051	MELCO to quote additional double block and vent isolation valves for on-line maintenance of heater system, to eliminate H2 purge of complete system. Snowy standard maintenance requirement	MELCO	1
Power Island	50 - Generator - Lube oil system	1064	There is a discrepancy between MELCO pipe sizes and MHI drawing A-21022 page 2 of 4. MHI to review and correct	MHI	1
Power Island	50 - Generator - Lube oil system	1056	MELCO design is heavily reliant on Operator alarm response and on site Operator rounds. This is not how Snowy normally operate. Additional instrumentation would be likely be installed on future upgrades. MELCO design to be reviewed for potential instrumentation upgrades	SNOWY HYDRO	1
Power Island	51 - Generator - Seal oil vacuum pump and tank	1084	AECOM to incorporate seal oil system drip / leak tray overflow to oily water system in their design	AECOM	2
Power Island	51 - Generator - Seal oil vacuum pump and tank	1084	Seal oil system drip tray or bunded area should be remotely monitored for large leaks and potentially auto draining function of sight glass. Similar to fuel oil / lube oil bunds	SNOWY HYDRO	1
Power Island	51 - Generator - Seal oil vacuum pump and tank	1085	Seal oil vacuum tank fill valve is a single point of failure which can lead to lube oil overfilling the tank and lube oil discharging via the vent stack, potential large quantities due to unmanned site. Alarm response cannot prevent this consequence and would happen quite quickly. Design review required	SNOWY HYDRO	1

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Power Island	53 - Generator - DC seal oil system	1116	MELCO to review design to define the potential consequences of an unmanaged seal oil system failure and loss of hydrogen containment. Snowy will use this information to risk assess the installation per HAZOP guidelines	MELCO	1
Power Island	53 - Generator - DC seal oil system	1123	Change DC pressure PI-5 to pressure transmitter for DC pump test run and linking to H2 automatic venting system. MELCO team suggest change is technically possible but may cause delays. Snowy to review schedule impact and instruct MELCO accordingly	SNOWY HYDRO	1
Power Island	53 - Generator - DC seal oil system	1124	MELCO team to confirm DC pump recirc line size. The large size valve passing may result in very low DC seal oil pressure	MELCO	1
Power Island	53 - Generator - DC seal oil system	1126	AC and DC suction pressure indicators not shown on drawing but will be provided. MELCO to update drawing	MELCO	2
Power Island	53 - Generator - DC seal oil system	1125	DC pump inlet (suction side) check valve stuck closed resulting in no oil pressure in a demand scenario. Why do we need this valve and is it normally open or closed. Confirm also design of this valve, i.e. spring, lockable, power cylinder??	MELCO	1
Power Island	53 - Generator - DC seal oil system	1141	Snowy to review redundant AC seal oil pump configuration requirement and work with MELCO on solution	SNOWY HYDRO	1
Power Island	54 - Generator - Gland seal oil system	1145	Gland seal system if currently a manually operated procedure that is required during hydrogen fill and 'potentially' at full speed to centre the seal rings to reduce shaft vibration. Remotely operated solenoid would be the ideal solution. MELCO to confirm the design requirements and schedule impact to be confirmed	MELCO	1
Power Island	Closed Cooling Water - 1 - Fin fans	3	Add drain points and vibration sensors to P&ID Sht 1 of 4	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	4	Piping ratings on drawings need to be corrected	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	5	Pumps have not been specified yet. System pressure with 2 pumps running to be checked against MHI supplied heat exchangers and the fin fan cooler design pressure	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	6	Delete upstream individual header pressure indicators and change the downstream individual header pressure indicators to temperature sensors to assist with flow balancing	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	7	Add fin fan overall dP sensor	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	8	Add helper cooler discharge pressure and temperature transmitter to P&ID	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans 2 - Helper cooler and booster pump	9	Review system design for thermal expansion to assess if a flexible connection is required	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	10	Review which sensor is better to control the fin fans, CT102 or CT103	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	11	Review sensor failure on loss of signal for fin fans, CT102 and CT103	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	12	Temperature sensors should be dual elements, even if only 1 is used. Consistent with MHI design	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	13	Flow balancing valves should be set and forget. Not move with water vibration. Valve selection to consider locking or rigid stem packing to hold commissioned position	AECOM	1
Power Island	Closed Cooling Water - 1 - Fin fans	23	Grease points access needs a lift. SHL to review site requirements hire or buy a scissor lift	SNOWY HYDRO	3
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	25	Add duty standby pumps to drawing	AECOM	1
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	26	Confirm piping pressure rated for two pumps running	AECOM	1
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	30	Review instrument impulse lines for low ambient temp. Threaded socket direct to pipe is probably the best approach.	AECOM	1
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	39	Potential forwarding pressure is sufficient to continuously leak out of helper spray nozzles. Review booster pump or spray bar isolation requirements	AECOM	1

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Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	45	Helper Cooler spray water is demin that needs to flow (if any) to Trade waste. System is not covered so rain water catchment would also flow to trade waste. To be considered in the design.	AECOM	1
Power Island	Closed Cooling Water - 3 - Expansion tank	57	Water consumption of pump gland seals and leakage to be estimated to evaluate automating tank filling and pump discharge pressure stability. More than 1 x per mth suggest automation required.	AECOM	1
Power Island	Closed Cooling Water - 3 - Expansion tank	47	Add PRVs to instrument air and forwarding demin supplies to prevent overpressure, Press Reg, Sight glass, manifold suction pressure transmitter and level switch to P&ID and suitably rated	AECOM	1
Power Island	Closed Cooling Water - 5 - GT HP Purge air coolers	97	MHI to review HP compressor protection requirements. What are the consequences if the closed cooling water temperature increases above 40 C. Do we need to shutdown the compressors to protect them from damage?	MHI	2
Power Island	Closed Cooling Water - 5 - GT HP Purge air coolers	105	MHI to confirm HP compressor oil pressure and if there is an exchanger leak, will the water flow into the compressor and cause damage? How is this detected?	MHI	2
Power Island	Closed Cooling Water - 6 - GTG H2 air coolers	115	P&ID line 100mm to be updated to 125mm	AECOM	2
Power Island	Closed Cooling Water - 6 - GTG H2 air coolers	116	Pressure regulation wont work as shown. AECOM to review water pressure balancing system. It is important to maintain 5.5 Bar cooling water at exchangers to inhibit H2 leak	AECOM	1
Power Island	Closed Cooling Water - 6 - GTG H2 air coolers	135	AECOM to review and confirm with MHI if any closed cooling water commissioning strainer / removal spool requirements	AECOM	1
Power Island	Closed Cooling Water - 7 - GT Control oil coolers	147	AECOM to review check valve quantity and location. Control oil only has 1 common NRV but other exchangers are individually controlled. Do we need them?	AECOM	1
Power Island	Closed Cooling Water - 3 - Expansion tank	61, 69	Expansion tank bladder inspection and repair access and maintenance requirements to be specified	AECOM	1
Power Island	Closed Cooling Water - 4 - Cooling water pumps	71. 91	Pump discharge manifold PRV to discharge to trade waste system. All (all nodes) CW system drain points need to go to trade waste	AECOM	1
Power Island	Closed Cooling Water - 4 - Cooling water pumps	87	On loss of AC supply, does the closed cooling water system (fans and / or pumps) need to be operational for any specified period time after a black stop. MHI to confirm any run down time requirements	MHI	1
Balance of Plant	Diesel	1.1.1	Requirement to be clear in procedures that quantity delivered is based on tanker dip gauges.	SNOWY HYDRO	2
Balance of Plant	Diesel	1.1.2	Refer to action of 1.1.15.	AECOM	1
Balance of Plant	Diesel	1.1.3	Check with the pump vendor if the selected pump can operate for 20 seconds with low flow.	AECOM	1
Balance of Plant	Diesel	1.1.4	Review requirement of bleed valve on suction line to the pump.	AECOM	1
Balance of Plant	Diesel	1.1.7	Show internal relief of pumps on P&IDs.	AECOM	1
Balance of Plant	Diesel	1.1.9	Operating Procedures to include a check of the diesel quality delivered to site.	SNOWY HYDRO	2
Balance of Plant	Diesel	1.1.10	Diesel should be regularly tested to ensure the level is suitable for the Gas turbine. Included regular sampling for quality testing in the operating procedures.	SNOWY HYDRO	2
Balance of Plant	Diesel	1.1.11	Review requirement for commissioning strainers.	AECOM	1
Balance of Plant	Diesel	1.1.11	Construction ITPs to include cleanliness checks.	SNOWY HYDRO	2
Balance of Plant	Diesel	1.1.12	Review requirement for valve with position indicator in diesel unloading bund.	AECOM	1
Balance of Plant	Diesel	1.1.13	Review requirement for bund size as per AS 1940. Consider making bund big enough for all components on B double.	AECOM	1
Balance of Plant	Diesel	1.1.14	Review where pump spill containment is discharged to. Preference is to keep in the pump bund area rather than being discharged into larger road containment bund.	AECOM	1
Balance of Plant	Diesel	1.1.15	Process interlock to be reviewed/designed to not allow running both pumps at the same time. Include permissive that valve should be opened before running pump.	AECOM	1
Balance of Plant	Diesel	1.1.16	Review process interlock that on/off valves to tank inlet are opened prior to starting the pump.	AECOM	1
Balance of Plant	Diesel	1.1.17	Review requirement for sight glass downstream of flexible couplings. See 1.1.4	AECOM	1

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Balance of Plant	Diesel	1.2.1	Review impacts of ramp up and ramp down of delivery to trucks. Review impacts on PD pumps and whether PSV will lift when FCV closes. Could replace PSV with Pressure Reducing Valve. Review if the FCV in the diesel loading skid is required.	AECOM	1
Balance of Plant	Diesel	1.2.2	Process interlock to be reviewed/designed to prevent running both pumps at the same time.	AECOM	1
Balance of Plant	Diesel	1.2.4	Integrate the vendor package with the loading pumps. E stop required for Load bay controller. Check if control should be independent of DCS e.g. Removal of air will close valves and stop the flow.	AECOM	1
Balance of Plant	Diesel	1.2.5	Check tanker loading connection (dry break connection), valving isolation and check valves. Check if there is a sight glass include in line.	SNOWY HYDRO	1
Balance of Plant	Diesel	1.2.6	Review pump head to maintain pressure of the loading arm below 5 barg	AECOM	1
Balance of Plant	Diesel	1.2.7	Review location of discharge of TRV to ensure section that is relieved will not exceed design pressure.	AECOM	1
Balance of Plant	Diesel	1.2.9	Confirm if tanker can be over pressured or has lid open. Ensure tanker vent system is interlocked to avoid overpressure in the tanker.	SNOWY HYDRO	1
Balance of Plant	Diesel	1.2.12	Consider bollards in unloading area	AECOM	1
Balance of Plant	Diesel	1.2.13	Consider whether a weigh bridge or other mechanism to measure amount of fuel being loaded	SNOWY HYDRO	1
Balance of Plant	Diesel	1.3.1	Add a flame arrestor to diesel storage tanks (as per Colongra site)	AECOM	1
Balance of Plant	Diesel	1.3.3	Consider needle control valve in air supply to operate the pump.	AECOM	1
Balance of Plant	Diesel	1.3.4	Use level transmitter as pump shutdown as well as the level switch.	AECOM	1
Balance of Plant	Diesel	1.3.5	Use level transmitter as pump shutdown as well as the level switch.	AECOM	1
Balance of Plant	Diesel	1.3.6	Review the employer requirements to have one or two transmitters. Review how critical this instrument is to the operation of the GT.	AECOM	1
Balance of Plant	Diesel	1.3.8	Review of AS 1940 to determine if any additional temperature control are required	AECOM	1
Balance of Plant	Diesel	1.3.9	SH to provide fuel specification (pour point) of selected fuel to determine if wax formation is likely at the minimum expected storage temperature.	SNOWY HYDRO	1
Balance of Plant	Diesel	1.3.12	Review drain/vent material selection to minimise corrosion. Review coating of tank.	AECOM	1
Balance of Plant	Diesel	1.3.13	Determine if density/viscosity of diesel change significantly with temperature. To be confirmed with fuel supplier	SNOWY HYDRO	1
Balance of Plant	Diesel	1.3.17	Confirm that a potential rain event (i.e. 1 in 100 rainfall event) will not cause instrumentation and control systems to be covered in water. Considering including float switch to alert before control switches are under water.	AECOM	1
Balance of Plant	Diesel	1.3.18	Consider the internal surface of diesel tank to be fully coated.	AECOM	1
Balance of Plant	Diesel	1.4.1	Interlock to prevent 3 pumps running at the same time.	AECOM	1
Balance of Plant	Diesel	1.4.2	Check diesel polishing package has alarm for the differential pressure across filters to alert operators of blocked filters in DCS.	AECOM	1
Balance of Plant	Diesel	1.4.11	Consider an additional separate pump for polishing package. Look at automated prioritised control of forwarding pumps.	AECOM	1
Balance of Plant	Diesel	1.5.1	One inlet return valve to each storage tank to be open at all times. Set fail action to fail last. Oil is returned after GT shutdown. Ensure the inlet line is open for the fuel return to tanks. Keep at least one inlet valve open for diesel return from GT after shutdown.	AECOM	1
Balance of Plant	Diesel	1.5.2	Redundancy and reliability issues need review. Consider running the standby pump at all times so if a single pump trips no loss of flow or pressure to the GT. Perform a dynamic study to determine if only running two pumps and time required for a third pump to start and compensate for loss of flow of tripped pump. How many pumps need to be running if there is a pump trip. Consider n+1 where n is the number of units.	AECOM	1
Balance of Plant	Diesel	1.5.6	Consider installing a small sump and weir in bund to contain smaller leak quantities at pump skid bund.	AECOM	1
Balance of Plant	Diesel	1.5.8	Change PI upstream of flowmeter to be PT	AECOM	1
Balance of Plant	Diesel	1.6.4	Review the interaction of the loading/unloading interaction with curb and lighting.	AECOM	1
Balance of Plant	Diesel	1.6.5	Review causes of fire/consequences. A fire could start on site undetected. Review fire protection and	AECOM	1
Balance of Plant	Diesel	1.6.10	Review bushfire impacts on the fuel tanks. Assess best materials for fencing etc. to minimise this risk. (NOTE: A fence will not prevent ember attack which comes from an elevated height higher than normal fence height).	AECOM	1
Balance of Plant	Diesel	1.6.12	O&Ms to be created by SH	SNOWY HYDRO	2
Balance of Plant	Natural Gas	2.1.3	Use temporary flexible connection for N2 purging with hoses and only connected when required for maintenance. Covered under operating procedures for only connecting N2 when purging is required.	SNOWY HYDRO	2

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Balance of Plant	Natural Gas	2.1.4	SH have requested to add facilities for a remote operated vent for each pipe section to be opened remotely by operators to reduce pressure in the pipeline over a selected time period e.g. 15 minutes in case of fire. Two vents will be required one for first section between battery limit ESD and SDV upstream of knockout drum and second vent required downstream of gas KO drum ESD for downstream equipment. Consider damage to the packing in the filter coalescer vessel from a high differential pressure across the filter material during venting. Change valve to ESD (currently SDV). Vent valve interlocked to not open until ESD is closed to prevent loss of gas. Review the operation of vent in conjunction with remote operation philosophy i.e., effect of ignition of vent and possibility of air entering the gas line when line depressurised. May effect ability for remote start-up. Vent valve will only close in emergency.	AECOM	1
Balance of Plant	Natural Gas	2.1.5	Perform dynamic study of the system based on closure times of the valves. Consider all system shutdown (trip) scenarios.	AECOM	1
Balance of Plant	Natural Gas	2.1.6	Confirm there is a safety relief valve in pressure reduction units supplied by MHI.	MHI	1
Balance of Plant	Natural Gas	2.1.9	Review location of vent stack with regard to radiation from ignition of NG. Review potential to co-locate new vents required in APA's vent area	AECOM	1
Balance of Plant	Natural Gas	2.1.10	Include pressure transmitter and local pressure indicator on main line. Provide additional tapping points for gauges if required.	AECOM	1
Balance of Plant	Natural Gas	2.1.11	Review whether integral DBB valves can be used instead of separate valves to save cost.	AECOM	1
Balance of Plant	Natural Gas	2.1.13	Update PID to show not permanently connected.	AECOM	1
Balance of Plant	Natural Gas	2.2.2	Review potential impact on reverse flow through KO pot and demister pad.	AECOM	1
Balance of Plant	Natural Gas	2.2.3	Review requirement for Emergency shut off valve EKG01AA161 upstream of KO drum. Consider changing to a manual valve as remote operation of the valve is not required (by SH)ESD can remotely isolate each GT if fire on one unit. Provide a schematic drawing (updated PFD) of ESD and vent valves on gas supply line to each gas turbine.	AECOM	1
Balance of Plant	Natural Gas	2.2.4	Change location of level transmitter on the Gas Knock Out Drum of upper tapping point to below filter media	AECOM	1
Balance of Plant	Natural Gas	2.2.5	Remove LSHH trip to shut turbine -Include LSH on maintenance schedule. Frequent tests to make sure it's working. Do not require duplicate drainage system because LSHH trip deleted.	AECOM	1
Balance of Plant	Natural Gas	2.2.7	Show a Manhole on Knock Out Drum on P&ID (HPP-AEC-MEC-GA-KOO-DRG-1090).	AECOM	1
Balance of Plant	Natural Gas	2.3.3	Raise an RFI to MHI on whether the position of the temperature flow control valve is important. Difficult to know that TCV has failed.	AECOM	1
Balance of Plant	Natural Gas	2.3.4	Check distance from MHI heater to ladder access on stack.	MHI	1
Balance of Plant	Natural Gas	2.4.2	Review setting level of DP alarm level value on Filter Coalescers to ensure sufficient time to swap to other filters (Duty/Standby).	AECOM	1
Balance of Plant	Natural Gas	2.4.3	Review potential impact on reverse flow through Knock Out Drum and demister when opening the remote	AECOM	1
Balance of Plant	Natural Gas	2.4.4	Consider adding sight glass on side of filter coalescers to determine condition of elements.	AECOM	1
Balance of Plant	Natural Gas	2.4.5	Remove LSHH trip to shut turbine. Include LSH on maintenance schedule (Frequent tests to make sure it's working). Do not require duplicate drainage system because LSHH trip deleted.	AECOM	1
Balance of Plant	Natural Gas	2.4.9	Change PI to PT upstream of filter for DCS indication.	AECOM	1
Balance of Plant	Natural Gas	2.4.10	Consider stairs instead of ladders for access.	AECOM	1
Balance of Plant	Natural Gas	2.5.3	Review where vents are discharge to e.g. Local High point vent	AECOM	1
Balance of Plant	Natural Gas	2.5.5	Review requirements for nitrogen purge and vent connection between heater and filter to be used during maintenance of filter.	AECOM	1
Balance of Plant	Natural Gas	2.6.4	Add small tank drain to allow sampling and flow to drain	AECOM	1
Balance of Plant	Natural Gas	2.6.6	Update datasheet to include a full vacuum conditions that may be caused by condensation of hydrocarbons	AECOM	1
Balance of Plant	Natural Gas	2.6.7	Sight glass to be added on drips tank. Add to P&ID.	AECOM	1
Balance of Plant	Natural Gas	2.6.9	Ball valves on P&IDs upstream of NRV to be locked open.	AECOM	1
Balance of Plant	Natural Gas	2.6.10	Redirect drain from vent pipe away from drips tank to another location to avoid filling drips tank with water.	AECOM	1
Balance of Plant	Natural Gas	2.7.3	Review requirement for ignition source control entry into hazardous areas e.g. separation barrier, post, chain. SH to provide procedures and training for entry to HA and ignition sources.	SNOWY HYDRO	1
Balance of Plant	Process Gas (Hydrogen)	1.1.1	Review amount of H2 required. Consider using less H2 gas bottles. (Raise RFI to SH to ask about minimum requirement for H2 storage cylinders).	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.1.2	Review timing for H2 trailer delivery and determine if leakage rate from generator is low enough to not reach low pressure trip whilst H2 trailer is being delivered and changeover.	SNOWY HYDRO	1

