



Process Safety driving Asset Management

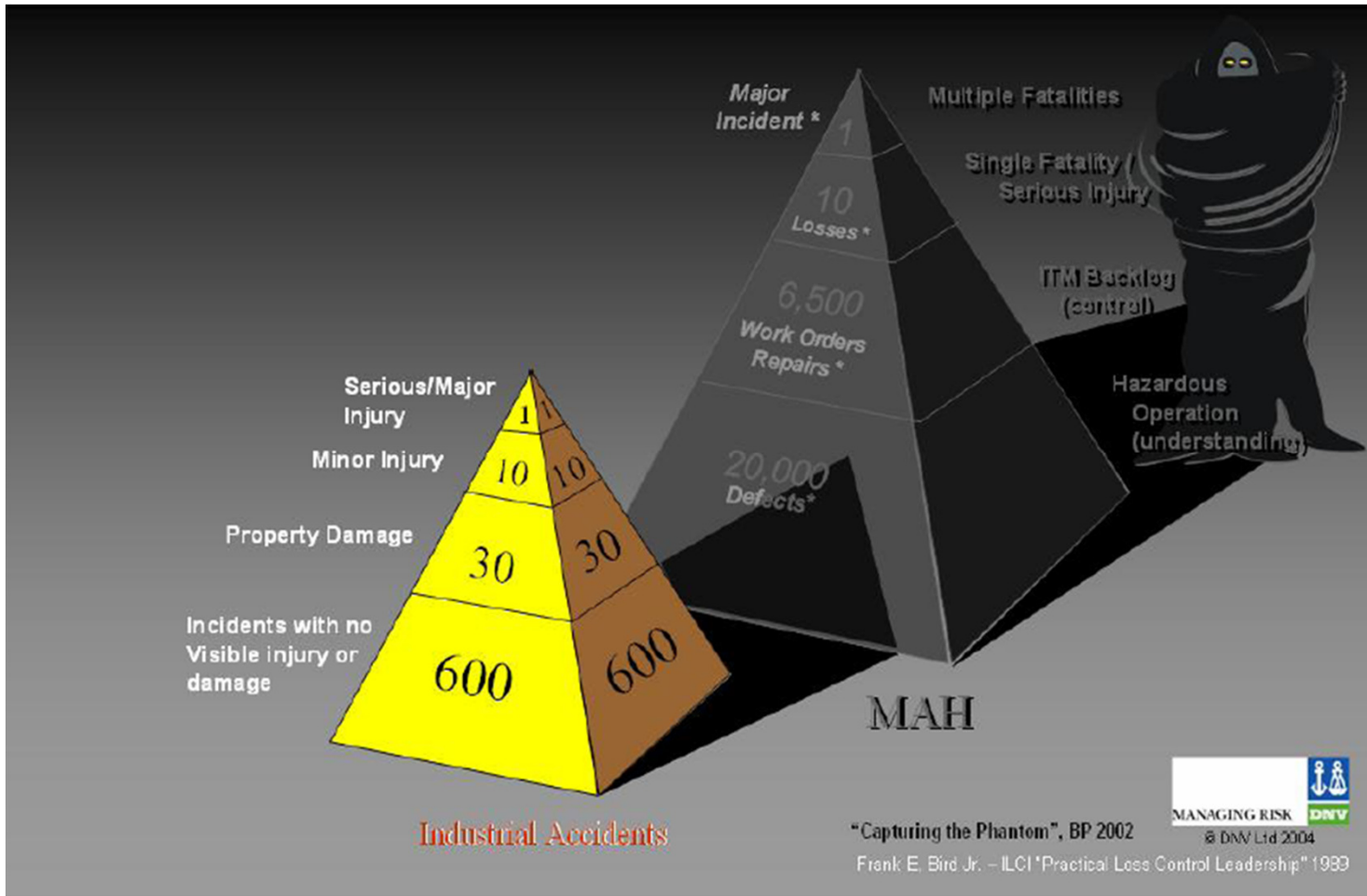
EEA AM Forum – 20th June 2017

Dave Moore
Engineering, Projects & Contracts Manager



What is Process Safety?

The Monster in the Cupboard...



Process Safety Methodology



- Process Safety is an internationally proven framework for **identifying the risks** of major accident hazards (e.g. explosions, flooding) resulting from significant plant failures
- Methodology **integrates** both the swiss cheese and risk models such as bowties
- It **collects data** on the risk barriers and provides **daily visibility** of their performance to the whole organisation and clearly indicates the **priority areas** for action



