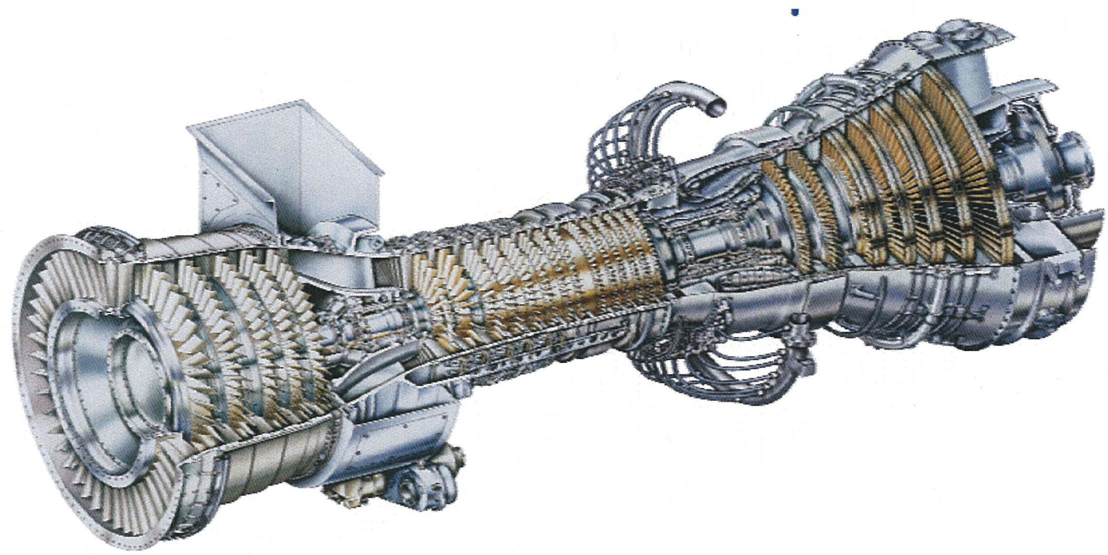
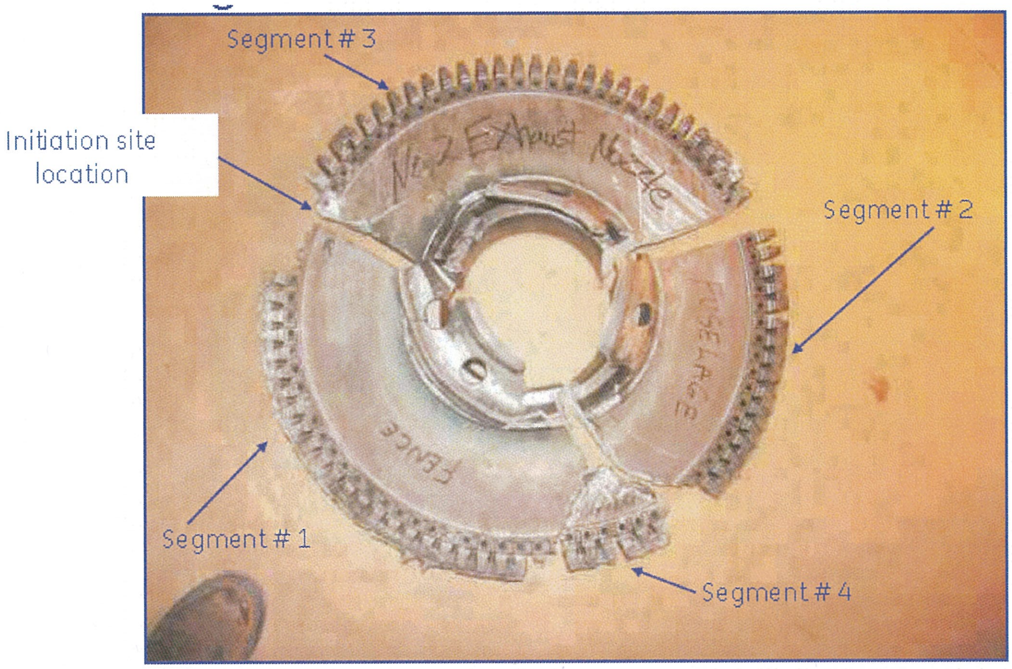
Appendix A – LM6000 Gas Turbine