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Balance of Plant	Process Gas (Hydrogen)	1.1.3	Review requirement for pressure transmitters on cylinder and trailer H2 supply lines. Considering adding a position indicator on DBB valves on each H2 supply line - This option is not preferred because the position indicator will be in a Hazardous area from the H2 flanges.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.1.4	Add pressure transmitter with alarm inside the H2 HP regulator panel downstream of PRV.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.1.5	Add NRVs to hydrogen supply line to lines adjoining trailer outlet and cylinder outlet.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.1.6	Review purpose of valve on line connected to hydrogen vent pipe (downstream of PRV). Consider locking bypass valve on PRV.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.1.7	SH to provide operating procedures to close valve.	SNOWY HYDRO	2
Balance of Plant	Process Gas (Hydrogen)	1.1.11	Consider a PT (downstream of the shutdown valve) that closes the shutdown valve. Review what the "shutdown" valve will be called from control perspective	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.1.13	Discuss with the Hydrogen supplier (BOC) availability and reliability of H2 supply.	SNOWY HYDRO	2
Balance of Plant	Process Gas (Hydrogen)	1.1.14	Review if small filter in N2 line is required to prevent any potential contamination carry over from N2 lines. Consider moving Nitrogen bottles to Hydrogen area to decrease the length of Nitrogen pipeline so this can be relatively cheaply changed to stainless steel.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.1.15	Review PSV set point downstream of PRV. Identify suitable set point based on the design pressure the downstream piping. Review pipe specification.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.2.2	Review valve fail positions and requirements of locking valves closed. Add valve Failure positions to the PID.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.2.3	Review vent line size and confirm large enough size for the number of RVs connected. Review choke velocity in vertical vent pipe and common vent header. Review design pressure of vent line.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.2.4	Review vent stack design - potential for liquid seal at base of vent stack to avoid reverse flow of air.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.2.5	Review the best location for ESD valve isolating H2 supply from GTs. Consider two ESD valves, one on the supply to each generator.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.2.6	Review requirement for remote line depressurising in event ESD valves closing.	AECOM	1
Balance of Plant	Process Gas (Hydrogen)	1.2.7	Hydrotest only to be done up to removable spool for each generator. Procedures for testing to prevent water being carried into the generator.	SNOWY HYDRO	2
Balance of Plant	Process Gas (Hydrogen)	1.2.8	Advise MHI of distance between process gas area and generator at each unit. MHI to advise whether pressure increase is acceptable for the pressure reduction panel.	AECOM	1
Balance of Plant	Process Gas (CO2)	1.3.1	Review requirement for NRV in system.	AECOM	1
Balance of Plant	Process Gas (CO2)	1.3.2	Review piping spec to ensure piping downstream of the PRV and inside the CO2 high pressure regulating panel is designed for maximum pressure supplied by cylinders.	AECOM	1
Balance of Plant	Process Gas (CO2)	1.3.4	Review method for getting CO2 cylinders from under roof cover (when cylinder packs are being replaced).	AECOM	1
Balance of Plant	Process Gas (CO2)	1.3.8	Is an emergency activation of CO2 purging required? (i.e. can this wait until an operator is present which maybe an hour later) To be confirmed in the MHI HAZOP. MHI to review operating manual and confirm.Emergency venting of CO2 on the MHI Malco panel upstream of the generator.If there is a fire is venting of the Hydrogen and purging with CO2 for the generator required.CO2 is added to the generator via manual valves (no automated valves)	MHI	1
Balance of Plant	Process Gas (Nitrogen)	1.4.1	Review requirement for N2 supply to the NG equipment and other areas on the Balance of Plant. Confirm whether forklifts can be used to take N2 bottles to the BOP when needed.	AECOM	1
Balance of Plant	Process Gas (Nitrogen)	1.4.2	Review piping spec to ensure piping downstream of the PRV and inside the N2 high pressure regulating panel is designed for maximum pressure supplied by cylinders	AECOM	1
Balance of Plant	Process Gas (Nitrogen)	1.4.6	Review method for getting N2 cylinders from under roof cover (when cylinder packs are being replaced).	AECOM	1
Balance of Plant	Process Gas (All)	1.5.3	Review requirement for separation bollards between H2 trailer and reduction panels.	AECOM	1
Balance of Plant	Process Gas (All)	1.5.4	Talk to BOC about changeover of the H2 trailers and timing of delivery.	SNOWY HYDRO	2
Balance of Plant	Process Gas (All)	1.5.4	Look at possibility of providing two trailer parking spaces next to each other to allow for easier changeover with one prime mover.	AECOM	1
Balance of Plant	Process Gas (All)	1.5.5	Review if any barricade are required for the H2 vent area.	AECOM	1
Balance of Plant	Process Gas (All)	1.5.7	O&Ms to be developed	SNOWY HYDRO	2
Balance of Plant	Compressed Air (Instrument)	1.1.1	Confirm hold up time of 5 min of receivers is adequate. Check RFI response from MHI. Confirm all GT air consumptions with MHI.	AECOM	1
Balance of Plant	Compressed Air (Instrument)	1.1.2	Review the lead/lag control by doing a setback in the control system.	AECOM	1
Balance of Plant	Compressed Air (Instrument)	1.1.4	Confirm there is an automatic system for removing water level in air knock out drum downstream of the compressor.	AECOM	1

Design Area	System or Sub-System	Finding Ref No:	Recommendations	Owner	Required Completion Phase
Balance of Plant	Compressed Air (Instrument)	1.1.6	Review the need to provide detailed instrument information from the compressors/dryer packages to the DCS for remote analysis. The aim is to provide enough information as to whether to send an operator to the site after hours.	AECOM	1
Balance of Plant	Compressed Air (Instrument)	1.1.7	Review specification to check the full range of ambient conditions are covered including wet air so vendor will select the appropriate type of filter.	AECOM	1
Balance of Plant	Compressed Air (Instrument)	1.2.6	Remove low low pressure trips on IA supply lines downstream of air receivers. Leave low pressure alarms. MHI have a low pressure alarm on instrument air system. On the GT there are 3 bleed valves that are kept shut. If the air pressure drops the air valves open and the GT trips.	AECOM	1
Balance of Plant	Compressed Air (Instrument)	1.2.7	Review CEMS IA consumption requirements. Add CEMS usage to IA consumption calculation if a large IA consumption is required.	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.3.1	Confirm there is an automatic system for removing water level in air knock out drum downstream of the compressor.	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.3.2	Confirm there is the facility for water removal in the evaporator in package.	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.3.3	Review the need to provide detailed instrument information from the compressors/dryer packages to the DCS for remote analysis. The aim is to provide enough information as to whether to send an operator to the site after hours.	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.3.4	Review the lead/lag control by doing a setback in the control system.	SNOWY HYDRO	1
Balance of Plant	Compressed Air (Service Air)	1.3.5	Review specification to check the full range of ambient conditions are covered including wet air so vendor will select the appropriate type of filter	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.3.7	Consider common vendor for IA and SA packages to reduce need for multiple service agents.	SNOWY HYDRO	1
Balance of Plant	Compressed Air (Service Air)	1.4.2	Confirm with MHI there are NRVs at the fuel module to prevent backflow into the SA system from high pressure purge air.	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.4.4	Include drainage of water in the long length of pipeline to the GT and also operation during cold temperatures i.e. freezing.	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.4.5	Consider using stainless steel for SA pipes.	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.4.8	Confirm there is triple redundant pressure indication on instrument and service air purging to the diesel system for pre start condition.	MHI	1
Balance of Plant	Compressed Air (Service Air)	1.4.9	Review requirement for using individual air receivers on the power island compared to one receiver on the BOP.	AECOM	1
Balance of Plant	Compressed Air (Service Air)	1.4.10	Consider installation of a temporary compressor fittings for attachment of hire compressors for IA and SA.	AECOM	1
Balance of Plant	Compressed Air (All)	1.5.1	See comments	AECOM	1
Balance of Plant	Compressed Air (All)	1.5.3	Ensure there is access for EWP to remove PSV's for maintenance.	AECOM	1
Balance of Plant	Compressed Air (All)	1.5.5	Review vessel dimensions to cater for inspection entry and requirement for confined space access.	AECOM	1
Balance of Plant	Water (Service)	1.1.2	Review the requirements for backup water supply in event of loss of water.	AECOM	1
Balance of Plant	Water (Service)	1.1.3	Review back up water supply for critical services i.e. safety showers.	AECOM	1
Balance of Plant	Water (Service)	1.1.4	Review potential impacts of extreme cold weather event and the impact of small drain lines freezing would have on site operation. Drain lines to be kept short to reduce risk of freezing.	AECOM	1
Balance of Plant	Water (Service)	1.1.5	Consider underground PE piping to safety showers and whether a heater is required in winter.	AECOM	1
Balance of Plant	Water (Service)	1.1.6	Construction partner to check the Snowy hydro standard for labelling pipeline and label pipes after construction and before commissioning.	SNOWY HYDRO (UGL)	2
Balance of Plant	Water (Service)	1.1.7	Add a sampling point to potable water line downstream of the site water meter and upstream of the service water tank. Consider facility for potable water lines to be flushed through into the service water tank to replace aged water in the line with fresh water. Potable water to be tested at periodic times as specified by SH.	AECOM	1
Balance of Plant	Water (Service)	1.2.1	Review tank outlets/connections - all nozzles to be fitted with valves for isolation	AECOM	1
Balance of Plant	Water (Service)	1.2.2	Replace level switch (LS/LAHH) with another LT because of critical service of tank and add HH to level transmitter.	AECOM	1
Balance of Plant	Water (Service)	1.2.3	Confirm tank paint internals on datasheet is compatible with anti-algacide chemicals	AECOM	1
Balance of Plant	Water (Service)	1.2.4	Ensure that drains from tank are separated on model as per P&ID.	AECOM	1
Balance of Plant	Water (Service)	1.2.5	Review size of hatch on tank roof to facilitate access for diving. Consider 900mm opening.	AECOM	1
Balance of Plant	Water (Service)	1.2.6	Confirm that there are facilities to install a barriers around hatch.	AECOM	1
Balance of Plant	Water (Service)	1.1.8	Consider isolation immediately after HW metering facility to allow ability to maintain downstream valves.	AECOM	1
Balance of Plant	Water (Service)	1.3.3	Confirm timing of third forwarding pump starting and affecting GT operation. Provide buffer time in evaporative cooler tank at GT.	MHI	1

Design Area	System or Sub-System	Finding Ref No:	Recommendations	Owner	Required Completion Phase
Balance of Plant	Water (Service)	1.3.6	Review use and quantities of portable chemical injection package. Check the quantities of chemicals in this package are kept under the DG minor storage thresholds.	AECOM	1
Balance of Plant	Water (Service)	1.3.7	Review the requirements for pressure indicator upstream of kickback PCV in minimum pump flow line.	AECOM	1
Balance of Plant	Water (Service)	1.3.8	Review methods for smoothing or minimising the number of pumps starts. Contemplate scenario of leakage and no other flow. Consider whether an accumulator or jockey pump is required for small flows.	AECOM	1
Balance of Plant	Water (Service)	1.3.8	Check if there is a signal from the GT whether the evaporative cooler is operating and the need for 1 or 2 pumps operating.	MHI	1
Balance of Plant	Water (Demin)	1.4.1	Review potential to provide direct connection from potable water supply upstream of service water tank to demin package.	AECOM	1
Balance of Plant	Water (Demin)	1.4.2	Measured values and alarms from demin package PLC to be available for mimic on the DCS for monitoring remotely by operators.	AECOM	1
Balance of Plant	Water (Demin)	1.5.1	Review requirements for duty/standby pumps within the packages or requirement to keep uninstalled spares. Alternatively, increase capacity of package to 55m3/h which removes the need for 2 packages to operate simultaneously to supply demin for 3 days continuous operation of GT on diesel.	AECOM	1
Balance of Plant	Water (Demin)	1.5.5	Notify the RO vendor of potential biocide use in the water supplied to demin package. Include in demin package specification.	AECOM	1
Balance of Plant	Water (Demin)	1.5.6	Notify the vendor that demin plant may not be used for long periods of time. Confirm demin plant can cope with periods of standby.	AECOM	1
Balance of Plant	Water (Demin)	1.6.1	Include two level transmitters instead of a LSH and LT.	AECOM	1
Balance of Plant	Water (Demin)	1.6.2	Review the overflow discharge location based on pH of demin and relocate to trade waste.	AECOM	1
Balance of Plant	Water (Demin)	1.6.3	Review the possibility of CO2 filter (on tank vent) blocking and causing tank to be under vacuum.	AECOM	1
Balance of Plant	Water (Demin)	1.6.4	Review location of tank drains from storm water to trade waste	AECOM	1
Balance of Plant	Water (Demin)	1.6.6	Review size of hatch on tank roof to facilitate diving access. Consider 900mm opening	AECOM	1
Balance of Plant	Water (Demin)	1.6.7	Confirm that there are facilities to install a barrier around hatch and locking facility.	AECOM	1
Balance of Plant	Water (Demin)	1.6.8	Review tank outlets/connections - all nozzles to be fitted with valves for isolation.	AECOM	1
Balance of Plant	Water (Demin)	1.7.1	Confirm if one pump is lost there is sufficient time for another pump to turn on before the flow switch trips the GT.	AECOM	1
Balance of Plant	Water (Demin)	1.7.1	Confirm if one pump is lost there is sufficient time for another pump to turn on before the flow switch trips the GT. RFI to be raised to MHI.	MHI	1
Balance of Plant	Water (Demin)	1.7.3	Consider bypass line around MHI orifice plate to facilitate commissioning.	AECOM	1
Balance of Plant	Water (Demin)	1.7.3	Consider bypass line around MHI orifice plate to facilitate commissioning. Raise an RFI to MHI.	MHI	1
Balance of Plant	Water (Demin)	1.7.4	Review potential to install automated valves on lines from forwarding pumps to demin treatment package for polishing and demin distribution to allow remote switchover between lines. Add polishing sequence to DCS to allow for remote operation.	AECOM	1
Balance of Plant	Water (Demin)	1.7.6	Review requirement of pressure indicator upstream of PCV.	AECOM	1
Balance of Plant	Water (Demin)	1.9.1	Chemicals and the dosing will be proposed by a water treatment vendor as required by the system. Check there is indication for low levels of chemicals	AECOM	1
Balance of Plant	Water (Demin)	1.9.2	Confirm if automated valves are not in position and there is an output into the DCS to show this. Confirm with package supplier if these valves are interlocked.	AECOM	1
Balance of Plant	Water (Service and Demin)	1.10.1	Raise RFI to SH to confirm stainless steel grade required (304 or 316).	AECOM	1
Balance of Plant	Water (Service and Demin)	1.10.3	Determine desired system response in emergency shutdown (from safety perspective). Apply this to all subsystems. Provide a list of impacts of any system shutdowns on ability of GT to operate.	AECOM	1
Balance of Plant	Water (Service and Demin)	1.10.4	Review location of all demin drains to ensure they all go to neutralisation pit.	AECOM	1
Balance of Plant	Fire Water	1.1.5	Update critical valves to be locked open e.g. for valves on fire fighting system (Show on P&ID).	AECOM	1
Balance of Plant	Fire Water	1.1.6	Confirm the pressure drop to the tank and flowrate meet the requirements of AS2419.	AECOM	1
Balance of Plant	Fire Water	1.1.7	Review requirement for nozzle fill point on tanks for emergency tank filling by tanker.	AECOM	1
Balance of Plant	Fire Water	1.1.8	Confirm that RFS connection standards are met.	AECOM	1
Balance of Plant	Fire Water	1.1.9	Review need for sample point on firewater system. Review best location for sample point i.e. one on each tank or upstream of fire water pumps.	AECOM	1
Balance of Plant	Fire Water	1.1.10	Review access provisions through tank liner and manhole access.	AECOM	1
Balance of Plant	Fire Water	1.1.12	Review tank outlets/connections - all nozzles to be fitted with valves for isolation.	AECOM	1

Design Area	System or Sub-System	Finding Ref No:	Recommendations	Owner	Required Completion Phase
Balance of Plant	Fire Water	1.1.13	Confirm tank bladder is compatible with biocides that may be required for water treatments.	AECOM	1
Balance of Plant	Fire Water	1.1.14	Provide description of how the auto fill valve will be maintained, isolated and bypass used.	AECOM	1
Balance of Plant	Fire Water	1.2.1	Review the potential to provide auto fill from site diesel storage tanks to the smaller diesel tank near diesel driven firewater pump. If diesel tank for pump is filled manually consider manual handling requirements of how this tank is filled.	AECOM	1
Balance of Plant	Fire Water	1.2.2	Add locked open valve on relief line. Review AS2941 to see if this is permitted	AECOM	1
Balance of Plant	Fire Water	1.2.3	Review the position of balance line to minimise potential of silting in line. Confirm height of line above tank	AECOM	1
Balance of Plant	Fire Water	1.2.6	Review battery system monitoring alarm interface with DCS for monitoring.	AECOM	1
Balance of Plant	Fire Water	1.2.7	Review where the outlet of TRV on firewater pump outlet is to be directed and select a suitable location.	AECOM	1
Balance of Plant	Fire Water	1.2.8	Review the potential for embers and overloading the air intake system in the event of a bushfire.	AECOM	1
Balance of Plant	Oily Water	1.3.4	Review management of algae in pit. Include in package spec and discuss potential options with vendors.	AECOM	1
Balance of Plant	Oily Water	1.3.6	Review use of stairs instead of ladder into pit. Look at removable type of stairs to prevent fouling of stairs.	AECOM	1
Balance of Plant	Oily Water	1.3.7	Review requirement for isolation of incoming drains to allow access to pit to provide correct isolation.	AECOM	1
Balance of Plant	Oily Water	1.4.1	Confirm interface of package with DCS. Determine what information needs to be transferred to DCS.	AECOM	1
Balance of Plant	Oily Water	1.4.3	Confirm if piping between filter and pumps and filter is designed for a vacuum conditions.	AECOM	1
Balance of Plant	Oily Water	1.4.4	Vendor supplier to confirm if oil water separator does not operate for a period of time what (if any) effects this would cause on the reliability of the unit. Specification of package to include mention of extended periods on downtime.	AECOM	1
Balance of Plant	Oily Water	1.4.5	Review potential impacts of winter operation. Include in specification that unit needs to operate during low ambient conditions	AECOM	1
Balance of Plant	Oily Water	1.4.6	Review the operational area of the skimmer pit. Consider sloped floor on main pit to concentrate sludge for ease of cleaning and allow oil/ water to be diluted.	AECOM	1
Balance of Plant	Oily Water	1.4.8	Ensure vent location is at an adequate height to disperse any hazardous vapours.	AECOM	1
Balance of Plant	Oily Water	1.5.1	Review oil and diesel vent points in the GT area to ensure no diesel can flow to the stormwater discharge point. All oil vents to drain to oily water system with concrete apron.	AECOM	1
Balance of Plant	Oily Water	1.5.2	Review requirements for capture during construction for containment of drainage carryover. To be reviewed in CHAIR.	AECOM	1
Balance of Plant	Oily Water	1.6.1	Confirm if oily water system is considered in fire safety study.	AECOM	1
Balance of Plant	Oily Water	1.6.2	Review the requirement for monitoring of fire traps liquid level and regular maintenance of fire traps.	AECOM	1
Balance of Plant	Oily Water	1.6.3	Review potential to install a smaller initial volume within decanting pit for concentrated spills. Consider interface level detection. Review requirement for detection of high-level oils in the observation pit and how this can be achieved.	AECOM	1
Balance of Plant	Oily Water	1.6.3	Review operational response to a high-level oil in the decanting pit.	SNOWY HYDRO	1
Balance of Plant	Oily Water	1.6.4	Review location of humeceptor in location to highest flood level.	AECOM	1
Balance of Plant	Oily Water	1.6.6	Seek further guidance from SH environmental team on whether a penstock valve is required on humeceptor discharge line to the environment.	SNOWY HYDRO	1
Balance of Plant	Trade Waste & Sewer	1.1.1	Confirm final pit volume is sufficient to contain all the flows from blade washing and closed loop cooling water volumes.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.1.3	Determine if the blade washing water with detergent can be disposed to the trade waste (HWC criteria for maximum concentration). When detergent is used for off-line blade washing (approx. once a year) the GT compressor wash pit should be isolated and removed by sucker truck.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.1.3	Test the blade wash water after commissioning to check analysis meets HWC criteria for trade waste.	SNOWY HYDRO	3
Balance of Plant	Trade Waste & Sewer	1.1.3	Confirm the iron concentration in wash water. Is 220 mg/l the normal concentration during off line washing?	MHI	1
Balance of Plant	Trade Waste & Sewer	1.2.1	Review the neutralisation pit capacity to cater for emergency storage in the event of not having access to pump out to the trade waste.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.2.5	Confirm the impacts of chemicals used in demin plant CIP to neutralisation pit. Confirm if the concentration of COD from the CIP chemicals from the demin plant will be suitable for discharge to trade waste or whether removal by tanker is more appropriate.	AECOM	1