Process Safety Questions



Key Performance Indicators

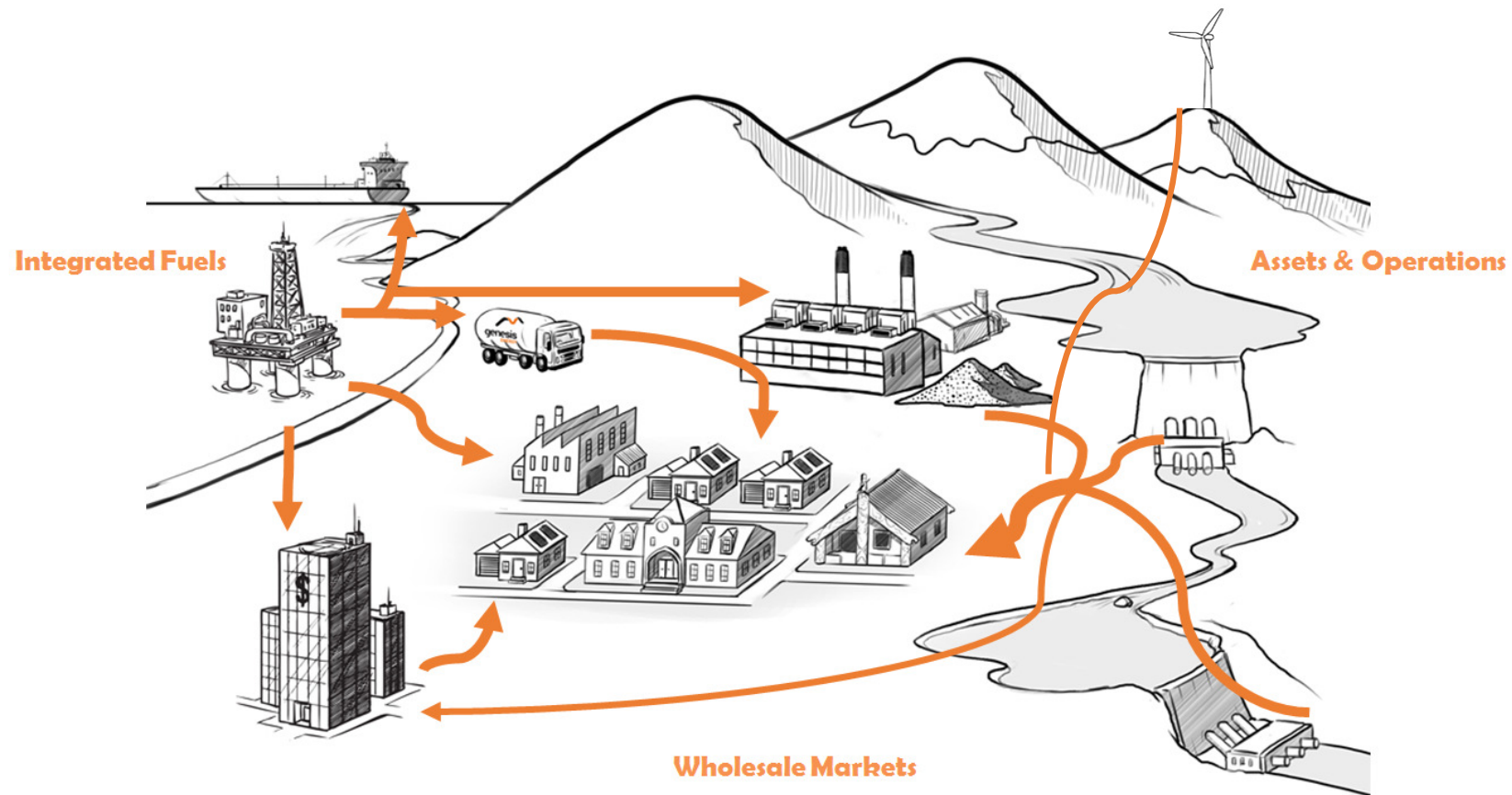


- Do you understand what can go wrong?
- Do you know what your systems are to prevent this happening?
- Do you have information to provide assurance they are working effectively?



Process Safety into Genesis Energy

Genesis Energy Asset Landscape



Drivers for Change



WHY?

Reactive Approach

Risk of Aging Plant

Lack of Visibility

Sub-optimal Eng Structure

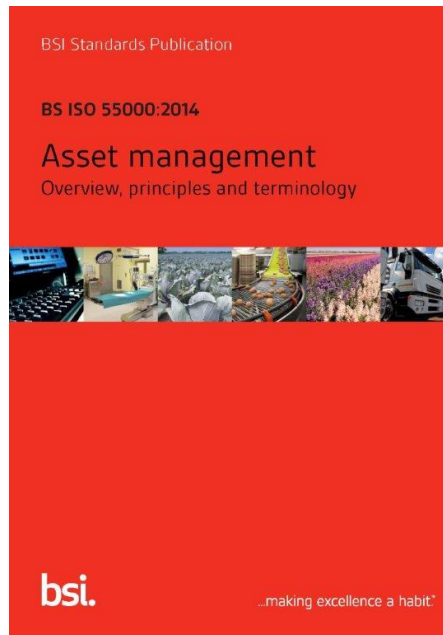
No Formal AM Framework

Confused Accountabilities

Poor Linkage to Strategy

Limited Company Buy-in

No Consistency to measure



WHAT

Visibility of Critical Safety

Risk Based Asset Care

Optimised Capital Forecast

Targeted Maintenance Spend

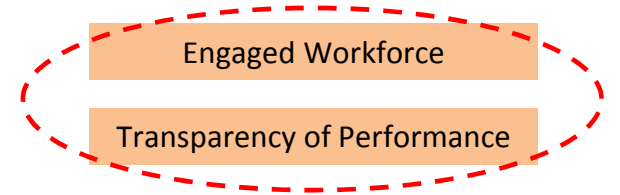
Improved Outage Alignment

Safer Works Procedures

Repeatable Framework

Engaged Workforce

Transparency of Performance



Question 1 – Do you understand what can go wrong?