Appendix B – Example of a failed Gas turbine disk



HPT Stage 1 Disk with Recovered Forward Shaft Cone Segments

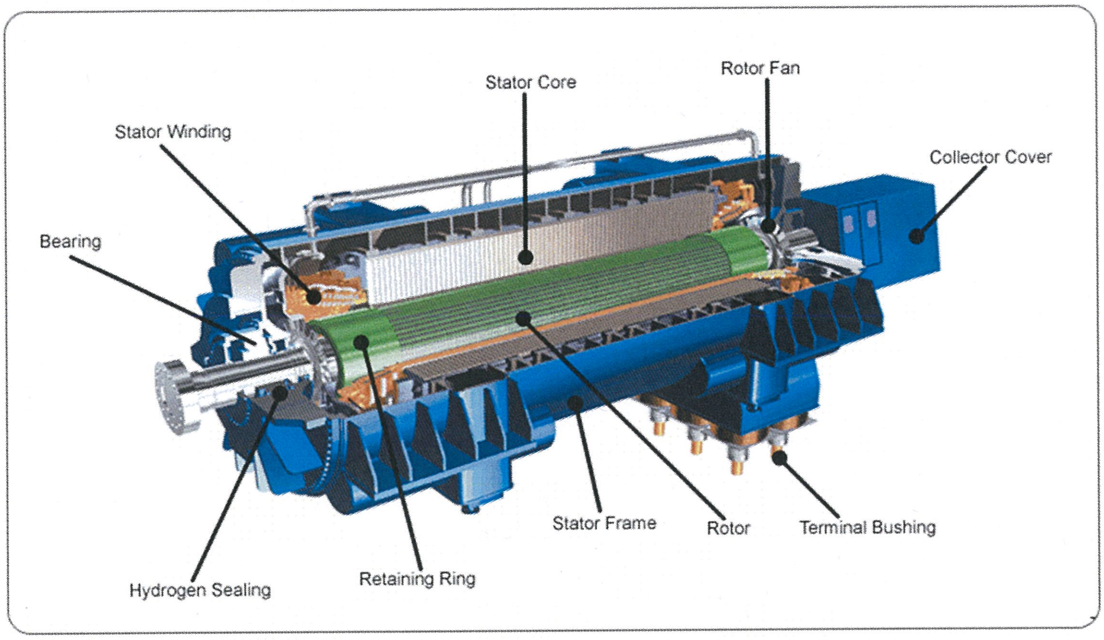
Note: This is off an aircraft and while this looks no different to an industrial stationery energy application (industrial unit) the industrial units are more robust and heavier than the aviation units.

Approximate diameter of disk = 700mm,

Weight = 80-100kg

Rotational speed = 12,000 RPM

Appendix C – Schematic of a Generator showing the Retaining Ring (which Mercury refer to throughout its evidence as End Caps).



Appendix D – Letter to Scott Wickman dated 23 June 2017.

Mercury

Scott Wickman
Project Leader
New Zealand Transport Agency
AUCKLAND

By email: Scott.Wickman@nzta.govt.nz

23 June 2017

Dear Scott

East West Link – Risk Assessment Process

I am writing to follow up about the risk assessment regarding the impact of the East West Link proposal on the Southdown site.

At the outset I think it is useful to remind you of Mercury's concerns about the proposal. On 7 October last year, after Mercury publicly announced that we would be using some of the Southdown site for solar / battery R&D and following a visit of NZTA teams to the Southdown site, Phil Gibson (General Manager – Hydro/Wholesale) wrote to your CEO. In this email, Phil pointed out that during 2016 Mercury's team had worked hard to help the NZTA team understand that the site was not 'available' for the East West link project and reiterated the message that had been expressed to the NZTA team when they visited the site that morning that the solar plans for the site do not change the requirement to preserve the site for Auckland's future electricity security of supply. This October email and earlier discussions with NZTA followed advice in February 2016 from my CEO to your Acting CEO that Mercury was not selling Southdown.

I reiterate Phil Gibson's statement from his 7 October email as it captures Mercury's views about Southdown: "Over the next 15 to 20 years, Auckland growth will likely put significant pressure on transmission capacity, even if we assume that solar and storage technology take up is high. While electricity customers hold diverse views as to the relative importance of price and renewables, they are absolutely consistent in their view that electricity supply must be reliable. Southdown is a unique site in Auckland due to its proximity to a gas pipe line and the electricity grid, its designation under the unitary plan as heavy industrial and its consent to operate as a generation facility. There is no other site in Auckland with these features which may be vital to security of supply in the future."