Design Area	System or Sub-System	Finding Ref No:	Recommendations	Owner	Required Completion Phase
Balance of Plant	Trade Waste & Sewer	1.2.6	Replace local PI with pressure transmitter downstream of transfer pumps to prove there is no damage to HWC trade waste main from the transfer pump. Review best location for this PT to measure discharge pressure.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.2.7	SDV's downstream of the transfer pumps to HWC line to fail closed. SDV's downstream of the transfer pumps returning to pit fail open to prevent dead heading of pump.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.2.8	Consider removal of pump with a roof above the pit	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.2.9	Materials of pit to consider acid and caustic dosing. (Epoxy coating).	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.2.10	Ensure dosing of acid and caustic is located at opposite end of pump suction and adequate recirculation time to ensure good mixing of neutralisation chemicals.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.3.1	Include either an alarm for continual operation of the pump (or too frequent operation) or investigate other solutions to reduce overdosing (Review requirement for two pH meters for checking that pH is moving in the expected direction).	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.3.2	Chemicals to be dosed are TBC. If caustic is used potential for freezing in lines needs to be considered. Include in the package specification the range of ambient temperature.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.3.4	Review the replacement process for the chemicals (tank or drum) and if minimal contact with the chemical for the operator	AECOM	2
Balance of Plant	Trade Waste & Sewer	1.3.7	Consider the type of acid and potential to vaporise. Dilute sulphuric acid is preferred.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.3.8	FS is sometimes included in the line downstream of the PSV to indicate the PSV has lifted. Check the vendor package includes this.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.4.4	Consider providing a sewer connection in temporary. offices/facilities area. Review potential to use temporary toilet blocks on site.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.4.5	Alarms from sewerage pit to DCS so operators are aware of high/low level in sewerage pit when no one on site.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.4.7	Consider odour from the tank and a filter.	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.5.2	Review application of flushing water to the pit and potential to use potable water and a garden hose	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.5.4	Confirm noise limits included in the package specifications	AECOM	1
Balance of Plant	Trade Waste & Sewer	1.5.5	Ensure safety shower is no further than 10 m from chemical storage if dosing chemicals are being decanted	AECOM	1
Power Island	General		Design interfaces between 3rd parties (AECOM balance of plant, MELCO hydrogen seal oil systems, Fire and Gas systems) were mostly but not fully developed. Design completion of the 3rd party interfaces will need to be managed carefully. Should the design or system interface change it would be best practice to HAZOP those sections of plant again. Review whether this additional study is required prior to construction.	SNOWY HYDRO	1
Power Island	HP Air Compressor		The high-pressure air compressors interlocks and protection is not well understood at this time and action items are with MHI to confirm with their 3rd party vendor. Review this section of the plant again on completion of design and suitable interlock and protection information becomes available.	MHI	1

Appendix F

Current HAZOP Recommendations Status

Design Area	System or Sub-System	Finding Ref (AECOM report)	Recommendations	Owner	Required Completion Phase 1- Prior to design completion 2 - Prior to commissioning 3 - Prior to handover	Type Firm action / recommendation A verification check Further Study For consideration	Does it relate to a SHL OI / procedure to be drafted?	Status
Power Island	General	Report	Design interfaces between 3rd parties (AECOM balance of plant, MELCO hydrogen seal oil systems, Fire and Gas systems) were mostly but not fully developed. Design completion of the 3rd party interfaces will need to be managed carefully. Should the design or system interface change it would be best practice to HAZOP those sections of plant again. Review whether this additional study is required prior to construction.	SNOWY HYDRO	1	Firm	No	CLOSED. Design interfaces between the various parties have been developed and will continue to be managed accordingly in order to finalise the design and close out the HAZOP actions.
Power Island	HP Air Compressor	Report	The high-pressure air compressors interlocks and protection is not well understood at this time and action items are with MHI to confirm with their 3rd party vendor. Review this section of the plant again on completion of design and suitable interlock and protection information becomes available.	MHI	1	Verify	No	CLOSED. During the progression of the design development, MHI were able to provide additional information regarding the air compressor interlocks and protection. MHI determined that the compressor's had adequate interlocks and protection for the intended design.
Power Island	1 - Fuel Oil - High pressure Pump	3	Confirm forwarding pump deadhead pressure and prv	SNOWY HYDRO	1	Verify	No	CLOSED. Dead head pressure of proposed pump (Goulds 3196 MTi Size 1.5 x3-13/5V) is 1098 kPag with a full diesel tank of 11 m. However, supply to GT has two pressure control set at 700 kPag so pressure should not normally exceed 700 kPag. Forwarding pumps also have minimum flow kick back valve which will be set at the pressure equivalent to the minimum flow for the forwarding pumps which will prevent the pumps being dead headed. The minimum flow kick back valve is fail open. (K. Wells)
Power Island	1 - Fuel Oil - High pressure Pump	4	Review bunding requirements around FO pumps	SNOWY HYDRO	1	Verify	No	CLOSED. General area around Main Fuel oil pump is not bunded. Pump skid has an integral drips tray with discharge point piped to the the oily water system. Given the high operating pressure of the outlet a rupture would not be contained in a reasonable sized bund in the case of a major rupture. The area is concrete/ hardstand and any spill will be directed to storm water with provision to impound a spillage via penstock vales.
Power Island	1 - Fuel Oil - High pressure Pump	5	Confirm $ cost per unit trip / 1 hr outage	SNOWY HYDRO	1	Verify	No	CLOSED Is this a HAZOP action? Looks commercial
Power Island	1 - Fuel Oil - High pressure Pump	6	All ball valves to be lockable	SNOWY HYDRO	1	Firm	Yes	CLOSED Manual Valve Spec HPP-AEC-MEC-GN-GEN-SPT-0003_B includes: "All isolation valves must be lockable by padlock. "
Power Island	1 - Fuel Oil - High pressure Pump	7	SHL to review who supplies instrumentation at MHI interfaces	SNOWY HYDRO	1	Study	No	CLOSED as per DOR in P&IDs
Power Island	1 - Fuel Oil - High pressure Pump	12	AECOM to consider heat tracing for FO dwg 2of 5. Start up temperature should be 11 deg C. Alternative may be an enclosure for the pump and piping	SNOWY HYDRO	1	Consider	No	CLOSED heater provided in FO tank and heat tracing to fuel nozzles.
Power Island	2 - Fuel Oil - Manifold pressure control	36	The screw pump has no min flow bypass return line. The HP pump only starts when burners are to be lit. When no burner flow the manifold pressure control valve acts as the min flow control. MHI to confirm forwarding pump flow rate through HP screw pump when shutdown	MHI	1	Firm	Yes	Awaiting AECOM response
Power Island	5 - Fuel Oil - Flow divider	95	MHI manual ball valves should all be lockable	SNOWY HYDRO	1	Firm	Yes	CLOSED MHI to supply complete valve list, SHL to indicate locking type for purchase
Power Island	6 - Fuel Oil - Burners	124, 517, 565	Pantac to review blade path flameout voting logic. One or multiple burners, adjacent burners, single or duplex t/c. No optical flame detectors	SNOWY HYDRO	2	Study	No	
Power Island	6 - Fuel Oil - Burners	127	MHI to advise combustion frequency sensor criticality. Commissioning tool or protection	MHI	2	Firm	No	CLOSED Extended operation can lead to catastrophic failure. Combustion components and blades
Power Island	6 - Fuel Oil - Burners	129	SHL investigating additional diesel fuel quality reports	SNOWY HYDRO	2	Study	No	CLOSED testing complete
Power Island	7 - Fuel Oil - Drain tank	144	MHI to confirm if there is a drain tank Hi level start permissive. Unit won't start with high level	MHI	1	Firm	Yes	CLOSED SHL to determine drainage or start permissive philosophy. Including environmental risk of overflow.
Power Island	7 - Fuel Oil - Drain tank	147	SHL to confirm with operations to see if small lines have been problematic with non-return valves failing / passing	SNOWY HYDRO	1	Study	No	
Power Island	7 - Fuel Oil - Drain tank	148	AECOM to consider drain pit discharge hi alarm to start pump and hi hi to alarm to remote operations	AECOM	1	Consider	Yes	IN PROGRESS Drain pit is gravity system connected directly into the site wide OW gravity system. No level switch/alarm included in the drain pit. Verify when design is complete.
Power Island	7 - Fuel Oil - Drain tank	149	AECOM Fuel oil discharge to oily water pit detection to be considered in design	AECOM	1	Consider	Yes	IN PROGRESS Noted. Flow switch added to overflow pipe to detect discharge through the Drains tank overflow line. This will detect discharge of fuel oil. Verify when design is complete.
Power Island	8 - Fuel Oil - Water injection	159	MHI to confirm at what load level water injection is enabled. Also when water injection is not correct the unit would go to run back load, where water injection is turned off.	MHI	1	Firm	Yes	CLOSED WI on at 100MW load at load up operation, Pilot water injection on during start up.WI off at 85MW at load down operation
Power Island	8 - Fuel Oil - Water injection	160	SHL to confirm action required when water injection is off, i.e. valley will try to restart water injection 3 times and max operating time without water injection is 15 minutes. Automatic shutdown required, tbc and advise to MHI or add into station controls	SNOWY HYDRO	2	Firm	Yes	CLOSED SHL to specify shutdown requirement on water injection fail to operate.
Power Island	8 - Fuel Oil - Water injection	161	Oily water pit to be covered with rain shelter	AECOM	1	Firm	No	IN PROGRESS Noted. Low profile cover shall be installed off the pit bund. Verify when the design is complete.
Power Island	9 - Fuel Oil - Water injection	169	AECOM to consider valve failure, excessive flow to oily water pit overflow during runback time. Flow balance required. MHI to advise oily water flow rate and volumes expected during normal operating conditions and if one of the drain valves fails open, MBN13AA735,AA736,AA737 based on SHL RFI document	AECOM	1	Firm	Yes	CLOSED. Drain pit uses a gravity drain system and has been sized matched to flow rate and not expected volume. So if the valves fail open and continue to flow it will be accomodated by the local drainage system.
Power Island	8 - Fuel Oil - Water injection	170	Water injection flow transmitter is a single point of failure which would cause diesel outage, so it is critical for operation. Redundancy for valve control per fuel oil control should be considered. MBU02CP531.	SNOWY HYDRO	1	Firm	Yes	Awaiting MHI quote for inclusion of additional transmitters
Power Island	8 - Fuel Oil - Water injection	171	Single point of failure mode analysis should be completed at a suitable time. SHL internal item	SNOWY HYDRO	3	Study	No	Awaiting MHI submission of logic diagrams
Power Island	8 - Fuel Oil - Water injection	172	Outage, run back, emergency trip restart time cost analysis required for Risk Assessment decision around device fault tolerance, i.e. trip or 1 hours outage = 800k (330MW x 2500MW/Hr x 1 hr), additional instrument = 20k installed	SNOWY HYDRO	1	Study	No	
Power Island	9 - Fuel Oil - Purge credit block valves	184	Purge credit details are not well understood by Operations. There is a manual, Operating Procedure(S4-96597), that describes it in more detail. Type B compliance, intermittent or continuous turning and start and re-purge credit are all good questions. Potentially every 8 days the unit needs repurging, which can lead to more blade wear (wobbling in root) and starter problems. This item to be revisited by Operations with MHI detail input.	SNOWY HYDRO	3	Study	Yes	CLOSED Purge Credit no longer required.
Power Island	9 - Fuel Oil - Purge credit block valves	191	MHI to review if fuel oil from the fuel oil purge credit can go to the tank not the pit as it is clean fuel. Environmental credit	SNOWY HYDRO	1	Study	Yes	CLOSED

Power Island	9 - Fuel Oil - Purge credit block valves	192	Fuel oil purge credit valves only have a single limit switch, preference for both open and closed indication, all valves (block, drain, N2). AECOM supply these valves	SNOWY HYDRO	1	Firm	Yes	PENDING CLOSURE This action superceded by MHI and SHL removing the purge credit system from the Fuel Oil System - TBC by offical instruction. Pending RFI on cancellation of purge oil credit system
Power Island	11 - Fuel Gas - Supply pressure control	216	MHI to check logic. Gas vent valve out of position during operation should be a trip. Redundant limit switches may be.	MHI	2	Verify	Yes	CLOSED MHI to ensure an alarm is set for the incorrect state of the vent valve in their GTC
Power Island	11 - Fuel Gas - Supply pressure control	217	AECOM should review vent valve position failure actions	AECOM	2	Study	No	CLOSED. Remote operated vent valve is located downstream of filter coalescers and will only be opened in emergency situation by an operator when gas supply needs to be vented down quickly for fire or gas leak. Actuated valve is air failure close. Data sheet will include requirement for duplicate limit switches. On start-up if 1 out of 2 limit switches show the vent valve is open then the GT startup should be prevented. (K. Wells) MHI gas vent points are piped to discharge point at safe location, adjacent to GT enclosure ventilation discharge. 8m above GT enclosure and 17m from ground level.
Power Island	11 - Fuel Gas - Supply pressure control	218	AECOM to review appliance manual isolation valve per AS3814 requirements within 5m of the appliance. Paul van Dyk to confirm AS3814 clause requirements	SNOWY HYDRO	1	Verify	No	CLOSED 5m is considered remote for individual burners but one lockable handvalve for the unti pre-coalscer meets the requirements. AECOM model location is similar to Laverton
Power Island	11 - Fuel Gas - Supply pressure control	219	Tapping points for pressure testing / leak testing valves not shown on P&ID. Additional testing points may be required. SHL to review based on length of pipework and valve locations.	MHI	1	Study	No	CLOSED SHL provided MHI mark up with tapping points. Additional tapping points were discussed and agreed.
Power Island	11 - Fuel Gas - Supply pressure control 17 - Fuel Gas - GT sweep (purge air)	223, 350	MHI to review AS3814 section 2.13 requirement for sufficient test points to verify the integrity of shutoff valve / train.	MHI	1	Study	No	CLOSED
Power Island	12 - Fuel Gas - Flow control	231	RFI for the purpose of the HAZOP the main question, is there a single point of failure (DPT) and what would be consequence of a critical time pressure excursion explosion. Is DPT control or protection, refer control description fig 2.9.1	MHI	1	Study	No	No reference to 2.9.1 in the HAZOP report CLOSED
Power Island	15 - Fuel Gas - Combustor drain valves	301	MHI to confirm temperature rating of pipework after MBA01AA704, burner drain valve. Rating drops from 525 to 60 Celsius	MHI	1	Verify	No	CLOSED. Since this valve is always closed during operation and opens after GT stops, the temperature of the drain and air flowing out is considered to be low at that time. In addition, although the piping from the drain valve to the pit depends on the design of the EPC side, the temperature is considered to be sufficiently low considering the heat dissipation during the piping.
Power Island	15 - Fuel Gas - Combustor drain valves	304, 871, 878	Water wash procedure has many manual valves which could potentially lead to false start by flooded combustion chamber and subsequently detergent flow into the oil water pit. SHL to develop a water wash procedure with 2 operators to cross check. Water washing drain header could also have small amounts of diesel residue from liquid fuel false start.	SNOWY HYDRO	3	Firm	Yes	CLOSED to be considered in Ops Readiness
Power Island	18 - Fuel Gas - Flow meter	368	Commissioning spool required for flow meter, that will need to be removed for pipe blow down activities. Mark up P&ID	AECOM	2	Firm	No	CLOSED. Note 3 has been added to PIDS 1094 and1144.
Power Island	19 - Fuel Gas - Filter and purge credit	397	Add instrument tapping point for Nitrogen entry for valve leak testing, with smaller volume than upstream line	AECOM	1	Firm	No	CLOSED. Nitrogen purge point has been added to PID 1097 for purging of Section of piping from after Filter/ Coalescers isolation valves, through temperature control valve, FGH and last chance cartridge filter.
Power Island	20 - Fuel Gas - Calorie meter	403	Calorie meter. 1. Cal gas bottles only have single regulator and no relief valve. Potential single point of failure. Is meter rated for cal gas pressure. 2. If reg fails, is it possible to reverse flow cal gas into the gas line? 3. Why is there a flow meter in the vent line?	MHI	1	Verify	No	CLOSED
Power Island	21 - Air & Flue Gas - Seal air	432	All ball valves to be lockable. Evan to confirm who is responsible for providing the pad locking system for all the manual isolation valves and to ensure the valves have lock tabs, refer also action item 4. Also send sample photos to MHI. The requirement is in the tender specification section 2.3	SNOWY HYDRO	1	Firm	No	Evan's name should be removed CLOSED SHL have confirmed MHI and AECOM will provide lockable valves.
Power Island	24 - Air & Flue Gas - GT HP Bleed valve	506	MHI to confirm failure mode of IGV, i.e. fail last position, fail ramp closed on loss of control oil or power?	MHI	2	Verify	No	CLOSED If the GT is tripped due to low control oil pressure, the IGV will not operate. Therefore, the IGV will open and trip, it has possibiliy to compressor surge.
Power Island	25 - Air & Flue Gas - Inlet duct flow 27 - Air & Flue Gas - Combustor and Exhaust	515, 563	2oo3 trip voting degradation to be reviewed on a trip by trip basis by SHL, 2oo3, 1oo2 or 2oo2 and 1oo1 = trip or run?	SNOWY HYDRO	2	Study	?	Awaiting MHI documentation
Power Island	29 - Lube Oil - Tank, pumps, prv	608	DC Lube oil pump to be tested prior or after each start to prove functionality. Replacing MBV01CP304 DC lube oil pressure gauge with a transmitter would facilitate fast auto test sequence. Requirements to be confirmed by SHL	SNOWY HYDRO	1	Firm	Yes	MHI to update relevant documentation to reflect change of instrument to transmitter
Power Island	30 - Lube Oil - GT bearings 50 - Generator - Lube oil system	633, 1060	SHL to review high temperature alarm shutdown requirements for Hunter. Remote operator may not react in time.	SNOWY HYDRO	2	Study	Yes	CLOSED Requirement has been reviewed in LOPA. Issue addressed in final LOPA report.
Power Island	30 - Lube Oil - GT bearings	646	SHL may request additional oil sampling point downstream of the bearings (generator and turbine). MHI to review installation requirements and advise accordingly	MHI	1	Verify	No	CLOSED. We will provide the sampling nozzle with hand operated valve(15A) for #1 and #2 GT bearing drain piping.Please confirm the attached P&ID(attachiment-2).This is additional request , we will inform our quotation and schedule impact later, so please make a decision as soon as possible.
Power Island	34 - Control Oil - Tank, pumps, temp control	724	There is a wall in the oil tank which may create different tank levels, design to be confirmed by MHI	MHI	1	Verify	No	CO TANK level condition will be added to GT start permissive condition.
Power Island	35 - Control Oil - Fuel valve position control	753	Fuel gas and Fuel Oil control oil dump valves are single point of failure and common cause fraction is high. Is this allowed per the standard. Valves should failsafe and individually actuated?? PVD to review in detail as part of AS3814 compliance	SNOWY HYDRO	1	Verify	No	CLOSED MHI existing control oil arrangement will remain, shut off valves will be considered one double block and bleed, purge credit function removed in place of 2x shut off and 2x vent valves.
Power Island	36 - Control Oil - Fuel valve trip solenoids & Inlet Guide Vanes	774	Control oil dump circuits to be reviewed against SIL requirements and AS3814 compliance	SNOWY HYDRO	1	Verify	No	CLOSED as above
Power Island	37 - Package Enclosure Ventilation	791	Note AECOM responsible for Fire protection of the Balance of Plant equipment such as lube oil package, fuel oil pump / valve systems and how that system is interlock or integrated into the plant DCS or MHI GT controls. AECOM is design stage now. Fire safety study is well advanced MHI fire and gas detection limited to GT enclosure and Fuel Gas valve systems. SHL to review final design proposal	SNOWY HYDRO	1	Study	No	CLOSED AECOM to include water based fire suppression in FO unit.
Power Island	37 - Package Enclosure Ventilation	792	Door tracking isolating the CO2 if someone enters the GT is to be confirmed by vendor and reviewed by SHL	SNOWY HYDRO	1	Verify	Yes	CLOSED MHI have provided quote for SHLs consideration
Power Island	38 - Air & Flue Gas - Inlet filter	805	Ambient conditions -5 C to +45 C. Anti-icing system was considered in the tender specification but MHI advised at that time it is not required. MHI to revisit the study and reconfirm anti-icing is not required.	MHI	1	Study	No	Likely to be N/A CLOSED
Power Island	42 - Evaporative Cooler - pump and tank unit	887	Valve numbers and instrument numbers and line sizes are not shown on the drawing. Return valve is shown as control valve but is actually a manual lockable isolation valve	MHI	3	Firm	No	CLOSED MHI have updated drawing