Assess Threats
(Failure Modes)



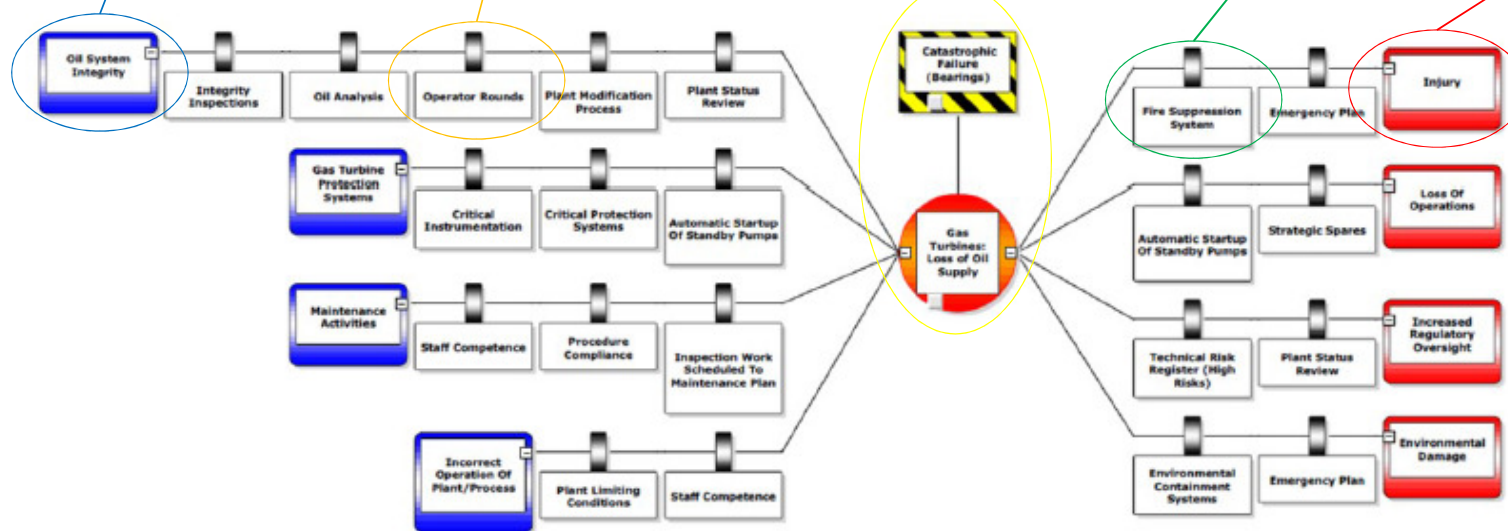
Assign Control Barriers



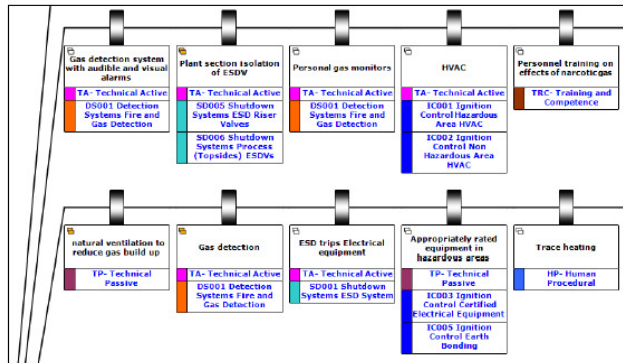
Assign Mitigation Barriers



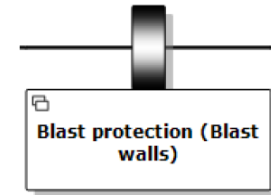
Genesis Energy Risk
Consequences



Question 2 – Do you know what your systems are to prevent this happening?

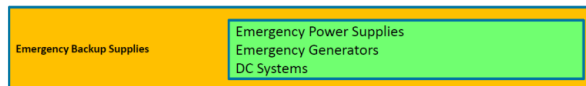


Assign Standards, processes & procedures to barriers

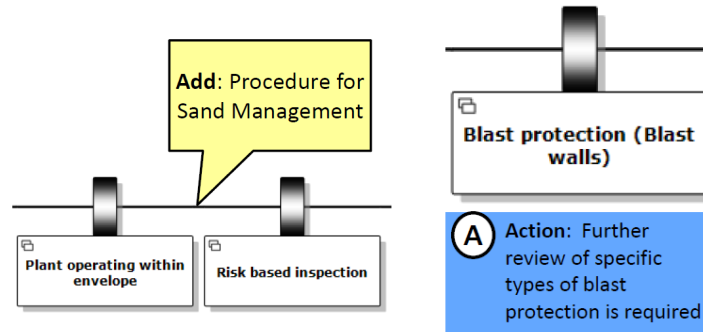


Effective	<Reason why barrier is effective>
Partially Effective	<Reason why barrier is only partially effective>
Ineffective	<Reason why barrier is ineffective>