Despite advice from Mercury, NZTA proceeded with a designation that affects almost half of the Southdown site and did not undertake an assessment of the impact of the proposal on the Southdown site. Mercury has slowly come to appreciate this impact; first raising it with you in February this year and through our submission on the proposal. We consider there is a high health and safety risk of harm to people if a road is introduced over the Southdown site and, due to the significance of this risk, the Board of Inquiry cannot approve NZTA's current proposal.

Since then we have told you repeatedly that we strongly recommend that NZTA commission a risk assessment on the health and safety risks of co-location so it can appreciate the problem of putting the road in its proposed location. At the same time, we have said that it is essential that NZTA work together with Mercury to understand these risks. For example:

(a) On 12 May following a meeting with you, our in-house lawyer wrote to you reiterating the message expressed at a high level in my evidence and that of Damian Phillis, that we believe there is a high health and safety risk if a road is introduced over the Southdown site and that an evaluation of the risk needs to be undertaken with input from Mercury.

(b) In response to that email and in advance of any preparation of rebuttal evidence by NZTA, we invited the NZTA team to the Southdown site on 2 June to view the site to illustrate the operational risks associated with the construction and operational stages of the road next to an operating Southdown site. We made available our onsite engineer and Damian Phillis for the afternoon. While Transpower brought engineers to the meeting, NZTA did not bring an electricity generation engineer or risk person to the site. After a tour of Southdown and its surrounds, you lead a brainstorming session about the risks to the site from the road during both the construction period and on an ongoing basis; you wrote down the risks identified and were going to circulate notes of the meeting identifying these risks. You haven't done that yet. Your concluding comments before you left the site were that the proposal could not stay the same with the risks identified, especially given NZTA's "Zero Harm" approach to health and safety.

(c) As part of the hearing process, we requested that there be a facilitated meeting regarding the risks at the Southdown site. I attended along with Chris Tyas (Southdown site engineer), Damian Phillis and Mercury's planning and traffic engineers. I appreciate that you were not at that meeting, but again no NZTA safety risk expert attended. Everyone acknowledged that NZTA hadn't undertaken a risk assessment about the impact of the proposal on the site and that one should be done and it should reflect risks known by those who operate on the site (Mercury, KiwiRail, Transpower, First Gas) as well as NZTA and Auckland Transport. There was agreement that there would need to be further discussions about the terms of reference for any assessment. That hasn't happened yet.

You and your team have been in contact with Mercury to advise that the matter of developing an agreed risk assessment process is something that you're keen to progress. We are pleased to hear it, although it is unfortunate that NZTA has started to engage on these significant issues so late in the process as these matters would have been better to work through in the preparation of NZTA's proposal.

As we have indicated following the facilitated meeting, we think it would be useful to have a meeting to explore who would undertake the risk work and what the terms of reference for the work looks like. We have started looking for risk assessment information associated with the generators to assist with that process.

Mercury's view is that the work needs to focus on the impact of the proposal on Southdown in its current configuration (including as a functioning power station). Assuming that the assessment confirms there is a real risk of significant harm from introducing the road onto our site near three generators we consider that the designation should be removed from the Southdown site.

On 8 June, at the facilitated meeting, your team introduced the idea that the Southdown site could be reconfigured to mitigate the risks associated with co-locating the East West Link road alongside the Southdown Power Station and you sought Mercury's assistance to identify acceptable site reconfiguration options. Comments from NZTA's team then and since to a range of people at Mercury about NZTA's desire to explore reconfiguration of Mercury's site, suggest to me that NZTA agrees that there is a real risk of significant harm from introducing the road onto our site, near three generators.

We appreciate NZTA wishes to build a safe roading network. If, through the first stage of the risk assessment process, NZTA accepts that the risk of the current proposal is too high and wants to explore the risk associated with new, alternative proposals then Mercury is willing to include that as a later step in the risk assessment process.

If a belated alternatives assessment occurs it should include locating the road well away from Southdown, but we are willing to work with NZTA to try to identify different ways the site might be configured to co-locate with a road while not adding delay to our ability to supply electricity to the market. The work to confirm the alternative site configurations will take time, however. As I have expressed to you and Chris Donnelly, Southdown is a complex

site with gas lines, electricity transmission towers, a gas substation and a nearby train line. All of these factors need to work in with our power station and solar research and development centre. I will get some advice about the time it takes for an engineering firm to assist us to create workable plans for a different power station configuration on the site, but in my experience this is likely to take a number of months and possibly more than a year.