Power Island	42 - Evaporative Cooler - pump and tank unit	893	Evap tank water is potable water. Should overflow or draining be discharged to Trade Waste or Storm Water. AECOM to review and design accordingly	AECOM	1	Study	Yes	IN PROGRESS. Part of larger trade waste discussion. Overflows and drains to be ported to trade waste. This is currently directed to the trade waste. AECOM cannot advise SH which is preferred as this should be advised by site Environmental manager. Blowdown is potable water with slight elevation of salts left behind due to evaporation - AECOM request to be advised if blowdown discharge/drainage should be changed as drain design impacted.
Power Island	42 - Evaporative Cooler - pump and tank unit	899	Evap tank has no sample point. MHI to review option to supply	MHI	1	Firm	Yes	CLOSED sample point added
Power Island	44 - Generator cooling water	928	MELCO interface details required for AECOM water services. Water pressure recently increased to 7.5 Bar. AECOM to advise MELCO final supply pressure. MELCO cooler to be designed accordingly	AECOM	1	Firm	No	CLOSED
Power Island	44 - Generator cooling water	932	MELCO to provide full list of generator protection settings, trips complete with alarms, auto shutdown and run backs	MELCO	2	Firm	No	CLOSED
Power Island	45 - Generator CO2 gas supply	951	Manual purging requires strict procedure with 2 people to cross check to confirm successful purge	SNOWY HYDRO	2	Firm	Yes	"strict" probably 'start' CLOSED to be included in Ops Readiness
Power Island	45 - Generator CO2 gas supply	950	CO2 site capacity to be assessed against minimum volume required for a successful purge times a safety factor. Potential bottle leak reduces capacity. Is adequate monitoring installed, flow pressure bottle weight	AECOM	1	Firm	No	IN PROGRESS Each generator requires 220 Nm3/time to purge which is equivalent to 15 G size cylinders ie 1 man pack. 4 manpack are to be kept on site which is double the quantity required to purge 2 generators. SH to review this quantity. There is a PIT downstream of the bottle connection. However, there is no FI on the process gas pressure reduction skid or the MHI CO2 supply skid. Weigh scales could be considered when the gas supplier and process gas pressure reduction skid design has been developed.
Power Island	45 - Generator CO2 gas supply 53 - Generator - DC seal oil system	957, 1128	Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. MHI incorporate in design, logic to action valve	MHI	2	Firm	No	Snowy Hydro has also instructed the Supplier to develop a suitable automated venting and purging design to reduce this risk and are currently working with the Supplier to implement this design.
Power Island	45 - Generator CO2 gas supply	958	Automated Hydrogen venting and CO2 purging system required. Not currently in the scope. AECOM to incorporate automate CO2 supply to the units	MELCO	2	Firm	No	Snowy Hydro has also instructed the Supplier to develop a suitable automated venting and purging design to reduce this risk and are currently working with the Supplier to implement this design. AECOM CO2 System as currently designed can be permanently connected to generator CO2 supply panel as designed by MHI.
Power Island	46 - Generator H2 gas supply	970	Unit H2 flow meter can be used for make up flow monitoring, leak and PRV lifting detection. MELCO to consider adding flow meter to measure H2 consumption	MELCO	2	Firm	No	Modification recommended to improve monitoring and detection of H2. Supplier currently reviewing the design change and implementation aspects.
Power Island	46 - Generator H2 gas supply	983	AECOM to review H2 pipework for dissimilar metals. MELCO supply all 304 stainless. Potential corrosion and Haz area issue	AECOM	1	Firm	No	CLOSED
Power Island	47 - Generator CO2	1004	CO2 line has no filter or strainer. It is rarely used which could create fouling issues. MELCO to consider and quote option	MELCO	2	Study	No	Awaiting quote from MELCO
Power Island	48 - Generator H2	1013	MELCO to review automating the Hydrogen make up valve as the site is normally not manned.	MELCO	2	Study	No	Snowy Hydro has also instructed the Supplier to develop a suitable automated make-up design to reduce this risk and are currently working with the Supplier to implement this design.
Power Island	48 - Generator H2	1014	Hydrogen pressure transmitter PT1 is potentially a single point of failure for an unmanned site. MELCO will consider multiplexing the transmitter PT1.	MELCO	2	Firm	No	Modification recommended to improve monitoring and detection of H2. Supplier currently reviewing the design change and implementation aspects.
Power Island	48 - Generator H2	1026	Dew point monitoring is currently not part of the scope. MELCO will consider adding the dew point monitor to the Gas control unit.	MELCO	2	Firm	No	Modification recommended to improve monitoring of H2 performance and quality. Supplier currently reviewing the design change and implementation aspects.
Power Island	48 - Generator H2	1022	MELCO to confirm what happens to the purity meter if CV-1 fails and flow is too low or no flow or needle valve set incorrectly. Hydrogen purity is important for purging requirements	MHI	2	Verify	No	CLOSED
Power Island	48 - Generator H2	1029	SHL to develop written procedure for sampling purity with portable analyser to confirm main analyser reading is correct. Drain sampling and valve switching is manual to select top or bottom of the generator sampling. Note sampling drain point is within hazardous area	SNOWY HYDRO	2	Firm	Yes	CLOSED to be considered in Ops Readiness
Power Island	48 - Generator H2	1017	Site wide review of field mounted instrumentation junction boxes and field panels required. These are normally fitted with heaters to prevent condensation	SNOWY HYDRO	1	Study	No	CLOSED
Power Island	48 - Generator H2	1018	MHI to supply instrumentation datasheets for action item 66. To confirm field instrumentation ratings, i.e. +5 - +45 non- condensing??	MHI	1	Firm	No	CLOSED
Power Island	48 - Generator H2	1020	AECOM to include a fire suppression system in the area around the gas control and seal oil unit to further mitigate and fire risk. Gas detection requirements in this area to be studied.	AECOM	1	Firm	No	AECOM has designed a fire suppression system in and around the seal oil and gas control unit.
Power Island	48 - Generator H2	1024	MELCO to consider adding check valve before CO2 manual isolation valve	MELCO	2	Verify	No	Modification recommended to reduce potential backflow risk. Supplier currently reviewing the design change and implementation aspects.
Power Island	49 - Generator H2 drying system	1045	Hydrogen dryer blower intake is open to atmosphere and in close proximity to the Operator swinging the 3-ways valves. Incorrect procedure (monthly) or Operator error would vent Hydrogen out of air intake. Operator exposure to fire / explosion (static). Design review required. Air intake pipe to safe area to seal system or automated double block and bleed per combustion standard	SNOWY HYDRO	1	Study	No	CLOSED to be considered in Ops Readiness
Power Island	49 - Generator H2 drying system	1040, 1051	MELCO to quote additional double block and vent isolation valves for on-line maintenance of heater system, to eliminate H2 purge of complete system. Snowy standard maintenance requirement	MELCO	2	Firm	No	Modification recommended to improve isolation and maintenance activities. Supplier currently reviewing the design change and implementation aspects.
Power Island	50 - Generator - Lube oil system	1064	There is a discrepancy between MELCO pipe sizes and MHI drawing A-21022 page 2 of 4. MHI to review and correct	MHI	1	Firm	No	CLOSED
Power Island	50 - Generator - Lube oil system	1056	MELCO design is heavily reliant on Operator alarm response and on site Operator rounds. This is not how Snowy normally operate. Additional instrumentation would be likely be installed on future upgrades. MELCO design to be reviewed for potential instrumentation upgrades	SNOWY HYDRO	1	Study	Yes	CLOSED
Power Island	51 - Generator - Seal oil vacuum pump and tank	1084	AECOM to incorporate seal oil system drip / leak tray overflow to oily water system in their design	AECOM	2	Firm	No	CLOSED Seal Oil tank and pump skid is installed within a bund and connected to the Oily water system. Oily water system connection is open in order to manage fire water (added in action 68 above). It is not practical to bund the area around ALL seal oil piping and the generator seals as it would extend to cover the entire generator foundation and has not been requested during design development progress
Power Island	51 - Generator - Seal oil vacuum pump and tank	1084	Seal oil system drip tray or bunded area should be remotely monitored for large leaks and potentially auto draining function of sight glass. Similar to fuel oil / lube oil bunds	SNOWY HYDRO	1	Firm	Yes	CLOSED. Seal Oil tank and pump skid is installed within a bund and connected to the Oily water system through an open drain/flame trap. Oily water system connection is open in order to manage potential fire water (added in action 68 above), therefore superceding remote monitoring of bund for leaks.
Power Island	51 - Generator - Seal oil vacuum pump and tank	1085	Seal oil vacuum tank fill valve is a single point of failure which can lead to lube oil overfilling the tank and lube oil discharging via the vent stack, potential large quantities due to unmanned site. Alarm response cannot prevent this consequence and would happen quite quickly. Design review required	SNOWY HYDRO	1	Study	No	MELCO have added level glass, however SHL still require a level switch in Oil Seperator tank.
Power Island	53 - Generator - DC seal oil system	1116	MELCO to review design to define the potential consequences of an unmanaged seal oil system failure and loss of hydrogen containment. Snowy will use this information to risk assess the installation per HAZOP guidelines	MELCO	2	Study	No	Snowy Hydro has also instructed the Supplier to develop a suitable venting design to reduce this risk and are currently working with the Supplier to implement this design.

Power Island	53 - Generator - DC seal oil system	1123	Change DC pressure PI-5 to pressure transmitter for DC pump test run and linking to H2 automatic venting system. MELCO team suggest change is technically possible but may cause delays. MELCO will consider changing DC pressure indicator PI-5 to pressure transmitter.	MELCO	2	Verify	No	The existing pressure indicator will be changed to a pressure transmitter. Snowy Hydro has also instructed the Supplier to develop a suitable venting design to reduce this risk and are currently working with the Supplier to implement this design.
Power Island	53 - Generator - DC seal oil system	1124	MELCO team to confirm DC pump recirc line size. The large size valve passing may result in very low DC seal oil pressure	MELCO	1	Verify	No	CLOSED
Power Island	53 - Generator - DC seal oil system	1126	AC and DC suction pressure indicators not shown on drawing but will be provided. MELCO to update drawing	MELCO	2	Firm	No	CLOSED
Power Island	53 - Generator - DC seal oil system	1125	DC pump inlet (suction side) check valve stuck closed resulting in no oil pressure in a demand scenario. Why do we need this valve and is it normally open or closed. Confirm also design of this valve, i.e. spring, lockable, power cylinder??	MELCO	1	Verify	No	CLOSED
Power Island	53 - Generator - DC seal oil system	1141	Redundant AC seal oil pump configuration requirement reviewed and recommended to MELCO for incorporation. MELCO will show the layout for the installation of the second AC pump.	MELCO	2	Firm	No	Modification recommended to improve redundancy. Supplier currently reviewing the design change and implementation aspects.
Power Island	54 - Generator - Gland seal oil system	1145	Gland seal system if currently a manually operated procedure that is required during hydrogen fill and 'potentially' at full speed to centre the seal rings to reduce shaft vibration. Remotely operated solenoid would be the ideal solution. MELCO to confirm the design requirements and schedule impact to be confirmed	MELCO	1	Verify	No	CLOSED to be considered in Ops Readiness
Power Island	Closed Cooling Water - 1 - Fin fans	3	Add drain points and vibration sensors to P&ID Sht 1 of 4	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 1 - Fin fans	4	Piping ratings on drawings need to be corrected	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 1 - Fin fans	5	Pumps have not been specified yet. System pressure with 2 pumps running to be checked against MHI supplied heat exchangers and the fin fan cooler design pressure	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 1 - Fin fans	6	Delete upstream individual header pressure indicators and change the downstream individual header pressure indicators to temperature sensors to assist with flow balancing	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 1 - Fin fans	7	Add fin fan overall dP sensor	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 1 - Fin fans	8	Add helper cooler discharge pressure and temperature transmitter to P&ID	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 1 - Fin fans 2 - Helper cooler and booster pump	9	Review system design for thermal expansion to assess if a flexible connection is required	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 1 - Fin fans	10	Review which sensor is better to control the fin fans, CT102 or CT103	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 1 - Fin fans	11	Review sensor failure on loss of signal for fin fans, CT102 and CT103	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 1 - Fin fans	12	Temperature sensors should be dual elements, even if only 1 is used. Consistent with MHI design	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 1 - Fin fans	13	Flow balancing valves should be set and forget. Not move with water vibration. Valve selection to consider locking or rigid stem packing to hold commissioned position	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 1 - Fin fans	23	Grease points access needs a lift. SHL to review site requirements hire or buy a scissor lift	SNOWY HYDRO	3	Firm	No	
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	25	Add duty standby pumps to drawing	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	26	Confirm piping pressure rated for two pumps running	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	30	Review instrument impulse lines for low ambient temp. Threaded socket direct to pipe is probably the best approach.	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	39	Potential forwarding pressure is sufficient to continuously leak out of helper spray nozzles. Review booster pump or spray bar isolation requirements	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 2 - Helper cooler and booster pump	45	Helper Cooler spray water is demin that needs to flow (if any) to Trade waste. System is not covered so rain water catchment would also flow to trade waste. To be considered in the design.	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 3 - Expansion tank	57	Water consumption of pump gland seals and leakage to be estimated to evaluate automating tank filling and pump discharge pressure stability. More than 1 x per mth suggest automation required	AECOM	1	Study	No	
Power Island	Closed Cooling Water - 3 - Expansion tank	47	Add PRVs to instrument air and forwarding demin supplies to prevent overpressure, Press Reg, Sight glass, manifold suction pressure transmitter and level switch to P&ID and suitably rated	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 5 - GT HP Purge air coolers	97	MHI to review HP compressor protection requirements. What are the consequences if the closed cooling water temperature increases above 40 C. Do we need to shutdown the compressors to protect them from damage?	MHI	2	Study	No	CLOSED There is no interlock system about CCW temperture high. But another interlock systems are equipped in HP purge air compressor control system. -Cooling water temperture rise occurs lub oil viscosity drops, so lub oil pressure low trip is equipped. -Cooling water temperture rise occurs lub oil temperture rise, 1st stage compressor output air temperture rise as a result. When it will rise up above setting value, HP purge air compressor will trip (1st stage air temperture high).
Power Island	Closed Cooling Water - 5 - GT HP Purge air coolers	105	MHI to confirm HP compressor oil pressure and if there is an exchanger leak, will the water flow into the compressor and cause damage? How is this detected?	MHI	2	Verify	No	CLOSED The normal lubricating oil pressure is about 0.2 ~ 0.3 MPaG. When leak occurs at lub oil cooler, cooling water leak into lub oil line.(Cooling water pressure : approx.0.57MPa) It will cause higher compressor outlet air temperature rise. Compressor has the protection of "1st stage compressor outlet air temp high".
Power Island	Closed Cooling Water - 6 - GTG H2 air coolers	115	P&ID line 100mm to be updated to 125mm	AECOM	2	Firm	No	
Power Island	Closed Cooling Water - 6 - GTG H2 air coolers	116	Pressure regulation wont work as shown. AECOM to review water pressure balancing system. It is important to maintain 5.5 Bar cooling water at exchangers to inhibit H2 leak	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 6 - GTG H2 air coolers	135	AECOM to review and confirm with MHI if any closed cooling water commissioning strainer / removal spool requirements	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 7 - GT Control oil coolers	147	AECOM to review check valve quantity and location. Control oil only has 1 common NRV but other exchangers are individually controlled. Do we need them?	AECOM	1	Verify	No	
Power Island	Closed Cooling Water - 3 - Expansion tank	61, 69	Expansion tank bladder inspection and repair access and maintenance requirements to be specified	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 4 - Cooling water pumps	71. 91	Pump discharge manifold PRV to discharge to trade waste system. All (all nodes) CW system drain points need to go to trade waste	AECOM	1	Firm	No	
Power Island	Closed Cooling Water - 4 - Cooling water pumps	87	On loss of AC supply, does the closed cooling water system (fans and / or pumps) need to be operational for any specified period time after a black stop. MHI to confirm any run down time requirements	MHI	1	Verify	No	CLOSED GT roll down to turning gear within 30-40mins after black out trip, and bearing oil is supplied by EOP (DC pump) with bypassing LO-cooler. Therefore, we don't think closed cooling water system is not need to be operational.
Balance of Plant	Diesel	1.1.1	Requirement to be clear in procedures that quantity delivered is based on tanker dip gauges.	SNOWY HYDRO	2	Firm	Yes	
Balance of Plant	Diesel	1.1.2	Refer to action of 1.1.15.	AECOM	1	N/A		Closed. High flow alarm added on flowmeter at pump discharge header to warn operator. Process interlock to prevent both pumps running, has been added in control philosophy.
Balance of Plant	Diesel	1.1.3	Check with the pump vendor if the selected pump can operate for 20 seconds with low flow.	AECOM	1	Verify	No	Closed. Note has been added to the data sheet for the unloading pump "HPP-AEC-MEC-DS-LLS-DST-3190-Rev B"