Assess effectiveness barriers



Define critical safety elements to barriers



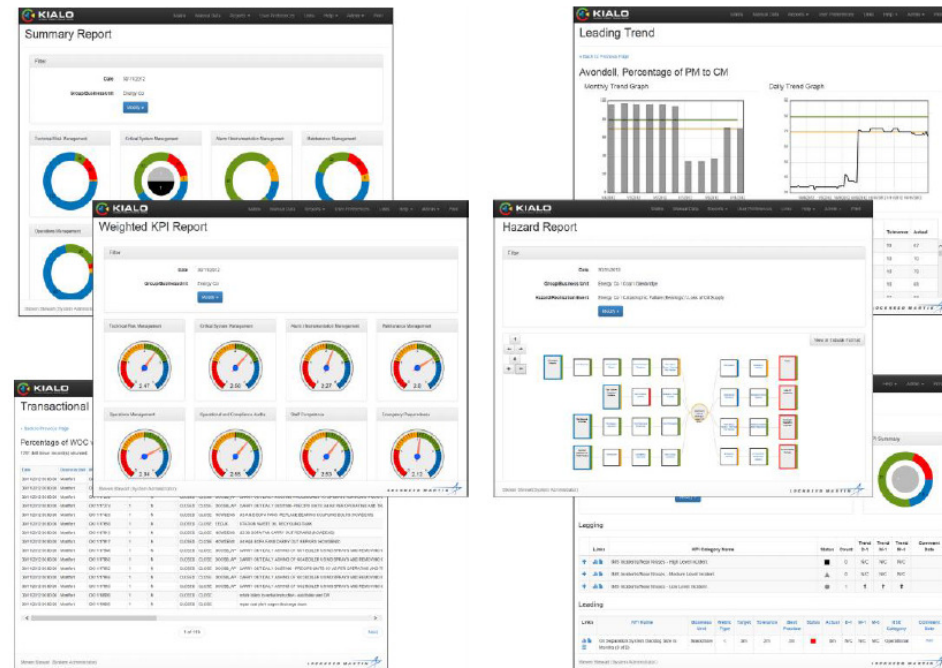
Add improvement notes or actions to barriers

Question 3 — Do you have information to provide assurance they are working effectively?



Barrier effectiveness is tracked by the dashboard using agreed KPI's

5-ACT-38	
Statutory Compliance	
EF Effective	
TP Technical Passive	
OSIEKE2A	
OSIEKE1A	
GEN-MGT-INS-PEQ01	
HLY-STI-FRM-PEQ26	
RCS1 Technical Risk Management	
1.8 Pressure System Safety	
RCS2 Safety Critical Systems	
SCE2 Pressure Containment Systems	
2.01 Pressure Vessels Hazard Levels A and B (AS4343)	





Process Safety into Asset Management

The Asset Management 'Question'



Are we doing the right things...

...on the right assets...

...at the right time.

GENERATION ASSET MANAGEMENT SYSTEM

Company Objectives, Strategy & Business Plan

ASSET MANAGEMENT SYSTEM

Policy & Strategy

Asset Management Policy

Asset Management Core Standard

Asset Management Strategy

Bowties & Management Plans

Scheme Asset Management Plans

Maintenance Plans

Equipment Asset Management Plans

Investment Programme

Bowties

Work Activity

Risk Control Areas

Technical Risk Management

Alarm & Instrumentation Management

Staff Competence

Safety Critical Systems

Maintenance Management

Emergency Preparedness

Operations Management

Dashboard, Audit & Governance

Simple and Useable Documents





EQUIPMENT ASSET MANAGEMENT PLAN

Power Transformers

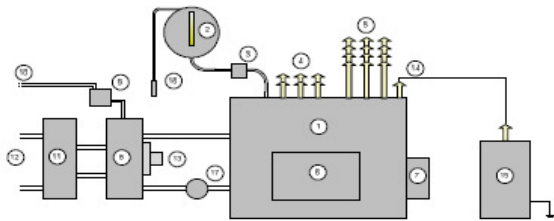
Technical Authority: Cameron Chapman

This EAMP covers the Portfolio Generator Step-Up (GSU) Transformers and the Huntly Station Transformers owned and operated by Genesis Energy and provides guidance to enable effective asset management for the next 20 years.

BOWTIES

ID	BowTie	Description
HL106-BAT-01	Electrical Systems - Power Transformers (T500, T510)	Generator transformers, excluding local service, distribution and earthing transformers.
HL106-BAT-01	Electrical Systems - Power Transformer (T600)	
HL106-BAT-01	Electrical Systems - Power Transformers (T1, T11, T2, T12)	
HL106-BAT-01	Electrical Systems - Power Transformers (T6, T8, T7, T8)	
T600X-BAT-01	Electrical Systems - Power Transformers (T2, T3)	
T600X-BAT-01	Electrical Systems - Power Transformers (T1 - T6)	
WIM0X-BAT-01	Electrical Systems - Power Transformers (T1 - T7)	