I hope the above provides some clarity. While at the facilitated meeting I accepted that a site reconfiguration could form part of the scope of a risk assessment (the process for which was to be agreed later), it was not my understanding that this was a prerequisite to moving forward with the risk assessment of the current proposal against the existing site configuration. While the wording of the record about the facilitated meeting is not perfect, I don't think it is inconsistent with Mercury's view on the issues around risk of the proposal that I have conveyed here.

I trust that this letter assists you to set up a helpful meeting regarding starting a risk assessment process for the proposal. Of course, if NZTA accepts that the risks of the proposal associated with the site are not compatible with its Zero Harm culture, then I suggest that it might be more efficient for NZTA to withdraw its current designation and start again.

Yours sincerely

James Flexman
Wholesale Markets Manager

Appendix E – Mercury response to Transpower's expression of interest.

Mercury

Hunter Humphries
Transpower
96 The Terrace

Wellington 6140
NEW ZEALAND

25 August 2016

Dear Hunter

Waikato and Upper North Island Voltage Management Long-List Consultation

Mercury is pleased to submit its views on Transpower's Waikato and Upper North Island Voltage Management Long-List Consultation.

We support the Grid Owner's desire to address limitations on reliably supplying the Upper North Island due to the risk of static and dynamic voltage instability following the retirements of Otahuhu and Southdown. Not only do these limitations pose a risk to well over a million consumers receiving a reliable supply of electricity, they also increase these consumers' reliance on more costly, (largely) thermal Upper North Island generation over (largely) renewable generation from outside the Upper North Island.

In fact, the potential for Upper North Island consumers to pay more for power at times of low UNI generation, transmission outages and/or high demand already exists today, by virtue of the Upper North Island Stability market constraint, which restricts power flow into the region for the contingency of the largest connected generator. Thus, such constraints, which dispatch energy in order to address voltage support deficiencies, have the potential to distort New Zealand's energy-only wholesale market for electricity.

Mercury believes the Grid Owner should design a programme of works to address the Upper North Island's voltage support requirements over the next thirty years. The need for voltage support in the region, broadly speaking, will likely only grow with time given population trends and relatively limited prospects for major generation projects. This programme should however consist of a variety of staged investments and options capable of responding to short/medium term changes in the need for voltage support with agility. Given the length of the analysis period and uncertainty around key drivers of voltage support needs (e.g., Huntly Rankine unit retirements which could be accelerated by the exit of the Tiwai smelter), Transpower must give strong consideration to the real option values conferred by the ability to undertake phased investment decisions.

Finally, Mercury is pleased to supply information to the Grid Owner on the high level feasibility and costs associated with converting its Southdown generators to synchronous condensers as a non-transmission solution. This information is commercially sensitive and provided in confidence to Transpower in the attached appendix. We believe that Southdown represents a reliable low cost dynamic voltage support option to de-risk the early closure of the Rankine units at Huntly. Southdown will complement investment in static voltage support and act as a bridge to future dynamic voltage support projects.

Our responses to the consultation questions are outlined below. If you have any questions on any aspect of our submission, please contact Buddhika Rajapakse on 09 308 8223.

Sincerely,

Graeme Hill

Acting GM Hydro/Wholesale

Level 14, ANZ Centre, 23-29 Albert Street
Auckland 1142

PO Box 90399
New Zealand

PHONE: + 64 9 308 8200
FAX: + 64 9 308 8209

mercury.co.nz

Q1	Do you agree with our assessment of need and project scope? Are there any other issues or considerations relating to the need or scope that we should incorporate into this project?	We agree with Transpower's assessment of need and the project scope. We agree that the timeframes for "analysis, regulatory approval, procurement, build and commissioning … are tight." We also agree that the post-Rankine voltage support requirements could very well become necessary several years in advance of December 2022, being the anticipated decommissioning date of the Rankine units. This is because a decision from the Tiwai aluminium smelter to close prior to December 2022 will almost certainly trigger an early retirement of the Rankine units. As Genesis Energy itself notes in its FY16 Results Presentation, "Most likely scenario in the event of Tiwai exit would be to close Rankine units."[1] It is therefore crucial that Transpower develops voltage support options that are flexible and robust to a relatively short notice Rankine unit departure. In other words, we submit that the requirement for the post-Rankine tranche of ~400 MW-equivalent voltage support could be triggered quickly. Transpower must secure voltage support options that can be deployed quickly and/or potentially procure some of the requirement in advance.
Q2	Do you agree with our draft long-list of components? If not, what components should we include or remove?	We agree with the long-list. Given that this is a long-listing exercise we do not support ruling any options out at this initial stage. However, we have strong reservations concerning the viability of component 4.3.1 in the long list, whereby the System Operator is expected to apply voltage stability limits based on dynamic analysis. Such constraints, which dispatch energy in order to address voltage support deficiencies, have the potential to distort New Zealand's energy-only wholesale market for electricity. Reliance on such voltage stability limits over other long-list components would restrict the level of power transfer into the Upper North Island and increase the reliance of Upper North Island consumers on local thermal generation. This is highly unlikely to be net beneficial for New Zealand given that renewable wind, geothermal and hydro generation dispatch would be restricted by the voltage stability limits. We are also concerned that voltage constraints throttling power transfer into the Upper North Island would bestow wholesale market power on a relatively small number of Upper North Island generators, thereby potentially increasing costs for Upper North Island consumers and hampering retail electricity competition. This also has the capability to undermine confidence in the wholesale market for electricity.