Balance of Plant	Diesel	1.1.4	Review requirement of bleed valve on suction line to the pump.	AECOM	1	Verify	No	Closed. Vent/Bleed valve added on each unloading pump suction line, refer PID-1065 Note: Not all compartments in the tanker have the same volume
Balance of Plant	Diesel	1.1.7	Show internal relief of pumps on P&IDs.	AECOM	1	Firm	No	Closed. Internal PRV added to each pump (P&IDs Rev C)
Balance of Plant	Diesel	1.1.9	Operating Procedures to include a check of the diesel quality delivered to site.	SNOWY HYDRO	2	Firm	Yes	
Balance of Plant	Diesel	1.1.10	Diesel should be regularly tested to ensure the level is suitable for the Gas turbine. Included regular sampling for quality testing in the operating procedures.	SNOWY HYDRO	2	Firm	Yes	
Balance of Plant	Diesel	1.1.11	Review requirement for commissioning strainers.	SNOWY HYDRO	1	Verify	No	Strainers have been included for the pumps, during the commissioning the team should install a strainer for this purpose and then replace it after flushing the line. ITPs by Snowy, action to be assigned to SH
Balance of Plant	Diesel	1.1.11	Construction ITPs to include cleanliness checks.	SNOWY HYDRO	2	Firm	Yes	
Balance of Plant	Diesel	1.1.12	Review requirement for valve with position indicator in diesel unloading bund.	AECOM	1	Firm	No	Closed. Valve with positioner has been added for tanker standing bund valve. Shown on PID HPP-AEC-MEC-DS-LLS-DRG-1065
Balance of Plant	Diesel	1.1.13	Review requirement for bund size as per AS 1940. Consider making bund big enough for all components on B double compartments on B double.	AECOM	1	Verify	No	Closed. Tanker standing area bund has been designed to hold 9000 Litre as per AS1940 (1.5 x compartment). KW: Unloading connection will now only have 2 connected hoses and previously designed for 5. So only a maximum of two compartments connected at one time. HPP-Basis of Design Chapter 5.1.5.1.1 Tanker unloading area
Balance of Plant	Diesel	1.1.14	Review where pump spill containment is discharged to. Preference is to keep in the pump bund area rather than being discharged into larger road containment bund.	AECOM	1	Verify	No	Closed. Note added to PID Rev C "Separate bund with drain to the oily water system to be provided for unloading pump and it should be kept separated from tanker bund area"
Balance of Plant	Diesel	1.1.15	Process interlock to be reviewed/designed to not allow running both pumps at the same time. Include permissive that valve should be opened before running pump.	AECOM	1	Firm	No	Closed. High flow alarm added on flowmeter at pump discharge header to warn operator. Process interlock to prevent both pumps running, has been added in control philosophy.
Balance of Plant	Diesel	1.1.16	Review process interlock that on/off valves to tank inlet are opened prior to starting the pump.	AECOM	1	Verify	No	Closed. As per current control philosophy valve open position on selected tank and close position on the other tank will give permissive to start the unloading pumps
Balance of Plant	Diesel	1.1.17	Review requirement for sight glass downstream of flexible couplings. See 1.1.4	AECOM	1	Verify	No	Closed. Sight glass 90EGA01CL001 added on suction header downstream of hose connection
Balance of Plant	Diesel	1.2.1	Review impacts of ramp up and ramp down of delivery to trucks. Review impacts on PD pumps and whether PSV will lift when FCV closes. Could replace PSV with Pressure Reducing Valve. Review if the FCV in the diesel loading skid is required.	AECOM	1	Study	No	Closed. An FCV (flow control system) is required to start the loading at a lower rate to prevent splashing inside the tanker compartment when the tanker is empty. A note has been added to the pump datasheet to specify a slow start operation. A modulating type PRV (90EGD01AA044) is proposed downstream of the PD pumps to relieve the excess supplied fuel to the pump suction side during the ramp up and down to have a smooth operation for the pump if required. The PRV is supplied by PD pump vendor and the vendor is responsible for the sizing.
Balance of Plant	Diesel	1.2.2	Process interlock to be reviewed/designed to prevent running both pumps at the same time.	AECOM	1	Firm	No	Closed. Process interlock to prevent both pumps running, has been added in control philosophy.
Balance of Plant	Diesel	1.2.4	Integrate the vendor package with the loading pumps. E stop required for Load bay controller. Check if control should be independent of DCS e.g. Removal of air will close valves and stop the flow.	AECOM	1	Firm	No	Closed. The PD pump with a modulating PRV can cope with changes in the flowrate caused by the flow control valve under the Load Bay Controller. Requirement for an E-Stop note added to the PID and included in the Load Bay duty specification. Failure of instrument air supply will close on-off valve to loading arm and stop flow. Requirement for package integration with the site DCS to control the unloading pumps has been added to package duty specification: HPP-AEC-MEC-DS- LLS-SPT-3186 Load bay controller will also be controlled by local PLC which will also stop the loading pump if the on/off valve is closed or the required load has been completed
Balance of Plant	Diesel	1.2.5	Check tanker loading connection (dry break connection), valving isolation and check valves. Check if there is a sight glass include in line.	SNOWY HYDRO	1	Verify	No	
Balance of Plant	Diesel	1.2.6	Review pump head to maintain pressure of the loading arm below 5 barg	AECOM	1	Verify	No	Closed. Current TRV system is cascaded to the storage tank with maximum 495 kPag pressure Jafar: Pump discharge pressure is 250 kPag and downstream PRV has set point of 300 kPag .
Balance of Plant	Diesel	1.2.7	Review location of discharge of TRV to ensure section that is relieved will not exceed design pressure.	AECOM	1	Verify	No	Closed. Current TRV system is cascaded to the storage tank with maximum 495 kPag pressure. This is far below the piping design pressure. Jafar: The TRV's are cascaded from loading arm to the storage tanks as following calculation for the worst case scenario and with 10% overpressure in opening for each TRV: (300*1.1+80)+50*1.1+50*1.1=520 kPag
Balance of Plant	Diesel	1.2.9	Confirm if tanker can be over pressured or has lid open. Ensure tanker vent system is interlocked to avoid overpressure in the tanker.	SNOWY HYDRO	1	Verify	No	
Balance of Plant	Diesel	1.2.12	Consider bollards in unloading area	AECOM	1	Consider	No	Closed. Loading arms extend beyond line of potential bollards, or guard rail. There will be bollards installed on approach and departure to the facility. No bollards to be installed across the face of the pump area as this could limit unloading arm movement and become a hinderance. Confirm arms are protected with breakaway coupling.
Balance of Plant	Diesel	1.2.13	Consider whether a weigh bridge or other mechanism to measure amount of fuel being loaded	SNOWY HYDRO	1	Consider	No	
Balance of Plant	Diesel	1.3.1	Add a flame arrestor to diesel storage tanks (as per Colongra site)	AECOM	1	Firm	No	Closed. Flame arrestor not required as per AS 1940. Decision to include is SH preference. JD: Flame arresters already shown in P&IDs (90EGB01AT001 and 90EGB02AT001)
Balance of Plant	Diesel	1.3.3	Consider needle control valve in air supply to operate the pump.	AECOM	1	Consider	No	Closed. Air regulator valve with a filter has been added in P&IDs (Rev C) instead of a needle valve.

Balance of Plant	Diesel	1.3.4	Use level transmitter as pump shutdown as well as the level switch.	AECOM	1	Firm	No	Closed. Added to control system, for unloading and transfer modes. Level switches have been replaced with transmitters.
Balance of Plant	Diesel	1.3.5	Use level transmitter as pump shutdown as well as the level switch.	AECOM	1	Firm	No	Closed. Low Low level Alarm with pump shutdown has been added to the level transmitter instead of the LSLL as a layer of protection for pump shutdown (LSLL has been removed and replaced by LT with LL alarm). The low level alarm will be retained for the tank changeover if the pumps are used for forwarding mode instead of using it for pump shutdown and interrupt GT operation.
Balance of Plant	Diesel	1.3.6	Review the employer requirements to have one or two transmitters. Review how critical this instrument is to the operation of the GT.	AECOM	1	Verify	No	Closed. Existing operations (at Colongra) are using two transmitters JD: LSLL replaced with level transmitter with HH, H, L, and LL alarm added to each tank
Balance of Plant	Diesel	1.3.8	Review of AS 1940 to determine if any additional temperature control are required	AECOM	1	Verify	No	Closed. Several Australian diesel supplier SDSs have closed cup flash point higher than 61.5 C. Therefore, the handling and storage temperature is lower than flash point and no need to classify as hazardous area. TT has been added on return line to monitor the return diesel from GT. Update: As per Client request, a heater has been added on the diesel tank to keep the temperature above 19 C. Heater will start when T drops below 19 C and will stop when rises above 25 C. It has been specified in the heater datasheet that the max allowable temperature is 50 C for tank medium. It has also been specified that the heater will be equipped with a skin overheat protection system to prevent diesel overheating.
Balance of Plant	Diesel	1.3.9	SH to provide fuel specification (pour point) of selected fuel to determine if wax formation is likely at the minimum expected storage temperature.	SNOWY HYDRO	1	Firm	No	
Balance of Plant	Diesel	1.3.12	Review drain/vent material selection to minimise corrosion. Review coating of tank.	AECOM	1	Firm	No	Closed. All tanks will be painted/coated internally. Vent and drain line material has been changed to stainless steel. Please refer to tank Datasheet HPP-AEC-MEC-DW-SFP-DST-3100_Rev B
Balance of Plant	Diesel	1.3.13	Determine if density/viscosity of diesel change significantly with temperature. To be confirmed with fuel supplier	SNOWY HYDRO	1	Verify	No	
Balance of Plant	Diesel	1.3.17	Confirm that a potential rain event (i.e. 1 in 100 rainfall event) will not cause instrumentation and control systems to be covered in water. Considering including float switch to alert before control switches are under water.	AECOM	1	Consider	No	Closed. All instrumentation inside the bund are already installed above one meter. Float level switch (high) added to the bund - P&ID RevC.
Balance of Plant	Diesel	1.3.18	Consider the internal surface of diesel tank to be fully coated.	AECOM	1	Consider	No	Closed. All tanks will be painted/coated internally. Please refer to tank Datasheet HPP-AEC-MEC-DW-SFP-DST-3100_Rev B
Balance of Plant	Diesel	1.4.1	Interlock to prevent 3 pumps running at the same time.	AECOM	1	Firm	No	Closed. This action is not valid anymore since pump control philosophy has been updated to run N+1 forwarding pumps. N is number of GT running as per snowy operation team request.
Balance of Plant	Diesel	1.4.2	Check diesel polishing package has alarm for the differential pressure across filters to alert operators of blocked filters in DCS.	AECOM	1	Verify	No	Closed. Monitoring of differential pressure across the filters in DCS with high alarm has been added (P&ID revC)
Balance of Plant	Diesel	1.4.11	Consider an additional separate pump for polishing package. Look at automated prioritised control of forwarding pumps.	AECOM	1	Consider	No	Closed. Separate pump with dedicated supply and return lines connected to the storage tank has been added for polishing package. Package will standalone. UPDATE : Request by client to remove polishing package pump and use forwarding pumps. Actuated valves can change flow from polishing to forwarding in seconds.
Balance of Plant	Diesel	1.5.1	One inlet return valve to each storage tank to be open at all times. Set fail action to fail last. Oil is returned after GT shutdown. Ensure the inlet line is open for the fuel return to tanks. Keep at least one inlet valve open for diesel return from GT after shutdown.	AECOM	1	Firm	No	Closed. 1- Added to the control philosophy - (one of the return valves to the storage tanks should be always open even in IDEL mode) 2- In forwarding mode relevant return valve for the selected tank would give permission to start the pumps and initiate the mode 3- In IDLE mode when no mode is selected one of the return valves to storage tank would be open, added to the control philosophy
Balance of Plant	Diesel	1.5.2	Redundancy and reliability issues need review. Consider running the standby pump at all times so if a single pump trips no loss of flow or pressure to the GT. Perform a dynamic study to determine if only running two pumps and time required for a third pump to start and compensate for loss of flow of tripped pump. How many pumps need to be running if there is a pump trip. Consider n+1 where n is the number of units.	AECOM	1	Study	No	Closed. JD: Pump control philosophy has been updated to run N+1 forwarding pumps. N is number of GT running as per snowy operation team request. PCV with bypass pipework of MFOP has been added to allow excess diesel to be returned to the diesel tank. KW: A dynamic analysis is not now required because of operating an extra pump above the flow requirements of the GT so an analysis of the dynamics of starting a spare pump is not required. KW: A separate RAMS study will address the issue of overall pump reliability
Balance of Plant	Diesel	1.5.6	Consider installing a small sump and weir in bund to contain smaller leak quantities at pump skid bund.	AECOM	1	Consider	No	Closed. Small sump and weir not preferred as this would require mobile equipment to treat spill which is not readily available on site. As bund is connected to oily water system, spills transfer directly to oily water pit and are treated at this location. No further action required.
Balance of Plant	Diesel	1.5.8	Change PI upstream of flowmeter to be PT	AECOM	1	Firm	No	Closed. PI has been changed to PT (P&IDs Rev C)
Balance of Plant	Diesel	1.6.4	Review the interaction of the loading/unloading interaction with curb and lighting.	AECOM	1	Verify	No	Closed. Originally the unloading connection was via a 5 arm trolley that could be moved around. Updated to provide 2 port connection arms. Action is no longer valid because the unloading trolley has changed to an overhead arm.

Balance of Plant	Diesel	1.6.5	Review causes of fire/consequences. A fire could start on site undetected. Review fire protection and remote monitoring of critical areas e.g. use of cameras	AECOM	1	Study	No	Closed. Refer to Fire Safety Study report for details HPP-AEC-MEC-FP-GEN-REP-0001 regarding causes of fire/consequences and recommended fire protection and monitoring. - Fire detection is included in the Turbine enclosure triggering CO2 suppression, alarm and shutdown - Fire detection(via fusible plug) in the FO unit triggering sprinkler system, alarm and shutdown -Fire detection via CCTV at the GT fuel oil piping (remote or local observation) to enable operator shutdown. - At the fuel forwarding pump the diesel is at ambient temperature, at lower pressures than the GT fuel oil piping and not collocated with other flammable materials so the risk a fire is low. For this reason cameras are not likely to installed in this area
Balance of Plant	Diesel	1.6.10	Review bushfire impacts on the fuel tanks. Assess best materials for fencing etc. to minimise this risk. NOTE: A fence will not prevent ember attack which comes from an elevated height higher than normal fence height).	AECOM	1	Study	No	Closed. Vegetation near site to be cleared in the future when site is operable. Fire safety study regarding the diesel tanks in bush fire scenario: The bulk fuel oil storage tanks will experience thermal radiation less than 19 kW/m2 but greater than 12.5 kW/m2. The planned storage tanks have been designed in accordance with the requirements of AS1940 and AS1692. The tanks have a fixed roof design, which eliminates the fire risks associated with floating roof designs. The tank vent is designed with a flame arrestor, which will inhibit ember ingress and prevent flame ingress from ignition of any vapour that occurs outside the vent because of any elevation in fuel oil temperature during a bushfire exposure event. Other than the specific design requirements of AS1940 and AS1692, the protection rationale and recommendations for the bulk fuel oil tanks is identical to that described for the potable and demineralised water tanks i.e. dedicated fixed on tank cooling is not recommended but provision of some fixed firewater monitors on the site firewater hydrant system to enable site personnel to direct cooling water onto the exposed surface of the tanks is recommended. No other specific control measures for plant in this area are planned.
Balance of Plant	Diesel	1.6.12	O&Ms to be created by SH	SNOWY HYDRO	2	Firm	No	
Balance of Plant	Natural Gas	2.1.3	Use temporary flexible connection for N2 purging with hoses and only connected when required for maintenance. Covered under operating procedures for only connecting N2 when purging is required.	SNOWY HYDRO	2	Firm	No	
Balance of Plant	Natural Gas	2.1.4	SH have requested to add facilities for a remote operated vent for each pipe section to be opened remotely by operators to reduce pressure in the pipeline over a selected time period e.g. 15 minutes in case of fire. Two vents will be required one for first section between battery limit ESD and SDV upstream of knockout drum and second vent required downstream of gas KO drum ESD for downstream equipment. Consider damage to the packing in the filter coalescer vessel from a high differential pressure across the filter material during venting. Change valve to ESD (currently SDV). Vent valve interlocked to not open until ESD is closed to prevent loss of gas. Review the operation of vent in conjunction with remote operation philosophy i.e., effect of ignition of vent and possibility of air entering the gas line when line depressurised. May effect ability for remote start-up. Vent valve will only close in emergency.	AECOM	1	Firm	No	Closed. - APA agreed that vent for gas pipeline can be collocated with cold vent for gas receiving station. - AECOM will look at radiation from new vent co-located with cold vent. - APA permit system requires all lines connected to vent to be purged and lock on isolation valves. Confirm there is a DBB on vent line to new vent in APA area. Update 4/3/22 See RFID-0000125. SH do not require remote operated vent valve or actuated inlet valve at the PS boundary . Remote operated vent valve has been retained downstream of the last chance cartridge filter . PIDS have been updated Added remote operated vent downstream of MHI cartridge filter. Removed RO vent valve at station boundary on request of SH. Maintenance venting only provided. There will be no actuated isolation valve at the gas inlet to the station. SH will rely on APA gas isolation valve. PIDS have been updated.
Balance of Plant	Natural Gas	2.1.5	Perform dynamic study of the system based on closure times of the valves. Consider all system shutdown (trip) scenarios.	AECOM	2	Consider	No	The gas pipeline dynamic modelling is waiting on the gas connection with APA to be finalised
Balance of Plant	Natural Gas	2.1.6	Confirm there is a safety relief valve in pressure reduction units supplied by MHI.	MHI	1	Verify	No	
Balance of Plant	Natural Gas	2.1.9	Review location of vent stack with regard to radiation from ignition of NG. Review potential to co-locate new vents required in APA's vent area	AECOM	1	Study	No	Closed. NG vent stack will be located in Process gas area will be a maintenance vent only. Radiation modelling has indicated that vent stack should be 17 m tall to limit radiation affects at boundary fence. Maintenance venting will be a controlled activity which will limit access to the area around the vent during operation of the vent. (UPDATE: 16-6-22- NG vent stack will be co-located with H2 vent which is 33m tall so NG vent stack will also be 33m tall)
Balance of Plant	Natural Gas	2.1.10	Include pressure transmitter and local pressure indicator on main line. Provide additional tapping points for gauges if required.	AECOM	1	Firm	No	Closed. Marked up on PID and added PI 90EKG01CP301 and PI 90EKG01CP302
Balance of Plant	Natural Gas	2.1.11	Review whether integral DBB valves can be used instead of separate valves to save cost.	AECOM	1	Verify	No	Closed. As per AEC ANZ-RFI-000167, SHL have instructed not to use integral DBB valves.
Balance of Plant	Natural Gas	2.1.13	Update PID to show not permanently connected.	AECOM	1	Firm	No	Closed. Marked up on PID - Note 3: Connection for calibration gas cylinder
Balance of Plant	Natural Gas	2.2.2	Review potential impact on reverse flow through KO pot and demister pad.	AECOM	1	Verify	No	Closed. Remote operated vent valve at PS inlet has been removed. RO vent valve downstream of cartridge filter will allow venting of piping downstream of KO drum and ESD valve upstream of KO drum, so no reverse flow is possible
Balance of Plant	Natural Gas	2.2.3	Review requirement for Emergency shut off valve EKG01AA161 upstream of KO drum. Consider changing to a manual valve as remote operation of the valve is not required (by SH)ESD can remotely isolate each GT if fire on one unit. Provide a schematic drawing (updated PFD) of ESD and vent valves on gas supply line to each gas turbine.	AECOM	1	Verify	No	Closed. ESD valve at inlet of KO drum has been retained as required by MHI PIDS and to isolate the gas supply to each GT in case of a fire or other emergency.
Balance of Plant	Natural Gas	2.2.4	Change location of level transmitter on the Gas Knock Out Drum of upper tapping point to below filter media	AECOM	1	Firm	No	Closed. : Marked up on PID (Rev C)
Balance of Plant	Natural Gas	2.2.5	Remove LSHH trip to shut turbine -Include LSH on maintenance schedule. Frequent tests to make sure it's working. Do not require duplicate drainage system because LSHH trip deleted.	AECOM	1	Firm	Yes	Closed. Removed LSHH . Marked up on PID (Rev C)
Balance of Plant	Natural Gas	2.2.7	Show a Manhole on Knock Out Drum on P&ID (HPP-AEC-MEC-GA-KOO-DRG-1090).	AECOM	1	Firm	No	Closed. Marked up on PID (Rev C) Drum diameter is estimated to be 1.5 m so MW is likely
Balance of Plant	Natural Gas	2.3.3	Raise an RFI to MHI on whether the position of the temperature flow control valve is important. Difficult to know that TCV has failed.	AECOM	1	Verify	No	Closed. Clarified with MHI. No possibility of overheating gas to gas turbine. A low temperature will generate an alarm at the GT inlet and will alert operations to check valve operation
Balance of Plant	Natural Gas	2.3.4	Check distance from MHI heater to ladder access on stack.	MHI	1	Verify	No	