ASSET SUMMARY



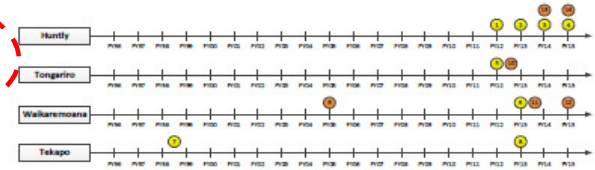
Item	Component	Scope / Transferable Points
1	Transformer Tank	Including all interconnecting pipe work up to isolation valves
2	Conservator	Including sight glass and interconnecting pipe work and valves
3	Protective Devices	Including Bushholts, Pressure Relief Device, sample lines, local cabling
4	LV bushings	Including oil filled and dry bushings, flexible braids, but excluding bus bar / cables
5	HV bushings	Including oil filled and dry bushings, flexible braids, but excluding bus bar / cables
6	Tap changer	Including sight glass and/or Bushholts where fitted
7	Marshalling Kiosk	Including all local cabling but excluding remote cabling
8	Insulating Liquid Cooler	
9	Header Tank	
10	Cooling Water Supply	Including all interconnector pipe work, pumps, strainers, radiator banks, instrumentation
11	Water to Water cooler	
12	Circulating Water Supply & Return	
13	Cooling Fan & Motor	Including all apparatus up to local electrical isolator
14	Transformer Neutral Bushing	Including terminations, flexible braids, bus bar and/or cables
15	Neutral Earth Resistor	Including terminations, flexible braids, bus bar and/or cables
16	Breather	Including all interconnector pipe work and breather dirt trap
17	Oil Pumps	Including all apparatus up to local isolator
	Miscellaneous equipment	Consideration should be given to any additional plant and apparatus that is an integral part of the transformer, e.g. Anti-condensation heater, Insulating liquid monitoring equipment etc.
Exclusions	Current and Voltage Transformers	Protection and Metering OT's and VT's are excluded from scope as these are covered under the Maintenance Strategy for Protection and Metering
	Main Earth Switchgear	Covered under the EAMP for Cables & Earthing
		Covered under the EAMP for 8KV Distribution & MV, LV Distribution

ASSET OVERVIEW

Location	Manufacturer	Rating	Age	Installed	
HLY	Huntly U1 (T1)	Siemens, Brazil	3phase 300MVA, 220/16.5kV	16	1999
	Huntly U2 (T2)	Tyree Electrical Company, Australia	3phase 300MVA, 220/16.5kV	44	1971
	Huntly U5 (T500)	Anso, Australia	3phase 403MVA, 220/138kV	10	2005
	Huntly U6 (T600)	Hyosung Corporation, South Korea	3phase 70MVA, 220/131kV	1	2014
	Huntly (T5-T6)	Tyree Electrical Company, Australia	3phase 30MVA, 220/131kV	-36	-1080
	Huntly (T7-T8)	Tyree Electrical Company, Australia	3phase 17.1MVA, 11/3.3kV	-36	-1080

Location	Manufacturer	Rating	Age	Installed	
TOO	Tokanu (T1-T4)	PT CG, Indonesia	3phase 70MVA, 220/131kV	3	2012
	Rangipo (T5-T6)	Hawker Siddley, UK	3phase 80MVA, 220/131kV	35	1980
	Tuati (T1-T3)	PT CG, Indonesia	3phase 28MVA, 110/131kV	10	2005
WIM	Piripaea (T4-T5)	Hyosung Corporation, South Korea	3phase 28MVA, 110/131kV	2	2013
	Kaitawa (T6-T7)	Hyosung Corporation, South Korea	3phase 35MVA, 110/131kV	1	2015
TKX	Tekapo B (T2-T3)	Tyree Electrical Company, Australia	1phase 91MVA, 220/131kV	41	1974
	Tekapo B (Spares)	Tyree Electrical Company, Australia	1phase 31MVA, 127/11kV	41	1974

HISTORICAL MILESTONES



Current Assets

1	HLY	T500	Internal inspections to investigate source of incipient fault. Paper degree of polymerisation (DP) testing completed
2	HLY	T2	In-situ inspections to assess asset condition (2012); Replacement of original 220kV Resin Bonded Paper bushings with modern Resin Impregnated Paper bushings. (2015)
3	HLY	T1	Limited in-situ inspections at transformer T3; prior to re-location to transformer T1 bay
4	RPO	T5-T6	Internal inspections to investigate source of incipient fault. Paper DP testing completed
5	TLR	T2	Limited in-situ inspections to complete a number of defects (i.e. oil leaks in the thermal imaging current transformer termination box)
6	TXB	T2-T3	Mid-life refurbishment on six in-service and spare transformers
7	TXB	T2-T3	Limited in-situ inspections completed on five in-service and spare transformer. No inspections undertaken on T2 Red phase. Paper degree of polymerisation testing completed

Replaced Assets

9	TLR	T1-T3	3 transformers replaced in 2005
10	TKX	T1-T4	4 transformers replaced in 2012
11	PRR	T4-T5	2 transformers replaced in 2013
12	KTW	T6-T7	2 transformers replaced in 2015
13	HLY	T600	Failed Unit 6 transformer whilst in service was replaced in 2014
14	HLY	T1	Unit 3 transformer interchanged with service-aged Unit 1 transformer in 2015