[1] https://www.nzx.com/files/attachments/242023.pdf (Slide 10.)

		We also believe that determining voltage stability limits in or approaching real-time is not straightforward. Conservative safety margins would become necessary to reliably dispatch power on the grid, exacerbating the aforementioned costs stemming from increased thermal generation and market power.
Q3	This document serves as an invitation to provide information on non-transmission solutions. Any submission on this aspect should provide as much detail on the non-transmission solution as possible. Do you have any suggestions or proposals for non-transmission solutions to meet the need? If so, please provide the information requested (in section 5.5) so that we can apply a high-level assessment against our short-listing criteria.	Please refer to the appendix.
Q4	Do you have any suggestions for enhancing Transpower's grid support contract (GSC) product design? If so, please provide your reasons, based on the rationale provided in our GSC design features document at www.transpower.co.nz/grid-support-contracts	No.
Q5	Do you agree with our criteria for short-listing? If not, what criteria should we modify, include or remove, and why?	The screening criteria should not just consider system security benefits but also the high level changes in fuel costs to New Zealand resulting from the deployment of a particular solution, as per the requirements of the "investment test" under Transpower's Capital Expenditure Input Methodology (For an example, see response to question 2.) Potentially adverse or perverse wholesale market impacts (e.g., see response to question 2) should also be considered at a high level (At least qualitatively.) We recognise that these impacts are not straightforward to contemplate but the investment test criteria explicitly include "competition effects (in the electricity market)"[2] that therefore warrant consideration.
Q6	Do you think that the demand growth assumptions are appropriate for this project? If not, how could we improve them?	Yes.

[2] http://comcom.govt.nz/dmsdocument/870 7.4.3 k and 7.4.9 – 7.4.11.

Q7	Do you think that, if the proposed removal of the DGPP and the RCPD charge from the TPM occur, net peak demand in the Upper North Island will be affected? If so, by how much?	We appreciate that net peak demand in the Upper North Island could be affected by changes to the TPM and DGPP, but we do not have a firm view on the extent to which this would occur.
Q8	Do you have any more detailed motor load information for the Upper North Island and Waikato that would allow us to improve our modelling?	No.
Q9	Are you aware of any other existing generation in the UNI that we should include in our analysis?	No.
Q10	Are you aware of any other dynamic reactive support sources that we should assume?	No.
Q11	Do you think that the generation scenarios are appropriate for this project? If not, how could we improve them, especially with regard to our assumptions on generation that will be built at or north of Huntly?	In regards to the generation build assumptions at Huntly or further north, we do not expect new peaking generation to be built so far in advance of the planned (2023) or "unplanned" (e.g., due to Tiwai exit) retirement of the Rankine units. The phasing in of the new generation to replace the planned 2023 Rankine unit exit is likely to be much closer to 2023 than not, due to the risk of market overcapacity and oversupply for example. Were the Rankine units to exit the market ahead of the planned 2023 date, it is even possible that the commissioning of the new peaking generation would follow the Rankine retirements, due to lead times in procuring plant, consenting, construction and so on. Furthermore, we do not anticipate the construction of a new Taranaki gas peaker (notwithstanding Junction Road and related projects) unless the Taranaki Combined Cycle unit is retired.
Q12	Is our proposed analysis period to 2045 reasonable for this project?	The analysis period is reasonable but we note that given the length of the analysis period and uncertainty around key drivers of the need (e.g., Rankine unit retirements which are dependent on factors such as the Tiwai smelter), Transpower must give strong consideration to the real option values conferred by the ability to undertake phased investment decisions. In other words, designing a programme of works consisting of a variety of staged voltage support investments and options is likely to be more net beneficial than one or two investments intended to be "one size fits all."
Q13	Do you think $25,300/MWh is appropriate for valuing expected unserved energy for this	Yes.

	project? If you are a large industrial consumer, is $25,300/MWh appropriate to your own assessment of your cost of non-supply?	
Q14	Do you think our discount rate assumptions are reasonable? If not, what discount rates would you consider more appropriate for this analysis?	Yes.