Balance of Plant	Natural Gas	2.4.2	Review setting level of DP alarm level value on Filter Coalescers to ensure sufficient time to swap to other filters (Duty/Standby).	AECOM	1	Verify	No	Closed. Filter / Coalescer offer has clean differential pressure as < 4kPag and change out differential pressure as 103 kPag. The NG is expected to be clean and oil free. A long run length is expected. The setting of the filter DP is set at 60% of the maximum differential pressure to allow sufficient time for changeover. (Included in the Control Philosophy - Section 10.5)
Balance of Plant	Natural Gas	2.4.3	Review potential impact on reverse flow through Knock Out Drum and demister when opening the remote vent at the station battery limit.	AECOM	1	Verify	No	Closed. Remote operated vent valve at PS inlet has been removed. RO vent valve downstream of filter/coalescers will allow venting of piping downstream of KO drum and ESD valve upstream of KO drum, so no reverse flow is possible
Balance of Plant	Natural Gas	2.4.4	Consider adding sight glass on side of filter coalescers to determine condition of elements.	AECOM	1	Consider	No	Closed. Sight glass has been removed from vessel as vendor has confirmed it is not necessary. Two LIT for each of upper and lower compartments to provide independent shut off of drain valves to prevent gas blow through.
Balance of Plant	Natural Gas	2.4.5	Remove LSHH trip to shut turbine. Include LSH on maintenance schedule (Frequent tests to make sure it's working). Do not require duplicate drainage system because LSHH trip deleted.	AECOM	1	Firm	No	Closed. Removed LSHH . Marked up on PID (Rev C)
Balance of Plant	Natural Gas	2.4.9	Change PI to PT upstream of filter for DCS indication.	AECOM	1	Firm	No	Closed. Marked up on PID , DPI 01EKG01CP101
Balance of Plant	Natural Gas	2.4.10	Consider stairs instead of ladders for access.	AECOM	1	Consider	No	Closed. A platform access is shown in the model
Balance of Plant	Natural Gas	2.5.3	Review where vents are discharge to e.g. Local High point vent	AECOM	1	Study	No	Closed. Local vents in this area are vented 7-8 m above the GT enclosure so well above location of people or sources of ignition. (See snip at right)
Balance of Plant	Natural Gas	2.5.5	Review requirements for nitrogen purge and vent connection between heater and filter to be used during maintenance of filter.	AECOM	1	Verify	No	Closed. Added N2 connection to PID 1097 downstream of last chance cartridge filter. This can be used to purge backwards from the last chance cartridge filter via fuel gas heater and through vent valve SDV 01MBP01DF006A upstream of the NG flow meter. This will allow better removal of gas as there is no isolation valves at the cartridge filter.
Balance of Plant	Natural Gas	2.6.4	Add small tank drain to allow sampling and flow to drain	AECOM	1	Firm	No	Closed. Marked up on PID (Rev C)
Balance of Plant	Natural Gas	2.6.6	Update datasheet to include a full vacuum conditions that may be caused by condensation of hydrocarbons	AECOM	1	Firm	No	Closed. Added FV to vessel data sheet
Balance of Plant	Natural Gas	2.6.7	Sight glass to be added on drips tank. Add to P&ID.	AECOM	1	Firm	No	Closed. Marked up on PID (Rev C) and added to data sheet
Balance of Plant	Natural Gas	2.6.9	Ball valves on P&IDs upstream of NRV to be locked open.	AECOM	1	Firm	No	Closed. Marked up on PID (Rev C)
Balance of Plant	Natural Gas	2.6.10	Redirect drain from vent pipe away from drips tank to another location to avoid filling drips tank with water.	AECOM	1	Firm	No	Closed. Redirected to local drain (P&ID Rev C)
Balance of Plant	Natural Gas	2.7.3	Review requirement for ignition source control entry into hazardous areas e.g. separation barrier, post, chain. SH to provide procedures and training for entry to HA and ignition sources.	SNOWY HYDRO	1	Verify	No	
Balance of Plant	Process Gas (Hydrogen)	1.1.1	Review amount of H2 required. Consider using less H2 gas bottles. (Raise RFI to SH to ask about minimum requirement for H2 storage cylinders).	AECOM	1	Verify	No	Closed. 15 cylinder rack will cover 2.7 days of normal leakage from 2xGT. @\2 racks will give 5 days coverage. If generators are not topped up the pressure will drop from nominal operating pressure of 4.5 barg to minimum operating pressure of 4.3 barg in 24 hours
Balance of Plant	Process Gas (Hydrogen)	1.1.2	Review timing for H2 trailer delivery and determine if leakage rate from generator is low enough to not reach low pressure trip whilst H2 trailer is being delivered and changeover.	SNOWY HYDRO	1	Verify	No	
Balance of Plant	Process Gas (Hydrogen)	1.1.3	Review requirement for pressure transmitters on cylinder and trailer H2 supply lines. Considering adding a position indicator on DBB valves on each H2 supply line - This option is not preferred because the position indicator will be in a Hazardous area from the H2 flanges.	AECOM	1	Verify	No	Closed. See item 1.1.2 - addition of 2x PITs (90QJH01CP101 and 90QJH02CP101) will give required information
Balance of Plant	Process Gas (Hydrogen)	1.1.4	Add pressure transmitter with alarm inside the H2 HP regulator panel downstream of PRV.	AECOM	1	Firm	No	Closed. Change PI immediately downstream of PRV to a PIT with high pressure alarm set at 5400kPag.
Balance of Plant	Process Gas (Hydrogen)	1.1.5	Add NRVs to hydrogen supply line to lines adjoining trailer outlet and cylinder outlet.	AECOM	1	Firm	No	Closed. Insert NRVs between isolation valves 90QJA01AA010 and 026 and the incoming nitrogen tee so hydrogen cannot flow back from the trailer to the cylinders
Balance of Plant	Process Gas (Hydrogen)	1.1.6	Review purpose of valve on line connected to hydrogen vent pipe (downstream of PRV). Consider locking bypass valve on PRV.	AECOM	1	Verify	No	Closed. Lock 15NB NC valve 90QJH01AA908 closed. KW - Connection to vent is allow line to be depressurised and vent to local vent. The valve is required
Balance of Plant	Process Gas (Hydrogen)	1.1.7	SH to provide operating procedures to close valve.	SNOWY HYDRO	2	Firm	Yes	
Balance of Plant	Process Gas (Hydrogen)	1.1.11	Consider a PT (downstream of the shutdown valve) that closes the shutdown valve. Review what the "shutdown" valve will be called from control perspective	AECOM	1	Consider	No	Closed. A PIT has been installed (see 1.1.4 above) with high and low alarms. A high high alarm has been added to shut the ESD (SDV) should that situation occur. PIT downstream of 2nd stage LP regulator will have a low alarm to show loss of H2 supply pressure.
Balance of Plant	Process Gas (Hydrogen)	1.1.13	Discuss with the Hydrogen supplier (BOC) availability and reliability of H2 supply.	SNOWY HYDRO	2	Study	No	
Balance of Plant	Process Gas (Hydrogen)	1.1.14	Review if small filter in N2 line is required to prevent any potential contamination carry over from N2 lines. Consider moving Nitrogen bottles to Hydrogen area to decrease the length of Nitrogen pipeline so this can be relatively cheaply changed to stainless steel.	AECOM	1	Verify	No	Closed. WBM Filter upstream of the PRV to be 5 micron particulate filter to arrest any dirt or scale. Nitrogen racks do not need to be permanently connected as used infrequently so fork hoist a rack to the N2 connection point and purge out oxygen before allowing gas to pass into the hydrogen system. Refer To N2 Distribution PID HPP-AEC-MEC-PA-GEN-DRG-1103 for connection to this panel
Balance of Plant	Process Gas (Hydrogen)	1.1.15	Review PSV set point downstream of PRV. Identify suitable set point based on the design pressure the downstream piping. Review pipe specification.	AECOM	1	Verify	No	Closed. PSV 90QJH01AA934 set at 15000 kPag which is the design pressure of the MHI pressure reduction panel. The pressure reduction panel reduces the pressure to 50 barg so with a PSV set at 150 barg well above the normal pressure downstream of the PRV so it is unlikely to accidentally lift. KW: MHI during the meeting said it would be no problem to increase the set point up to 150 barg. After HAZOP meeting MHI informed by RFI 58 that pressure can be increased to 200 barg if AECOM preferred. FN: The process gas facility and associated high pressure components to be provided within Vendor scope. This will include complete process design according to duty specification for Process Gas Facility (HPP-AEC-MEC-PA-GEN-SPT-3961). The supply includes mechanical design including strength calculation for all pressure parts, detailed design analysis for attachments, supports, setting bolts, etc. (HPP-AEC-MEC-PA-GEN-SOW-3960). P&ID -1100 has a HOLD to finalise piping classes for high pressure piping with the supplier.
Balance of Plant	Process Gas (Hydrogen)	1.2.2	Review valve fail positions and requirements of locking valves closed. Add valve Failure positions to the PID.	AECOM	1	Verify	No	Closed. Lock normally closed valve in question (90QJH01AA933) closed.

Balance of Plant	Process Gas (Hydrogen)	1.2.3	Review vent line size and confirm large enough size for the number of RVs connected. Review choke velocity in vertical vent pipe and common vent header. Review design pressure of vent line.	AECOM	1	Study	No	On Hold. Status update 8.9: Hydrogen pressure reduction and distribution system on HOLD as MHI are in the process of redesigning the GT gas charging and inerting panel to handle possibly up to 200bar inlet pressure direct from the cylinders/tube trailers as well as changing the GT inerting system from CO2 to N2.
Balance of Plant	Process Gas (Hydrogen)	1.2.4	Review vent stack design - potential for liquid seal at base of vent stack to avoid reverse flow of air.	AECOM	2	Study	No	In progress of being closed. A liquid seal and combined flame trap to be installed at the base of the vent stack to isolate H2 from air entering the stack As site will be unmanned for periods a level transmitter will be considered in this package
Balance of Plant	Process Gas (Hydrogen)	1.2.5	Review the best location for ESD valve isolating H2 supply from GTs. Consider two ESD valves, one on the supply to each generator.	AECOM	1	Verify	No	Closed. ESDs (90QJH01AA218KA01 and 90QJH01AA216KA01) for each GT should be located at the start of the branch lines to each GT so the ESD closure is only to the GTG with the problem so a GT running normally is not affected by the other's abnormal operation Note has been added re location in the P&ID (i.e. minimise distance from the tee to ensure these will be installed at the start)
Balance of Plant	Process Gas (Hydrogen)	1.2.6	Review requirement for remote line depressurising in event ESD valves closing.	AECOM	1	Verify	No	Closed. H2 line depressurisation is a last resort action and should not be carried routinely for a GT shutting down as the gas supply is continuously required for topping up each generator. Venting the line down risks introducing air and water vapour into the H2 gas line with associated explosion risk. Additionally it may risk expensive damage to the GTG internals in the presence of CO2 and water vapour.
Balance of Plant	Process Gas (Hydrogen)	1.2.7	Hydrotest only to be done up to removable spool for each generator. Procedures for testing to prevent water being carried into the generator.	SNOWY HYDRO	2	Firm	Yes	
Balance of Plant	Process Gas (Hydrogen)	1.2.8	Advise MHI of distance between process gas area and generator at each unit. MHI to advise whether pressure increase is acceptable for the pressure reduction panel.	AECOM	1	Firm	No	Closed. Distance has been advised in Aconex AEC-ANZ-RFI-000199. Question was asked about increasing PRV setting from 700 kPag to 800 kPag. Meeting 16-9-22. MHI will review. MHI said it was not likely to be a problem
Balance of Plant	Process Gas (CO2)	1.3.1	Review requirement for NRV in system.	AECOM	1	Verify	No	Closed. Additional check valves to be installed immediately downstream of the first fixed pipework isolation valve (32NB)
Balance of Plant	Process Gas (CO2)	1.3.2	Review piping spec to ensure piping downstream of the PRV and inside the CO2 high pressure regulating panel is designed for maximum pressure supplied by cylinders.	AECOM	1	Verify	No	CO2 System on Hold. Pipework from the cylinders to be rated for 200 Barg CL1500 to allow for HP PRV failure or leakage. From the 800 kPag PRV the weight of pipe can be reduced to CL600 as there is adequate protection from two LP PSVs Spec breaks in P&ID to show this? WBM - Yes, but note there is an error in the original comment as CO2 pressure in the cylinders reaches a maximum of only 65barg on a hot day The process gas facility and associated high pressure components to be provided within Vendor scope. This will include complete process design according to duty specification for Process Gas Facility (HPP-AEC-MEC-PA-GEN-SPT-3961). The supply includes mechanical design including strength calculation for all pressure parts, detailed design analysis for attachments, supports, setting bolts, etc. (HPP-AEC-MEC-PA-GEN-SOW-3960). A HOLD has been added to the P&ID "Pipe classes for high pressure piping are to be finalised with supplier".
Balance of Plant	Process Gas (CO2)	1.3.4	Review method for getting CO2 cylinders from under roof cover (when cylinder packs are being replaced).	AECOM	1	Verify	No	CO2 system on HOLD. CO2 cylinders will be racked and the racks are designed to be handled by fork hoists,,, hiab lifts or craned. Building roof line of covering building must be high enough to allow fork hoist access. Where is this documented to make sure that this happens? It is not, still awaiting further information before
Balance of Plant	Process Gas (CO2)	1.3.8	Is an emergency activation of CO2 purging required? (i.e. can this wait until an operator is present which maybe an hour later) To be confirmed in the MHI HAZOP. MHI to review operating manual and confirm.Emergency venting of CO2 on the MHI Malco panel upstream of the generator.If there is a fire is venting of the Hydrogen and purging with CO2 for the generator required.CO2 is added to the generator via manual valves (no automated valves)	MHI	1	Study	No	
Balance of Plant	Process Gas (Nitrogen)	1.4.1	Review requirement for N2 supply to the NG equipment and other areas on the Balance of Plant. Confirm whether forklifts can be used to take N2 bottles to the BOP when needed.	AECOM	1	Verify	No	Closed. There is no cover at process gas area. Adequate forklift access provided around the gas bottles / cylinder packs
Balance of Plant	Process Gas (Nitrogen)	1.4.2	Review piping spec to ensure piping downstream of the PRV and inside the N2 high pressure regulating panel is designed for maximum pressure supplied by cylinders	AECOM	1	Verify	No	Closed. Piping material spec conforms with pressure stated in PIDs The process gas facility and associated high pressure components to be provided within Vendor scope. This will include complete process design according to duty specification for Process Gas Facility (HPP-AEC-MEC-PA-GEN-SPT-3961). The supply includes mechanical design including strength calculation for all pressure parts, detailed design analysis for attachments, supports, setting bolts, etc. (HPP-AEC-MEC-PA-GEN-SOW-3960). A HOLD "Pipe classes for high pressure piping are to be finalised with supplier" has been added on P&ID
Balance of Plant	Process Gas (Nitrogen)	1.4.6	Review method for getting N2 cylinders from under roof cover (when cylinder packs are being replaced).	AECOM	1	Verify	No	Closed. There is no cover at process gas area. Adequate forklift access provided around the gas bottles / cylinder packs
Balance of Plant	Process Gas (All)	1.5.3	Review requirement for separation bollards between H2 trailer and reduction panels.	AECOM	1	Verify	No	Closed. Bollards are included
Balance of Plant	Process Gas (All)	1.5.4	Talk to BOC about changeover of the H2 trailers and timing of delivery.	SNOWY HYDRO	2	Study	No	
Balance of Plant	Process Gas (All)	1.5.4	Look at possibility of providing two trailer parking spaces next to each other to allow for easier changeover with one prime mover.	AECOM	1	Consider	No	Closed. Two H2 trailer parking areas have been provided for in the design. Equipment and building locations have been adjusted as required to suit min clearance needs.
Balance of Plant	Process Gas (All)	1.5.5	Review if any barricade are required for the H2 vent area.	AECOM	1	Verify	No	Closed. Fence has been included to separate the H2 storage area and vent stack from the other area
Balance of Plant	Process Gas (All)	1.5.7	O&Ms to be developed	SNOWY HYDRO	2	Firm	Yes	