ASSET RANKING

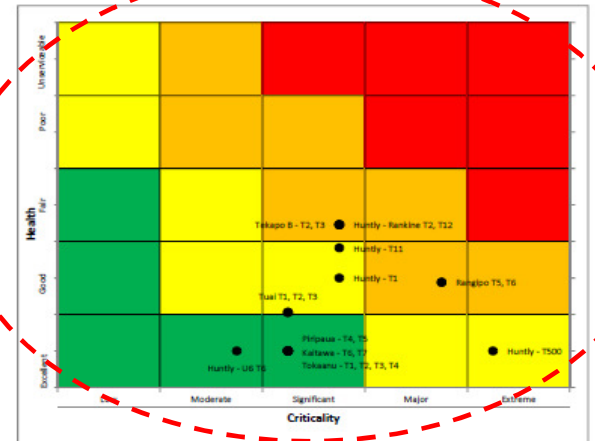


Table below discusses assets that have an orange or red health score. See Asset Health Guidelines for more details.

Huntly	T2	220kV RBP bushings require replacement. Project presently underway.
Rangipo	T5-T6	Internal inspections to investigate source of incipient fault. Paper degree of polymerisation testing completed
Tuati	T1-T3	Oil has tested positive for corrosive sulphur tests
Tekapo B	T2-T3	Oil has tested positive for corrosive sulphur tests. 220kV RBP bushings with known design deficiencies.

ASSET RISKS

The following table shows risks classified as High or Extreme. See BowTieX for the complete risk register.

Bowtie #	Risk Assessment			Risk Description	Mitigation	Assessment
	L	C	Score			
HL106-BAT-01	1	5	5 - Mod.	Consequence: Operational and Financial Description: No contingency plan to address a forced outage on T500. Failure of transformer T500 will result in a forced outage of approx. 18 months. Specific Deficient Barriers: Critical Spares	HL106-BAT-002	Project
HL106-BAT-01	2	5	10 - High	Threat: Cable Termination Box Faults Description: T12 has a leak into the LV cable box which has caused deterioration of the cable termination kit in the past. Specific Deficient Barriers: Maintenance	HL106-BAT-006	Maintenance
HL106-BAT-01	2	5	10 - High	Threat: Cable Termination Box Faults Description: T7 & T8 oil Leaks into LV cable boxes causing deterioration of cable terminations Specific Deficient Barriers: Nil	HL106-BAT-010	Maintenance
TK00X-BAT-01	2	5	10 - High	Threat: Transformer Winding Failure Description: Corrosive sulphur issue identified. Specific Deficient Barriers: Nil	TK00X-BAT-003	Maintenance
TK00X-BAT-01	3	4	12 - High	Threat: Oil preservation system failure Description: Dryoil operation reliability questionable. Recent failures. Specific Deficient Barriers: Maintenance	TK00X-BAT-011	Project
TK00X-BAT-01	2	5	10 - High	Threat: Tap Changer failure Description: Maintenance routines and DGA testing needs to be reviewed and confirmed Specific Deficient Barriers: Maintenance	TK00X-BAT-003	Maintenance
WIM0X-BAT-01	2	5	10 - High	Threat: Transformer Winding Failure Description: Corrosive sulphur issue identified. Specific Deficient Barriers: Nil	WIM0X-BAT-002	Maintenance

INSURANCE REPORT

Ref	Actions	Accountability	Priority	Due Date
2010.02	Main Transformer Contingency Plans. During discussions relating to contingency plans and the availability of strategic spares for major plant and equipment it became evident that there is currently no transformer strategic spare in respect of the combined cycle unit, and that transformer failure contingency plans have not been established. Strategic options available have not been identified in relation to a catastrophic equipment failure event.	Technical Risk Management	High	30/06/17

ASSET LIFECYCLE AND OPERATING PRINCIPLES

The generator transformers are designed to deliver a service life of 30 years. Good asset management practices can lead to a service life of 40-45+ years can be expected. If the winding sets are maintained appropriately an extended life of up to 50 years can be achieved, however, critical components such as h.v. and l.v. bushings, tap changers and ancillary controls need to be replaced after a period of 25-30 years. In addition, mid-life refurbishments need to be undertaken after a service life of 25 years. In some cases, it is not economical to perform equipment replacements (i.e. bushings, tap changer etc.) and mid-life refurbishments after a period of 25 years. In such instances, replacement of complete asset is considered.

Genesis Energy has invested considerable effort in delivering compatibility across replaced assets. The replaced Unit 6 transformer is directly inter-changeable with the four transformers at Tokanu Power Station. In addition, the transformers at Piripaea and Tuati are inter-changeable, while the transformers at Kaitawa can also see service at Piripaea and Tuati.

PERFORMANCE TARGETS

Performance targets are outlined in the Scheme AMP's and there are no performance targets set at the equipment-level. This will be in place for the next iteration of the EAMP.

EAMP Improvement Opportunity

Develop performance targets for assets covered by this EAMP.

ASSET LIMITATIONS

There are no known asset limitations at present.