Appendix – Southdown Non-Transmission Solution

TBC

Appendix –Southdown Non-Transmission Solution

Question	Answer
Full Contact Details	Buddhika Rajapakse Mercury New Zealand Limited Level 3, Mercury Building 109 Carlton Gore Rd, New Market Auckland 1023 PO Box 90399. Auckland 1142. New Zealand Buddhika.Rajapakse@mercury.co.nz P +64 9 308 8223 M +64 21 296 2301
Are you registered Market Participant?	Yes
How reliability of non-transmission solution will be delivered?	Non-transmission solution (Synchronous Condensing through Southdown generators) is planned to be delivered at existing SWN2201 site which is still connected to Grid. An agreed number of units should be available to provide synchronous condensing remotely to a desired level of N-1 dynamic reactive support capability.
Sufficient technical details to enable an assessment of the component(s), especially its reliability?	Southdown has currently 3 (SWN 101,102,105) units and each unit could provide circa +35/-15 MVAR reactive support (*subject to modelling and testing*). Each unit will require roughly 5 days of planned annual maintenance outages. Estimated availability per unit is around 97% (factoring in a 2% forced outage factor). Given the relatively early stage of this project it is difficult to offer other reliability metrics.
In the case of load reduction solutions, the nature of motor load?	N/A
Indicative cost and price information, ideally as an expected cost with an upper and lower bound?	**Availability Fee:** (see table below) **Event Fee:** An hourly fee of [redacted]/ **hour per unit** with minimum running time of **04 hours.** **Note:** Please note that this pricing information is indicative based on very early engineering estimates in range of **+/- 30%.** The pricing also only reflects technical aspects of the installation and will be subject to change depending on commercial terms negotiated with Transpower.
The size of the non-transmission solution, both current and projected?	Each unit at Southdown could provide +35 /-15 MVAR (*subject to modelling and testing*) reactive support. Those could be installed / commissioned in single project or could be added in staged fashion as per agreement.

Availability Fee:

Fixed Annual Availability Fee	2 Year Contract	5 Year Contract	10 Year Contract
1 Unit	[redacted]	[redacted]	[redacted]
2 Units	[redacted]	[redacted]	[redacted]
3 Units	[redacted]	[redacted]	[redacted]

Appendix –Southdown Non-Transmission Solution

The construction and commissioning timetable for any not-yet commissioned plant?	Conversion of Southdown first unit to stand-alone synchronous condensers could take 6-12 months from award of contract. Subsequent units could also take 6-12 months.
The times the component would be available?	All the agreed units should be available all year around except planned/forced outages.
How far ahead of first use it would be appropriate to contract for your non-transmission solution?	At least 12 Months ahead of first use
How long would you require to respond to a request for proposal if we sought more detailed information.	12 Weeks

Appendix F – Section 7.4 of the AEE submitted August 2003

7.4 STORAGE AND USE OF HAZARDOUS SUBSTANCES

7.4.1 Existing Hazardous Substances

The existing Southdown power station requires the use of a number of hazardous chemicals to be stored and used on site. These are principally used for machine lubrication, transformer cooling and for water treatment, although a bowser of diesel fuel is also maintained for the site standby generator. The existing hazardous substances are generally stored in bunded areas within the building that houses the water treatment system and steam turbine. In addition the generators and transformers containing oil are independently bunded.

7.4.2 Proposed Hazardous Substances

Some additional quantities of existing hazardous substances will be necessary to provide for the additional gas turbine generator. This includes fuel oils and water treatment chemicals. However the principal additional substance required is the bulk storage of diesel.

For other than diesel the storage will largely be in existing facilities. The existing small dangerous goods store will be upgraded to cater for the increase in volumes of hazardous substances stored.