Balance of Plant	Compressed Air (Instrument)	1.1.1	Confirm hold up time of 5 min of receivers is adequate. Check RFI response from MHI. Confirm all GT air consumptions with MHI.	AECOM	1	Verify	No	Closed. MHI confirmed in the meeting that no specific residence time for the AR on the PI is required so the AR can be reduced in size. Refer to SHL-HPP-MM-000035
Balance of Plant	Compressed Air (Instrument)	1.1.2	Review the lead/lag control by doing a setback in the control system.	AECOM	1	Verify	No	Closed. Control philosophy and Instrument Air Compressor package specification has a note that each compressor can be set to run an equal amount of time during the week to limit excessive running of one compressor.
Balance of Plant	Compressed Air (Instrument)	1.1.4	Confirm there is an automatic system for removing water level in air knock out drum downstream of the compressor.	AECOM	1	Verify	No	Closed. Section added to IA package tech spec HPP-AE-ME-CP-IAS-DST-0038 for the KO drum to include automatic drainage
Balance of Plant	Compressed Air (Instrument)	1.1.6	Review the need to provide detailed instrument information from the compressors/dryer packages to the DCS for remote analysis. The aim is to provide enough information as to whether to send an operator to the site after hours.	AECOM	1	Verify	No	Closed. SHL have requested as much information as possible from the OA package to enable a decision to be made about a call out for maintenance. A note has been added to Control Philosophy and IA package specification that All package outputs need to be included in DCS. The DCS shall mimic the status and alarms of the package.
Balance of Plant	Compressed Air (Instrument)	1.1.7	Review specification to check the full range of ambient conditions are covered including wet air so vendor will select the appropriate type of filter.	AECOM	1	Verify	No	Closed. Ambient conditions included in air compressor/dryer packages. Maximum humidity of 100% listed in the tech spec.
Balance of Plant	Compressed Air (Instrument)	1.2.6	Remove low low pressure trips on IA supply lines downstream of air receivers. Leave low pressure alarms. MHI have a low pressure alarm on instrument air system. On the GT there are 3 bleed valves that are kept shut. If the air pressure drops the air valves open and the GT trips.	AECOM	1	Firm	No	Closed. PID updated to remove the trips.
Balance of Plant	Compressed Air (Instrument)	1.2.7	Review CEMS IA consumption requirements. Add CEMS usage to IA consumption calculation if a large IA consumption is required.	AECOM	1	Verify	No	Closed. Confirmed with CEMS supplier that there is no large IA use expected. If purge air is required for the CEMS and there is insufficient IA available, purge blowers can be supplied that mount in the stack to supply this air. 8 Nm3/h of air has been allowed for each CEMS in the compressor sizing which should be adequate to cover the IA required by the CEMS unit.
Balance of Plant	Compressed Air (Service Air)	1.3.1	Confirm there is an automatic system for removing water level in air knock out drum downstream of the compressor.	AECOM	1	Verify	No	Closed. Section added to SA package tech spec HPP-AE-ME-CP-IAS-DST-0039 for the KO drum to include automatic drainage
Balance of Plant	Compressed Air (Service Air)	1.3.2	Confirm there is the facility for water removal in the evaporator in package.	AECOM	1	Verify	No	Closed. Section added to SA package tech spec HPP-AE-ME-CP-IAS-DST-0039 "The dryer should have a drain or facility of water removal to remove unwanted water in the compressed air stream"
Balance of Plant	Compressed Air (Service Air)	1.3.3	Review the need to provide detailed instrument information from the compressors/dryer packages to the DCS for remote analysis. The aim is to provide enough information as to whether to send an operator to the site after hours.	AECOM	1	Study	No	Closed. A note has been added to Control Philosophy and IA package specification that All package outputs need to be included in DCS. The DCS shall mimic the status and alarms of the package.
Balance of Plant	Compressed Air (Service Air)	1.3.4	Review the lead/lag control by doing a setback in the control system.	SNOWY HYDRO	1	Verify	No	
Balance of Plant	Compressed Air (Service Air)	1.3.5	Review specification to check the full range of ambient conditions are covered including wet air so vendor will select the appropriate type of filter	AECOM	1	Verify	No	Closed. Ambient conditions included in air compressor/dryer packages. Maximum humidity of 100% listed in the tech spec.
Balance of Plant	Compressed Air (Service Air)	1.3.7	Consider common vendor for IA and SA packages to reduce need for multiple service agents.	SNOWY HYDRO	1	Consider	No	CLOSED common vendor confirmed
Balance of Plant	Compressed Air (Service Air)	1.4.2	Confirm with MHI there are NRVs at the fuel module to prevent backflow into the SA system from high pressure purge air.	AECOM	1	Verify	No	Closed. See RFI 117 raised on 9-3-22. MHI have confirmed that the shutoff valves for each system will be open at different times and there is a NRV in the line to the service air. Also the shutoff valve for the service air is failure closed.
Balance of Plant	Compressed Air (Service Air)	1.4.4	Include drainage of water in the long length of pipeline to the GT and also operation during cold temperatures i.e. freezing.	AECOM	1	Firm	No	Closed. Pipe material spec revised to 316SS and P&ID marked up accordingly
Balance of Plant	Compressed Air (Service Air)	1.4.5	Consider using stainless steel for SA pipes.	AECOM	1	Consider	No	Closed. Pipe material spec revised to 316SS and P&ID marked up accordingly
Balance of Plant	Compressed Air (Service Air)	1.4.8	Confirm there is triple redundant pressure indication on instrument and service air purging to the diesel system for pre start condition.	MHI	1	Verify	No	
Balance of Plant	Compressed Air (Service Air)	1.4.9	Review requirement for using individual air receivers on the power island compared to one receiver on the BOP.	AECOM	1	Verify	No	Closed. A single SA receiver at the outlet of the compressor on the BOP is considered sufficient as the SA compressor is sized for the max flow case.
Balance of Plant	Compressed Air (Service Air)	1.4.10	Consider installation of a temporary compressor fittings for attachment of hire compressors for IA and SA.	AECOM	1	Consider	No	Closed. Assume dryer operating and only compressors have failed. Connection point for portable compressor added upstream of the air dryers on one of the IA and one of the SA packages.
Balance of Plant	Compressed Air (All)	1.5.1	See comments	AECOM	1			
Balance of Plant	Compressed Air (All)	1.5.3	Ensure there is access for EWP to remove PSV's for maintenance.	AECOM	1	Firm	No	Closed. Access ladders have been provided to optimise space and footprint requirements; a platform has also been provided for access to the PSVs in 3D model.
Balance of Plant	Compressed Air (All)	1.5.5	Review vessel dimensions to cater for inspection entry and requirement for confined space access.	AECOM	1	Verify	No	Closed. Access hatch on air receivers are DN600 to allow for internal inspection of the vessels included in P&ID and datasheet
Balance of Plant	Water (Service)	1.1.2	Review the requirements for backup water supply in event of loss of water.	AECOM	1	Verify	No	Closed. The SW tank is large enough to run for 10 hours to supply the demin plants and the GT evaporative coolers for 10 hours No rainwater collection is provided by the building designers. Can be added at a later stage if required Backup supply to safety showers is provided by a connection from the SW tank and pumps
Balance of Plant	Water (Service)	1.1.3	Review back up water supply for critical services i.e. safety showers.	AECOM	1	Verify	No	Closed. Backup supply is provided by a connection from the SW tank and pumps. Emergency water tank was removed from scope because it will have similar quality water as the SW tank
Balance of Plant	Water (Service)	1.1.4	Review potential impacts of extreme cold weather event and the impact of small drain lines freezing would have on site operation. Drain lines to be kept short to reduce risk of freezing.	AECOM	1	Verify	No	Closed. Supply line to service water tank is underground a) Water drain lines will be insulated. b) SW P&IDs marked up with a note to keep the drain lines short.
Balance of Plant	Water (Service)	1.1.5	Consider underground PE piping to safety showers and whether a heater is required in winter.	AECOM	1	Consider	No	Closed. Safety showers underground piping H1 spec used.
Balance of Plant	Water (Service)	1.1.6	Construction partner to check the Snowy hydro standard for labelling pipeline and label pipes after construction and before commissioning.	SNOWY HYDRO (UGL)	2	Verify	No	
Balance of Plant	Water (Service)	1.1.7	Add a sampling point to potable water line downstream of the site water meter and upstream of the service water tank. Consider facility for potable water lines to be flushed through into the service water tank to replace aged water in the line with fresh water. Potable water to be tested at periodic times as specified by SH.	AECOM	1	Firm	Yes	Closed. Sampling point has been added downstream of the metering station. A note has been added to drain and flush the line to replace aged water.

Balance of Plant	Water (Service)	1.2.1	Review tank outlets/connections - all nozzles to be fitted with valves for isolation	AECOM	1	Firm	No	Closed. Isolation valves shown on instruments. Other tank nozzles already show isolation valves. There is no isolation valve required for inlet line downstream of the fill valve as it is top entry with breathing hole. Included on/off valve upstream of LV and added one gate valve and one RPZ valve downstream.
Balance of Plant	Water (Service)	1.2.2	Replace level switch (LS/LAHH) with another LT because of critical service of tank and add HH to level transmitter.	AECOM	1	Firm	No	Closed. LAHH LS changed to LT
Balance of Plant	Water (Service)	1.2.3	Confirm tank paint internals on datasheet is compatible with anti-algacide chemicals	AECOM	1	Verify	No	Closed. Material spec galvanised carbon steel. Biocide package is deleted from scope as algae growth is not expected to grow without a light source inside a dark tank
Balance of Plant	Water (Service)	1.2.4	Ensure that drains from tank are separated on model as per P&ID.	AECOM	1	Firm	No	Closed. 3D model shows separated drains and overflow as per the P&ID
Balance of Plant	Water (Service)	1.2.5	Review size of hatch on tank roof to facilitate access for diving. Consider 900mm opening.	AECOM	1	Verify	No	Closed. Hatch size on the tank roof has been changed from 600 NB to 900 NB
Balance of Plant	Water (Service)	1.2.6	Confirm that there are facilities to install a barriers around hatch.	AECOM	1	Verify	No	Closed. Tank Datasheet includes hatch with lockable catch and removable safety screen with 1.5kN strength
Balance of Plant	Water (Service)	1.1.8	Consider isolation immediately after HW metering facility to allow ability to maintain downstream valves.	AECOM	1	Consider	No	
Balance of Plant	Water (Service)	1.3.3	Confirm timing of third forwarding pump starting and affecting GT operation. Provide buffer time in evaporative cooler tank at GT.	MHI	1	Verify	Yes	
Balance of Plant	Water (Service)	1.3.6	Review use and quantities of portable chemical injection package. Check the quantities of chemicals in this package are kept under the DG minor storage thresholds.	AECOM	1	Verify	No	Closed. Algae will not grow in a dark tank the SW is unlikely to require dosing with additional chemicals. Package can be brought to site on a temporary basis for dosing if required. Dosing point will be kept on PID
Balance of Plant	Water (Service)	1.3.7	Review the requirements for pressure indicator upstream of kickback PCV in minimum pump flow line.	AECOM	1	Verify	No	Closed. PT and PI added upstream of the PCV
Balance of Plant	Water (Service)	1.3.8	Review methods for smoothing or minimising the number of pumps starts. Contemplate scenario of leakage and no other flow. Consider whether an accumulator or jockey pump is required for small flows.	AECOM	1	Verify	No	Closed. SH agree with use of a jockey pump. A jockey pump has been added to the P&IDs.
Balance of Plant	Water (Service)	1.3.8	Check if there is a signal from the GT whether the evaporative cooler is operating and the need for 1 or 2 pumps operating.	MHI	1	Verify	No	
Balance of Plant	Water (Demin)	1.4.1	Review potential to provide direct connection from potable water supply upstream of service water tank to demin package.	AECOM	1	Verify	No	Closed. Minimum pressure required for Demin package is 200 kPag. Consider if flow is restricted to the demin plant when filling the FW tanks. Pressure drop to be calculated if supply line pressure is adequate. P&IDs have been updated - demin water package water supply upstream of the service water tank.
Balance of Plant	Water (Demin)	1.4.2	Measured values and alarms from demin package PLC to be available for mimic on the DCS for monitoring remotely by operators.	AECOM	1	Firm	No	Closed. PLC based skid The DCS will mimic the status and alarms of the demin plant skid DCS will have supervisory control over the skid Note added to P&IDs and Control Philosophy to include all package outputs in DCS. Redundant communication connection has been specified to the demin plant. SH have confirmed that they want all the information from the demin package to allow remote analysis on whether a call out is required.
Balance of Plant	Water (Demin)	1.5.1	Review requirements for duty/standby pumps within the packages or requirement to keep uninstalled spares. Alternatively, increase capacity of package to 55m3/h which removes the need for 2 packages to operate simultaneously to supply demin for 3 days continuous operation of GT on diesel.	AECOM	1	Verify	No	Closed. It is usually not practical to source demin water from outside sources. However, facilities have been provided to fill the demin tank from a tankers. Both packages can run simultaneously to supply demin water if the level is low.
Balance of Plant	Water (Demin)	1.5.5	Notify the RO vendor of potential biocide use in the water supplied to demin package. Include in demin package specification.	AECOM	1	Firm	No	Closed. Vendor package specification has been updated
Balance of Plant	Water (Demin)	1.5.6	Notify the vendor that demin plant may not be used for long periods of time. Confirm demin plant can cope with periods of standby.	AECOM	1	Firm	No	Closed. Demin water will require polishing. Demin plant will be run for a few hours a day to upkeep system (as per other SH plants). Added a note in technical specification that package should include recirculation and flushing system in case of idle periods
Balance of Plant	Water (Demin)	1.6.1	Include two level transmitters instead of a LSH and LT.	AECOM	1	Firm	No	Closed. LSH changed to LT
Balance of Plant	Water (Demin)	1.6.2	Review the overflow discharge location based on pH of demin and relocate to trade waste.	AECOM	1	Verify	No	Closed. P&IDs marked up to show all drains to go to neutralisation pit
Balance of Plant	Water (Demin)	1.6.3	Review the possibility of CO2 filter (on tank vent) blocking and causing tank to be under vacuum.	AECOM	1	Verify	No	Closed. SH confirmed they prefer not to have N2 blanketing - SH prefer a CO2 filter rather than N2 blanketing CO2 filter can be installed at ground level for ease or replacement and have duty / stand by arrangement CO2 filter to be supplied with vendor for Demin tanks. JD: As per item 16 of technical clarification for the Demin tank with Supplier HPP-AEC-MEC-DW-SFP-ERS-0001_B, vendor has confirmed that tank venting system will be designed and finalised considering the pressure drop for CO2 absorber.
Balance of Plant	Water (Demin)	1.6.4	Review location of tank drains from storm water to trade waste	AECOM	1	Verify	No	Closed. P&IDs marked up to show all drains to go to neutralisation pit
Balance of Plant	Water (Demin)	1.6.6	Review size of hatch on tank roof to facilitate diving access. Consider 900mm opening	AECOM	1	Verify	No	Closed. SH commented they would put a RO camera into the tank in preference to a person Hatch size on the tank roof changed to 900 NB
Balance of Plant	Water (Demin)	1.6.7	Confirm that there are facilities to install a barrier around hatch and locking facility.	AECOM	1	Verify	No	Closed. Tank Datasheet includes hatch with lockable catch and removable safety screen with 1.5kN strength
Balance of Plant	Water (Demin)	1.6.8	Review tank outlets/connections - all nozzles to be fitted with valves for isolation.	AECOM	1	Verify	No	Closed. Isolation valves shown on the instrumentation nozzles as well (All other tank inlets and outlets already show an isolation valve). No isolation valve added to the overflow nozzle
Balance of Plant	Water (Demin)	1.7.1	Confirm if one pump is lost there is sufficient time for another pump to turn on before the flow switch trips the GT.	AECOM	1	Verify	Yes	Closed. Minimum pressure for low PS is 30 kPa and PS has a delay of 4 seconds. A PCV has been added at the demin pump suction to maintain the pressure. SH accepts this solution
Balance of Plant	Water (Demin)	1.7.1	Confirm if one pump is lost there is sufficient time for another pump to turn on before the flow switch trips the GT. RFI to be raised to MHI.	MHI	1	Verify	No	

Balance of Plant	Water (Demin)	1.7.3	Consider bypass line around MHI orifice plate to facilitate commissioning.	AECOM	1	Consider	No	Closed. Connecting drawing to be marked up accordingly
Balance of Plant	Water (Demin)	1.7.3	Consider bypass line around MHI orifice plate to facilitate commissioning. Raise an RFI to MHI.	MHI	1	Consider	No	
Balance of Plant	Water (Demin)	1.7.4	Review potential to install automated valves on lines from forwarding pumps to demin treatment package for polishing and demin distribution to allow remote switchover between lines. Add polishing sequence to DCS to allow for remote operation.	AECOM	1	Verify	No	Closed. The pump is not sized to do both polishing and supplying water to the GT. Mode of operation to be selected by changing position of automated valves a) To be confirmed with SH if valves are to be actuated. b) Polishing sequence has been added to the control philosophy.
Balance of Plant	Water (Demin)	1.7.6	Review requirement of pressure indicator upstream of PCV.	AECOM	1	Verify	No	Closed. PT with a PI added upstream of the pressure regulator
Balance of Plant	Water (Demin)	1.9.1	Chemicals and the dosing will be proposed by a water treatment vendor as required by the system. Check there is indication for low levels of chemicals	AECOM	1	Verify	Yes	Closed. Included in the vendor package specification that there are instruments for low level of chemicals
Balance of Plant	Water (Demin)	1.9.2	Confirm if automated valves are not in position and there is an output into the DCS to show this. Confirm with package supplier if these valves are interlocked.	AECOM	1	Verify	No	Closed. Included in the vendor package specification that output of automated valves to trade waste to have an output that can be monitored and alarmed. P&ID -1059 a note has been added to show position indication on the XVs 90GCB01AA962 AND 90GCB01AA043 in DCS.
Balance of Plant	Water (Service and Demin)	1.10.1	Raise RFI to SH to confirm stainless steel grade required (304 or 316).	AECOM	1	Firm	No	Closed. AECOM piping is specified as 316. MHI has put 304 SS on their PIDS for Demin water lines/ equipment 316 is more expensive than 304 SS SH confirmed 316 SS is acceptable and has been specified in PMS
Balance of Plant	Water (Service and Demin)	1.10.3	Determine desired system response in emergency shutdown (from safety perspective). Apply this to all subsystems. Provide a list of impacts of any system shutdowns on ability of GT to operate.	AECOM	1	Study	Yes	Closed. Demin package stoppage does not stop GT Apply this to all subsystems
Balance of Plant	Water (Service and Demin)	1.10.4	Review location of all demin drains to ensure they all go to neutralisation pit.	AECOM	1	Verify	No	Closed. P&IDs marked up to show all drains to go to neutralisation pit
Balance of Plant	Fire Water	1.1.5	Update critical valves to be locked open e.g. for valves on fire fighting system (Show on P&ID).	AECOM	1	Firm	No	Closed. Discussion was referring about whether the drain valves on the FW tanks should be locked closed. Fire water supply line valves within the HW metering skid, 90GKB01AA205 and 90GKB01AA008 marked up as locked open (LO)
Balance of Plant	Fire Water	1.1.6	Confirm the pressure drop to the tank and flowrate meet the requirements of AS2419.	AECOM	1	Verify	No	Closed. The worst-case firewater demand scenario was identified following NFPA 15 deluge demand methodology (More conservative than AS2419.1). The maximum demand for the fire pumps is 11,600 L/min. For more details refer to the HPP-AEC_MEC-FP-GEN-REP-0001 Fire Safety Study report. As per AS2419, the minimum filling rate of 5.8 l/s (21 m3/h) is required to fill one of the tanks in 24 hours, while the system has been designed to fill the tanks with 20 l/s (72 m3/h) which is the maximum supply rate to the site. The piping is large enough to fill the tanks in the required time to satisfy AS2419.
Balance of Plant	Fire Water	1.1.7	Review requirement for nozzle fill point on tanks for emergency tank filling by tanker.	AECOM	1	Verify	No	Closed. A 100 NB spare nozzle N15 has been provided as shown on P&ID -1070. As per the Fire Safety Study report HPP-AEC_MEC-FP-GEN-REP-0001, the two firewater tanks will be designed and constructed in accordance with AS 2304 Water storage tanks for fire protection systems.
Balance of Plant	Fire Water	1.1.8	Confirm that RFS connection standards are met.	AECOM	1	Verify	No	Closed. The facility will have two water tanks storing potable and one tank for demineralised water, each of 1,700 m3 working capacity, which NSW RFS will be able to access in the event of responding to a local bushfire event. A spare nozzle has been provided on each tank with a valve and blind flange (for dust protection of the valve internals). The facility will have an adapter that can be fitted to this nozzle that is then suitable for NSW RFS to connect to. Refer to the Fire Safety Study report.
Balance of Plant	Fire Water	1.1.9	Review need for sample point on firewater system. Review best location for sample point i.e. one on each tank or upstream of fire water pumps.	AECOM	1	Verify	No	Closed. SH prefer the ability to sample from each tank. Sample point added on each tank
Balance of Plant	Fire Water	1.1.10	Review access provisions through tank liner and manhole access.	AECOM	1	Study	No	Closed. Standard Fire water tank design as AS2304 specified. Liner will not restrict access for inspection during maintenance
Balance of Plant	Fire Water	1.1.12	Review tank outlets/connections - all nozzles to be fitted with valves for isolation.	AECOM	1	Verify	No	Closed. Isolation valves shown on instrumentation and added downstream of LCVs, relief discharge lines and balance line
Balance of Plant	Fire Water	1.1.13	Confirm tank bladder is compatible with biocides that may be required for water treatments.	AECOM	1	Verify	No	Closed. The fire water tank is not expected to be dosed with algaecides as algae does not grow in dark conditions
Balance of Plant	Fire Water	1.1.14	Provide description of how the auto fill valve will be maintained, isolated and bypass used.	AECOM	1	Firm	No	Closed. Upstream isolation valve has been added to the PID 1070 for both FW tank autofill valves to avoid the need to drain large quantities of water. Description added to Basis of design to describe the reasons why the valve was added e.g. for maintenance of the autofill valve
Balance of Plant	Fire Water	1.2.1	Review the potential to provide auto fill from site diesel storage tanks to the smaller diesel tank near diesel driven firewater pump. If diesel tank for pump is filled manually consider manual handling requirements of how this tank is filled.	AECOM	1	Verify	No	Closed. Diesel tank for FW pump is too far away from diesel area so the diesel tanks will be manually filled. Snowy Hydro to consider handling requirements
Balance of Plant	Fire Water	1.2.2	Add locked open valve on relief line. Review AS2941 to see if this is permitted	AECOM	1	Firm	No	Closed. Valves marked up as locked open. AS2941 to be reviewed
Balance of Plant	Fire Water	1.2.3	Review the position of balance line to minimise potential of silting in line. Confirm height of line above tank	AECOM	1	Verify	No	Closed. Valves marked up as locked open. AS2941 to be reviewed
Balance of Plant	Fire Water	1.2.6	Review battery system monitoring alarm interface with DCS for monitoring.	AECOM	1	Verify	No	Closed. Battery Charger Supply failure has been added to the FW pump data sheet and will alarm to the DCS
Balance of Plant	Fire Water	1.2.7	Review where the outlet of TRV on firewater pump outlet is to be directed and select a suitable location.	AECOM	1	Verify	No	Closed. P&ID marked up with "safe location" to be determined in 3D model