ASSET LIFECYCLE AND OPERATING PRINCIPLES

The typical design lifecycle of the active elements of communications equipment is 10-15 years. Technological change can accelerate the change to 5-8 years. The more physical assets such as buildings and towers have a lifetime or lifecycle of 20-50 years, and long distance cables typically 15-20 years. Comms active assets will typically be updated a number of times over the lifetime of generators, dams and transmission lines.

Communications is often critical for the operation and control of key elements of the larger power system assets, and much of the design and operation of comms assets stems from the need to build in resilience and redundancy. This means more than just the equipment and requires looking closely at the heating and cooling environment, control of rodents, moss and mould, adequacy of power supplies and maintainability of the systems employed. Modern day equipment itself typically requires little maintenance but the systems to maintain the environment require regular checking and attention.

Systems that provide monitoring of system status and propagation of alarms to responders are an essential part of maintaining performance. So too are designs that allow moves and changes with good change control to be made without severe disruption to the users of the services.

Standard communications life cycle activities are summarised in the below table.

Description	Typical Frequency
Walk/drive cable routes	6 monthly
Active equipment environmental inspection	6 monthly
Surge arrester integrity check	Annually
Tower climbing inspection – comms equipment check	6 monthly
Tower climb/mechanical inspection	5 yearly
Building exterior inspection	Annual
Road/track access inspection	Annually
Emergency supplies provisions at inaccessible sites	April each year
Link performance statistics review	Annually
AC/DC power supply inspection	Annually
Battery load test	At 80% and 100% of design lifetime, then annually.
Active parts replacement (fans, lasers)	As per manufacturer's recommendation
Spares inspection and check list for adequacy	Annually
Documentation and backup files check for currency	Audit a small number annually

PERFORMANCE TARGETS

Performance targets are intended for inclusion the next iteration of the EAMP. They should derive from the Scheme AMPLs.

EAMP Improvement Opportunity

- Develop performance targets for assets covered by this EAMP.

ASSET LIMITATIONS

Poor performing radio links RPS-POD and RPS-TUK are affecting performance of existing traffic flow. Projects are in place to identify solutions and restore the link performance. The projects are running late due to resource limitations.

Capacity limits on links from Tual to Tokaanu are limiting CCTV performance. A project is underway to take over the links from Transpower and enhance the capacity as part of refreshing the equipment.

Land mobile systems in the Renewables are suffering from poor Teamtalk performance in many areas and beginning to fall into disrepair. A trial of a new system is planned for Walkaremoana and, subject to suitable performance, this will be used as the basis for replacing the existing system in Tongariro and Tekapo as well.

LEGISLATION AND REGULATION

Legislation and Regulation affect the implementation of radio and fibre optic systems. H&S requirements affect the need for labelling and control of access to some assets.

Asset	Code/Regulation	Sections	Requirements
Radio links and land mobile repeaters	Frequency licenses from MBE/NSM (Radio Spectrum Management) and related conditions.	Approximately 50 licenses, Generation wide.	Radio spectrum management legislation and regulations.
Fibre optic links	Regulations relating to safety and labelling.	-	-
Site Infrastructure	Relating to tower and building performance, and the access conditions in National Parks.	-	-

TECHNICAL STANDARDS

Besides technical standards identified in the BowTies, the following publications also drive asset management practices.

Reference Document	Detail
ISO9001 and IEC standards and practices	Various industry best practice guidelines and standards.

EXTERNAL PROVIDER AGREEMENTS

External service providers are engaged for a range of services both on an ongoing basis and a one-off basis, depending on the task. The normal Genesis Energy preferred supplier are engaged for testing, installations, consumables and materials as required.

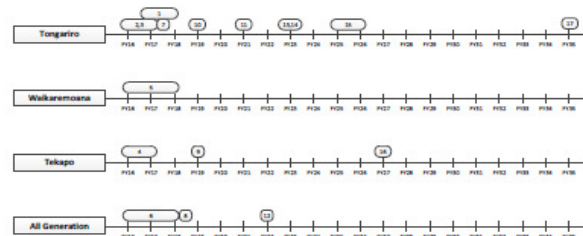
Provider	Asset	Service provided	Contact person	Contract Details
Convent Network Solutions	Nokia, Avaya, CNMS	Monitoring of Nokia and Avaya systems via CNMS.	Stephen Elcoat	Ongoing contract, ref: (contract #)02-CT15-193 CommTel Technical Services Agreement
Vodafone	TKU-TKB link	Provide the link and monitoring of its performance.	-	Ongoing contract, ref: (contract #)
Sperk	TKU-TXA, TKU-TUI links	Provide the links and monitoring of their performance.	-	Ongoing contract, ref: (contract #)
Transpower	KMA-TUI link	Provide the link and monitor it's performance.	NOC – Manu.	Ongoing contract, ref: (contract #)
TPWS/Broad Spectrum	All	Fibre, radio, telephony maintenance and installation. Hourly Trunked Radio and telephony maintenance.	Renewables - HLY - John Field	Ongoing contract, ref: (contract #) Also used for one-off works (case by case)
Teamtalk	TKU, TEK Fleetlink RT	Land Mobile Radio (RT) service	-	Ongoing contract, ref: (contract #)
Richardson's	RT maintenance	RT maintenance	-	Case by case
Skycom	HLY trunked radio	Moves and changes	-	Case by case
Dove	HLY BOA	Maintenance as needed.	-	Case by case

ASSET SUPPORT HARDWARE & SOFTWARE

See AMS Standard for details on the systems and processes common across all generation schemes and sites. The following table lists the hardware and software used to manage the assets covered in this EAMP.