For diesel storage it is proposed to construct two 20m diameter by 15m high mild steel storage tanks. The stored volume of approximately 9,500m^3 represents approximately 30 days fuel storage for one gas turbine generator operating full time. A single bund, containing a gross volume of 6,067 m^3 will be constructed to provide spill containment. This represents 110% of the volume of a tank plus the volume of non-failed tanks contained beneath the coping level of the bund. Because of the confined nature of the proposed storage site, it will be necessary to construct the bunds in concrete with vertical walls.

The bunding area available is 2,274m^2. The bund volume above requires the construction of 2.7m high concrete walls. It is intended that, on the western side, these bund walls will be common with the ancillary buildings to be built as part of the expansion project. Fluid level indication will be via a prominently located visual indicator. Site management procedures will require the bund to be checked daily for water or oil build up. A manually valved sump will be provided to facilitate drainage and this will be packed with an oil absorbing product to remove trace amounts of fuel oil from stormwater during release to the stormwater system.

The diesel fuel storage tanks on site will be filled by road tankers using a purpose built unloading facility. This will incorporate appropriate control facilities. Appropriate valving and tank level indication will be provided in the bunded area.

Additional water treatment capacity is likely to be required on the site to provide the necessary high purity water for NO_2 control for the new gas turbine generator. These facilities are likely to include a reverse osmosis plant and pH correction facility.

Additional bulk storage facilities for caustic soda and sulphuric acid will be provided. Additional 20 litre plastic containers of water additives such as corrosion inhibitor will also be required. Should the number of these increase significantly, a separate bunded storage area will be provided for them.

Similarly, for lubricating oil it is proposed to build a purpose built shed for storage.

7.4.3 Risk Assessment

A risk assessment has been undertaken on all hazardous substances with a HFSP Quantity Ratio (or "Effects Ratio" in the terms of the District Plan) in excess of two. i.e. diesel, oil and sulphuric acid. As part of the methodology a work breakdown structure was produced to separate the hazardous substances into a series of defined sources or elements. This provided a logical framework for identification and helps to ensure significant risks are not over-looked.

Risks were considered under the following sources/elements:

Risks assessed include:

Diesel Fuel:
- Fuel tanks leaking
- Fuel tank filling
- Fuel tank rupture
- Fuel tank fire

Lubricating and generator oils:
- Delivery and unloading
- Handling and transportation
- Storage
- Dispensing of oil into tank or generator

Transformer oils:
- Storage of oil
- Other risks

Caustic soda and sulphuric acid:
- Delivery and unloading of materials
- Storage of materials

Risks have been rated in terms of the likelihood of the event occurring, and the consequences, or potential impact of the event should it occur. Appendix 3 includes details of the risk assessment in a series of tables.

Each risk was prioritised by comparing the scores for consequence and likelihood against the risk criteria matrix, which ranks risks against 6 defined classes or sets, i.e. Negligible, Low, Moderate, High, Very High and Extreme.

In general, all risks prioritised as "high, very high or extreme" require due diligence and appropriate care. Risks prioritised as moderate, low and negligible ranked risks

must be regularly monitored to ensure these risks do not move to a higher ranking as the project develops.

The risk assessment has taken account of the following issues.

- **Separation distance to people sensitive activities**: There are no schools,hospitals or other people sensitive activities in the vicinity of the site. The nearest residential activities are 1.2 kilometres from the site and are shielded by Mt Richmond Domain. Ericsson Stadium is the nearest facility which can hold large numbers of people, which is also over 1.2 km from the site.

- **Location in relation to nearest aquifer, stream or the coast:** The site is less than 100 metres from the coastal marine area.

- **Nature of sub soil and site geology***:* The site has a basalt lava flow layer under less than 2 metres of non engineered fill.

- **Distance to sensitive habitats:** The Mangere Inlet is a sensitive estuarine habitat with mangrove margins.

- **Cumulative and synergistic effects, and bio accumulation of hazardous substances used or stored:** The principal hazardous substance stored is diesel. Other materials are separately stored where appropriate.

- **Fire safety and fire water management:** There is substantial water supply to the site as well and storage in the stormwater pond.

- **Adherence to health, safety and environmental management systems:** Existing management systems and procedures are fully in place.

- **Spill contingency and emergency planning, monitoring and maintenance schedules:** Existing management systems and procedures are fully in place.

- **Site drainage and off site infrastructure:** The existing stormwater containment system is adequate for the proposed activity. However drainage is to wetland areas that feed into the Mangere Inlet. Other off site infrastructure taken into account include rail and road routes, gas lines and transmission lines.

- **The transportation of hazardous substances:** Transportation will be by road tanker.