Balance of Plant	Fire Water	1.2.8	Review the potential for embers and overloading the air intake system in the event of a bushfire.	AECOM	1	Verify	No	Closed. The firewater tanks provide water to fire pumps. The fire pumps are 100% duty and standby arrangement and in accordance with AS 2941. The will be two diesel driven pumps with one designated as the duty pump and the other as the standby pump. Both pumps are housed in a dedicated Fire Pump Room located adjacent to the fire water tanks and fire appliance hardstand for accessing the tanks suction and system booster assemblies. Air intake in the bushfire scenario has a very low risk of being compromised.
Balance of Plant	Oily Water	1.3.4	Review management of algae in pit. Include in package spec and discuss potential options with vendors.	AECOM	1	Verify	No	Closed. As per current design there is a roof shelter (open sides) over the oily water pit, however this will not prevent sunshine into the pit content and there will be a chance of growing algae. The oily water vendor has not been finalised yet, however in current offer there is coarse filter in the package to capture the large debris and algae. The filter has easy access for cleaning purpose. PDT with High alarm will be added to warn operators to clean the filter. Since there is no continuous source for this pit, we expect to have dry pit for most of the days so algae growth is not expected to be an issue
Balance of Plant	Oily Water	1.3.6	Review use of stairs instead of ladder into pit. Look at removable type of stairs to prevent fouling of stairs.	AECOM	1	Verify	No	Closed. Pit to be maintained annually. An embedded steel rung ladder will be installed for emergency access in and out of the pit. More accessible means for planned entry to the pit have been assessed as outlined below and would be provided in addition to the emergency fixed steel rung ladder. Stairs Stairs offer a viable solution as they provide safe access for both levels of the oily water pit by incorporating a landing for the upper level. The potential ability for the stairs to be hinged at the upper point and be lifted clear of the oily water when not in use is being investigated. This would limit plant growth on the stairs and contact with oily water.
Balance of Plant	Oily Water	1.3.7	Review requirement for isolation of incoming drains to allow access to pit to provide correct isolation.	AECOM	1	Verify	No	Closed. Inlet valve to be provided and access permit to pit to specify that valve is closed as a condition of entry Structural Dwg No : HPP-AEC-CIV-ST-BPS-DRG-5650
Balance of Plant	Oily Water	1.4.1	Confirm interface of package with DCS. Determine what information needs to be transferred to DCS.	AECOM	1	Verify	No	Closed. Interface with DCS is highly dependent on type of package and equipment inside. For the current selected package the signals would be (to be finalised by vendor): Start/Stop, Status, Common Alarm/Fault, LAH on Decanting tank PDAHH on coarse filter and Recycle valve Status. Added to package Specification.
Balance of Plant	Oily Water	1.4.3	Confirm if piping between filter and pumps and filter is designed for a vacuum conditions.	AECOM	1	Verify	No	Closed. Will be finalised by manufacturer Added to package Spec.
Balance of Plant	Oily Water	1.4.4	Vendor supplier to confirm if oil water separator does not operate for a period of time what (if any) effects this would cause on the reliability of the unit. Specification of package to include mention of extended periods on downtime.	AECOM	1	Verify	Yes	Closed. Separator package may need to be run when not required to keep all equipment working properly. Will be finalised by manufacturer. Added to package Spec.
Balance of Plant	Oily Water	1.4.5	Review potential impacts of winter operation. Include in specification that unit needs to operate during low ambient conditions	AECOM	1	Verify	No	Closed. Will be finalised by manufacturer. Added to package Spec to follow project winterisation philosophy.
Balance of Plant	Oily Water	1.4.6	Review the operational area of the skimmer pit. Consider sloped floor on main pit to concentrate sludge for ease of cleaning and allow oil/ water to be diluted.	AECOM	1	Verify	No	Closed. Pit is provided with sloped floor and the inlet is 300mm above the base of pit to allow for sediment/sludge build up. Operational pump stop float switch is 300mm above pit base so that sludge does not enter oily water separator. Periodic maintenance is completed by vacuum truck that will suck sludge from base of pit. Maintenance to be completed regularly to limit sludge build up.
Balance of Plant	Oily Water	1.4.8	Ensure vent location is at an adequate height to disperse any hazardous vapours.	AECOM	1	Verify	No	Closed. Will be finalised by manufacturer. Added to package Spec.
Balance of Plant	Oily Water	1.5.1	Review oil and diesel vent points in the GT area to ensure no diesel can flow to the stormwater discharge point. All oil vents to drain to oily water system with concrete apron.	AECOM	1	Verify	No	Closed. The MHI PIDS were reviewed for vents that could release to the atmosphere. All drain from the fuel oil system either drain to the Fuel oil tank or the oil drain pit. The vent on the fuel oil drain tank vents to an elevated vent 12-15m high with an oil catch pot arrangement to capture small droplets of oil. There is an 100mm overflow on the drain tank that overflows to the oily drain pit (refer to MHI PIDS A-21041/2/3/4/5/6-C) IL: All the stormwater must pass through HumeCeptor which has over 4000 litres of oil containment capacity. Any diesel that bypass OWS inlet will be captured by HumeCeptor
Balance of Plant	Oily Water	1.5.2	Review requirements for capture during construction for containment of drainage carryover. To be reviewed in CHAIR.	AECOM	1	Study	No	Closed. Transfer to CHAIR workshop

Balance of Plant	Oily Water	1.6.1	Confirm if oily water system is considered in fire safety study.	AECOM	1	Verify	No	Closed. Yes, it has been considered and regarded as a low consequence risk. Sources of oily water, where there is a credible fire risk have a flame trap at the entry to the oily water drain included in the design. There are no sources of flammable liquid connected to the oily water system, only combustible liquids and oils drained into the oily water pit will be cool or cooled by the water in the pit which is a significant heat sink for the oil. As a combustible liquid these oils do not have a significant vapour above their surface making them difficult to ignite; however, ember attack might cause flame pockets. It is expected such flame pockets would be quenched by the bulk temperature of the compartments in the oily water system. It was considered that the oily water pit is well-separated from other infrastructure and a fire in the oily water pit does not represent a damage risk to other site infrastructure. Damage to equipment and structures in the oily water pit is considered to have very low impact. The density of ember attack, hence heating density, is reduced by the planned roof over the oily water pit system. The entire area of the oily water pit will be accessible with firewater hydrant hoses. After considering the likelihood and consequence no increased fire protection is considered justified.
Balance of Plant	Oily Water	1.6.2	Review the requirement for monitoring of fire traps liquid level and regular maintenance of fire traps.	AECOM	1	Verify	Yes	Closed. David Lockley has provided a flame trap assessment which indicated risk of fire explosion is negligible as concentration of flammable gas is not sufficient for ignition. Temperature of diesel/oily gas not sufficient to ignite.
Balance of Plant	Oily Water	1.6.3	Review potential to install a smaller initial volume within decanting pit for concentrated spills. Consider interface level detection. Review requirement for detection of high-level oils in the observation pit and how this can be achieved.	AECOM	1	Verify	No	Closed. a)The inlet of the main oily water pit contains a deeper section where the floating weir oil skimmer floats on the surface and skims the highest concentration of oil for concentrated spills. The skimmer and OW package operation will be activated by a level switch. Interface detection would not work well in the incoming pit because of significant water level differences. c) Oil/water interface instrument is shown on PID HPP-AEC-MEC-GN-GEN-DRG-1085. Specification for Oily water package has a note added HPP-AEC-MEC-DS-PFS-DST-0036 "The vendor to propose a facility/instrumentation to detect the oil presence at the outlet side of the system in the observation pit in order to switch the package operation shut down the package to decrease the chance of oil escape to clean storm water system."
Balance of Plant	Oily Water	1.6.3	Review operational response to a high-level oil in the decanting pit.	SNOWY HYDRO	1	Study	Yes	
Balance of Plant	Oily Water	1.6.4	Review location of humeceptor in location to highest flood level.	AECOM	1	Verify	No	Closed. The 1 per cent AEP flood level is 9.73 mAHD and the Probable Maximum Flood (PMF) level is 11.71 mAHD (WMAwater, 2010). HumeCeptor outlet invert is 9.99 mAHD so slightly above the 1% AEP Level. In the PMF the outlet is below PMF level, however the flow is from the site to the watercourse so HumeCeptor functions normally. HumeCeptor cannot be raised and capture all site flows, and is above 1% AEP (100yr) level so considered acceptable. No action required
Balance of Plant	Oily Water	1.6.6	Seek further guidance from SH environmental team on whether a penstock valve is required on humeceptor discharge line to the environment.	SNOWY HYDRO	1	Verify	No	
Balance of Plant	Trade Waste & Sewer	1.1.1	Confirm final pit volume is sufficient to contain all the flows from blade washing and closed loop cooling water volumes.	AECOM	1	Verify	No	In progress of being closed. Evaporative cooler blowdown water currently drains to the neutralisation pit downstream of the blade wash pit so is not taken into account in the pit sizing. Offline water maximum water volume with detergent is 1.5m3 (without detergent, maximum volume is 1 m3). Blade washing water does not meet Trade waste specification. Will be removed by truck During on-line washing there is no water drained from the exhaust duct. Current proposal is for 5 m3 pit volume so risk of overflow is negligible. Operations could also provide a vacuum truck during offline washing to further safeguard the environment. During on-line washing there is no water drained from the exhaust duct. Water/air temperature draining out is 525 deg C so piping is designed for 525 deg C. Tank will most likely be concrete. Frequency is more often (TBC) so sizing of the tank will be finalised after information is available.
Balance of Plant	Trade Waste & Sewer	1.1.3	Determine if the blade washing water with detergent can be disposed to the trade waste (HWC criteria for maximum concentration). When detergent is used for off-line blade washing (approx. once a year) the GT compressor wash pit should be isolated and removed by sucker truck. Test the blade wash water after commissioning to check analysis meets HWC criteria for trade waste.	AECOM	1	Study	Yes	Closed. Blade washing with detergent is likely to be infrequent (once a year). MHI confirmed that detergent is used during off-line blade washing. SH confirmed detergent is used for the best clean to remove residue. The wash water is removed by a truck. Blade washing is a supervised procedure.
Balance of Plant	Trade Waste & Sewer	1.1.3	Confirm the iron concentration in wash water. Is 220 mg/l the normal concentration during off line washing?	MHI	1	Verify	No	
Balance of Plant	Trade Waste & Sewer	1.2.1	Review the neutralisation pit capacity to cater for emergency storage in the event of not having access to pump out to the trade waste.	AECOM	1	Verify	No	Closed According to the Trade Waste Pump Station Design Report there is a total available emergency storage capacity of 64.3 kL including the wet well and neutralisation pit that exceeds the two-hour emergency scenario capacity using the peak inflow of 8.9 L/s

Balance of Plant	Trade Waste & Sewer	1.2.5	Confirm the impacts of chemicals used in demin plant CIP to neutralisation pit. Confirm if the concentration of COD from the CIP chemicals from the demin plant will be suitable for discharge to trade waste or whether removal by tanker is more appropriate.	AECOM	1	Verify	No	In progress of being closed. Awaiting for package supplier design. Volume of CIP water is likely to be small (1-2 m3). HW may sample the waste from time to time. Trade Waste limit on COD is 1500 mg/L. Estimated TDS on reject water is 350~500 ppm based on potable water TDS of 110 ppm and no issue on reject water. In case of high TDS or ions > Hunter spec, it can be diluted in the neutralisation pit or an IBC/drum for demin package neutralisation to be emptied by a truck.
Balance of Plant	Trade Waste & Sewer	1.2.6	Replace local PI with pressure transmitter downstream of transfer pumps to prove there is no damage to HWC trade waste main from the transfer pump. Review best location for this PT to measure discharge pressure.	AECOM	1	Firm	No	Closed. PT with high alarm has been added to the PID at battery limit with the Hunter Water
Balance of Plant	Trade Waste & Sewer	1.2.7	SDV's downstream of the transfer pumps to HWC line to fail closed. SDV's downstream of the transfer pumps returning to pit fail open to prevent dead heading of pump.	AECOM	1	Firm	No	Closed. During discharge to the trade waste both valves can be open to maintain circulation RO moved to the SDV bypass line to have permanent recycle and mixing during the transfer
Balance of Plant	Trade Waste & Sewer	1.2.8	Consider removal of pump with a roof above the pit	AECOM	1	Consider	No	Closed. The roof over the neutralisation pit has been retained in the design and a crawl beam with trolley/chain-block for lifting the pumps out of the pit for maintenance will be provided.
Balance of Plant	Trade Waste & Sewer	1.2.9	Materials of pit to consider acid and caustic dosing. (Epoxy coating).	AECOM	1	Consider	No	Closed Demin Vendor will consider materials for tank The neutralisation of demin "Clean in Place" streams will now be included in the demin package and there will be no dosing of acid and caustic into the pit.
Balance of Plant	Trade Waste & Sewer	1.2.10	Ensure dosing of acid and caustic is located at opposite end of pump suction and adequate recirculation time to ensure good mixing of neutralisation chemicals.	AECOM	1	Verify	Yes	Closed. No longer relevant as there will be no direct dosing into pit.
Balance of Plant	Trade Waste & Sewer	1.3.1	Include either an alarm for continual operation of the pump (or too frequent operation) or investigate other solutions to reduce overdosing (Review requirement for two pH meters for checking that pH is moving in the expected direction).	AECOM	1	Firm	Yes	Closed. The neutralisation of demin "Clean in Place" streams will now be included in the demin package and there will be no dosing of acid and caustic into the pit.
Balance of Plant	Trade Waste & Sewer	1.3.2	Chemicals to be dosed are TBC. If caustic is used potential for freezing in lines needs to be considered. Include in the package specification the range of ambient temperature.	AECOM	1	Study	Yes	Closed. The neutralisation of demin "Clean in Place" streams will now be included in the demin package and there will be no dosing of acid and caustic into the pit.
Balance of Plant	Trade Waste & Sewer	1.3.4	Review the replacement process for the chemicals (tank or drum) and if minimal contact with the chemical for the operator	AECOM	2	Study	No	Closed. Proposed Demin Vendor has been asked to provide the SDS for all chemicals proposed to be used so that SHL can assess and respond appropriately.
Balance of Plant	Trade Waste & Sewer	1.3.7	Consider the type of acid and potential to vaporise. Dilute sulphuric acid is preferred.	AECOM	2	Consider	No	Closed. Proposed Demin Vendor has been asked to provide the SDS for all chemicals proposed to be used so that SHL can assess and respond appropriately.
Balance of Plant	Trade Waste & Sewer	1.3.8	FS is sometimes included in the line downstream of the PSV to indicate the PSV has lifted. Check the vendor package includes this.	AECOM	1	Verify	No	Closed. Dosing will be manually controlled by an operator so the action is no longer relevant
Balance of Plant	Trade Waste & Sewer	1.4.4	Consider providing a sewer connection in temporary. offices/facilities area. Review potential to use temporary toilet blocks on site.	AECOM	1	Consider	No	Closed. Portable toilets are not preferred by SH because of industrial relations issues. Maximum number of people on site is expected to be 50 during a scheduled outage. Consider provision of appropriate temporary facilities, if required, as part of mobilization planning for major outages. A sewer connection has not been included in the design.
Balance of Plant	Trade Waste & Sewer	1.4.5	Alarms from sewerage pit to DCS so operators are aware of high/low level in sewerage pit when no one on site.	AECOM	1	Firm	Yes	Closed. A high high level from the sewage pit will give an alarm in the DCS. HH alarm levels are show on HPP-AEC-CIV-MW-WWS-DRG-2422 and HPP-AEC-CIV-MW-WWS-DRG-2425.
Balance of Plant	Trade Waste & Sewer	1.4.7	Consider odour from the tank and a filter.	AECOM	1	Consider	No	Closed. Usually filters are used on larger municipal facilities. According to the Trade Waste Pump Station Design report: odour release and the build-up of toxic gases such as hydrogen-sulphide was considered in the design. The access covers would provide a seal against egress of gasses, which could cause backpressure on the upstream gravity network and unintended odour release elsewhere on site. A vent pole will be mounted to the adjacent controls and administration building to disperse odour at a 12.5 m height above the finished surface level.
Balance of Plant	Trade Waste & Sewer	1.5.2	Review application of flushing water to the pit and potential to use potable water and a garden hose	AECOM	1	Verify	No	Closed. A connection from service water for flushing purpose has been added to the PID for the sewer pit
Balance of Plant	Trade Waste & Sewer	1.5.4	Confirm noise limits included in the package specifications	AECOM	1	Verify	No	Closed. The pumps are more than 1 km away from residential neighbours. Also, typically these pumps are installed < 10 m away from houses. Therefore, the noise is not an issue and limits have not been specified.
Balance of Plant	Trade Waste & Sewer	1.5.5	Ensure safety shower is no further than 10 m from chemical storage if dosing chemicals are being decanted	AECOM	1	Firm	No	Closed. Location of safety showers positioned as per requirements of AS 4775. Neutralisation of "Clean in Place" streams from demin plants will be done within demin package. There are two safety showers installed at demin package.

Appendix G

Environmental Representative Endorsement Letter

HBI Healthy Buildings International Pty Ltd
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13 December 2022

Isaac Strachan
Health, Safety and Environment Lead
Snowy Hydro Limited
Lot 3, Pier 8/9, 23 Hickson Rd
Walsh Bay NSW 2000

REF: HAZOP

Dear Isaac,

RE: Hunter Power Project HAZOP Report (Rev 1 8th December 2022)

I refer to Snowy Hydro Limited's (SHL) submission of the following document required by Condition B12 (b) of the Hunter Power Project (Kurri Kurri Gas-Fired Power Station) Infrastructure Approval (SSI 12590060) for review and endorsement by the Environmental Representative:

- Hunter Power Project, Snowy Hydro Limited HAZOP Report (Rev 1 8th December 2022)

It is noted that:
- The HAZOP Report has been developed by SHL to provide a summary of the Hazard and Operability (HAZOP) Study performed on the Project detailed design and to satisfy Condition B12 (b) of the Infrastructure Approval.
- As required by Condition B12 (b), the HAZOP study was chaired by a qualified person independent of the development, approved by the Secretary and contained a program for the implementation of the recommendations from the study.
- The ER review did not undertake a technical review of the Hazard and Operability Study findings or the HAZOP Report.
- Following ER review, the document is considered to be consistent with requirements of B12(b).

Notwithstanding the above, as the approved Environmental Representative for the Hunter Power Project (Kurri Kurri Gas-Fired Power Station) and as required by Conditions A23(a), the HAZOP Report (Rev 1 8th December 2022) is endorsed for submission to the Secretary for consideration and approval.

Snowy Hydro Limited and their contractors must continue to obtain and comply with any relevant approval, licence or permit required for the works; complying with relevant Conditions of Approval as they relate to the works; and appropriate notifications being issued prior to the works.

Yours sincerely

Greg Byrnes
Environmental Representative – Hunter Power Project (Kurri Kurri Gas-Fired Power Station)