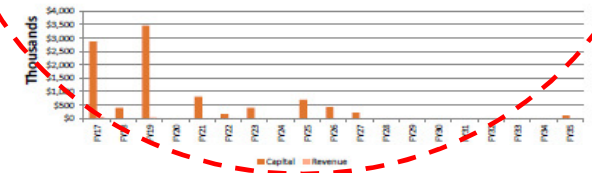
System	Description
CNMS	Monitoring and control of Nokia and Avaya systems.
System configurations	Standalone ruggedised PCs for configuration and control of active devices.
Performance of new and changed ethernet links	Aviatrix Ethernet tester

20-YEAR INVESTMENT PLANNING



Current major planned projects for communications as of publication of this plan. See PlanView for major projects or more details.

ID	Location	PP Value \$M	Project Title	Start	End	Total Forecast
1	Tongariro	1000663	TGO Radio Replacement for - TUK & NSC	FY17	FY18	\$170,000
2	Tongariro	1001004	TGO Poutu Dam Comms Pole Replacement	FY16	FY17	\$12,500
3	Tongariro	1001025	TGO Eastern Diversion Comms Capacity Upgrade	FY16	FY17	\$615,000
4	Tekapo	1000668	Tekapo Comms DC	FY16	FY17	\$51,000
5	Tokaanu to Tual	1000271	Tual Communications - Tual/Tokaanu link	FY16	FY18	\$961,955
6	All Gen	1000873	GEN Trunked radio system Improvements	FY17	FY18	\$470,944
7	Tongariro	1001216	TKU Intake - TKU Fibre Replacement	FY17	FY17	\$514,000
8	All Gen	1001269	GEN Telecoms Monitoring(CNMS) Functional Additions	FY18	FY18	\$150,000
9	Tekapo	1000851	TEX Comms Fibre Replacement Between TXA & TKS	FY19	FY19	\$2,400,000
10	Tongariro	1001043	TGO Phange Tower and Building Refurbish	FY19	FY19	\$1,000,000
11	Tongariro	1001217	TGO WDV Fibre Replacement	FY21	FY21	\$800,000
12	All Gen	0001733	Telecoms Monitoring (CNMS) Life Cycle Upgrade	FY22	FY22	\$150,000
13	Tongariro	0001149	TGO MDA-MGD Fibre cable replacement	FY23	FY23	\$120,000
14	Tongariro	0001148	TGO POI-RPO Fibre cable replacement	FY23	FY23	\$100,000
15	Tongariro	0000621 - 0000633, 0000638 - 0000640	TGO - Various sites; multiples, FOTS, DMK, Wideband LHF replacements	FY25	FY26	\$1,100,000
16	Tekapo	0001123	TEX Control/Transport layer comms replacement	FY27	FY27	\$300,000
17	Tongariro	0000617	TGO Communication Systems network maintenance	FY35	FY35	\$100,000



GAPS & IMPROVEMENT ACTIONS

Table below collates all recommendation in the EAMP. For BowTie Improvements, see BowTieXP for more details.

Ref	Improvement/Opportunity	Accountability	Priority	Due Date
ACT-6	Unable to update some systems e.g. Unit 5 & 6 no longer able to get updated patches for these systems. PM's required. Cash management agreement to accept risk of out of date virus protection.	Technical Authority	High	Dec-2016
ACT-7	Provide physically diverse cable routes for critical routes	Technical Authority	Med	Jun-2018
ACT-8	Include monitoring of Poutu Radio link into comms monitoring	Technical Authority	Med	Mar-2017
ACT-28	Fibre Protection Design standards have been applied at the main sites but not at smaller sites and repeaters. Assess requirements and suitability as fibre protection systems themselves may damage communications systems.	Technical Authority	Med	Jun-2017
ACT-31	It is necessary to review periodically that the power system assets that the non-redundant communications links are communicating with can withstand loss of communications for shorter or longer times.	Technical Authority	Med	Annual Review required
ACT-59	Cyber security policies need agreement at corporate level	Technical Authority	High	Dec-2016

Category:	Equipment Asset Management Plan	Document ID:	TBC
Owner:	Systems Engineer	Revision:	1.0
Author:	Systems Engineer	Issue Date:	
Approver:	Engineering, Projects and Contracts Manager	Next Review Date:	December 2016
Revision Comment:	Version 1		

Success to date



Bowties

- ✓ Identification of Safety Critical Systems and adherence to Regulatory Compliance – Visibility
- ✓ Identification of maintenance, process improvements and gaps - Continuous Improvement
- ✓ Alignment with and inform business strategy – Bottom up asset management
- ✓ IP Transfer and Capture – Engagement of the workforce

Asset Planning

- ✓ Project forecasting and governance – Visibility
- ✓ Asset rankings with project programme prioritisation – right thing, right assets, right time
- ✓ Risks and investment informing for business planning - Bottom up asset management



Questions?