7.4.4 Environmental Plan

An Environmental Management Plan (EMP) has been prepared and is included in Appendix 3. The EMP reports on matters listed as conditions for Rules 5.5.16 of the 'Proposed Auckland Regional Plan: Air, Land and Water'.

The EMP identifies specific chemical substances held on site and sets out the methods to be used to ensure they avoid contacting stormwater run-off or the method for

separation from retained stormwater. The EMP also identifies appropriate auditing requirements to ensure performance of all components of the EMP.

Specifically, the issues covered are asbestos contamination, stormwater, sludge, storage and delivery of hazardous substances. Asbestos contamination and stormwater are also covered by existing, separate documents. These plans will be amalgamated into single document.

7.4.5 Conclusions

Fuel storage requirements dominate the results of a Hazardous Facility Screening Procedure undertaken for the proposed expansion. Substantial bunding and discharge management facilities will be put in place to manage any risk of gross discharge to the site or surrounding environment. Likewise, all operating machines and transformers will be provided with their own bunded storage allowing managed separation of dripped or spilt oil and treatment of the captured water.

Site management procedures, and particularly spill management procedures will be amended accordingly to cater for the additional volumes of oil and chemicals stored on site and the introduction of a large volume of diesel storage.

7.5 VISUAL AND LANDSCAPE EFFECTS

7.5.1 Introduction

A landscape visual impact assessment has been undertaken by King Consultants and is included as Appendix 4.

The assessment methodology involves describing the landscape character of the area and then evaluating the visual impact of the proposed additional structures on the existing landscape character. This includes assessment of the visibility of the site and proposed structures, and the visual absorption capacity (VAC) of the visual catchment area in which the site sits.

7.5.2 Existing Landscape Character

The Southdown power station is located within the industrial zoned area of Southdown, which in turn backs on to Penrose, a similar industrially zoned area. This landscape is a highly modified one comprising predominantly manmade elements and structures with a high visual absorption capacity (VAC). This includes a number of electricity transmission towers which introduce a vertical element to the landscape together with the exhaust stacks of the Southdown power station and other industries.

The site location is a predominantly flat area on the edge of the Mangere Inlet. However, there are two major natural landforms situated within close proximity. Firstly, Hamlins Hill, a regional park situated immediately to the east, which is largely covered in pasture. This landform separates the power station site from the

Appendix G – Jacobs Fire Risk Review - battery trial

5. Fire Risk Review

Jacobs commissioned WAP Fire Services to undertake a review of the merits of indoor or outdoor location for battery storage units in relation to fire risks.

5.1 Cause and Development of Fire

The lithium – ion battery is statistically a safe and reliable product. In the normal state it is a closed cell.

The principal causes of fire in a battery are:

1) overheating from external heat sources
2) damage to a component or components

Once overheating or damage has occurred the mechanism of fire development is thermal runaway in the battery itself. This would result in physical expansion of the battery and electrical shorts would occur within the battery. Rupture of a cell may result in venting and ignition of gases and cell contents, exposing adjacent cells.

Statistically the principal cause of damage has been from over charging of a battery cell. Other causes are physical impact damage, shorts, and reverse polarity.

The thermal runaway may occur at temperatures as low as 70°C - 90°C.

5.2 Storage Location

The risk due to overcharging is independent of the location of the battery racks. Likewise the risks due to shorts and reverse polarity are independent of location.

The risk due to overheating from external heat sources other than the battery system is less for outdoor storage than for indoor storage, principally due to the physical spread of plant.

Risk of overheating of adjacent units due to battery failure and heat/debris transmission to other units is less for free-standing outdoor storage than for indoor storage principally as the internal walls of the building (or container) will contain heat and smoke which would free vent for units outdoors.

The risk of impact damage is higher for outdoor storage (for a non-containerised BESS) than for indoor storage. The frequency of movements through the indoor storage area is likely to be more than outdoors but the severity of impact is likely to be less as speeds indoors are expected to be lower.

5.3 Severity of Fire

Irrespective of location a fire within a battery storage unit resulting in thermal runaway is expected to result in the loss of the whole storage unit. A fire without thermal runaway is expected to have limited effect.

As above the likelihood of involving more than one unit s greater for indoor storage. The likelihood of the fire involving more than one unit is also greater for indoor storage as access for firefighting is more difficult for indoor storage units than for units located outdoors.

However, with the outdoor option it is likely that the batteries and power conversion units would be housed in separate containers [redacted] which would add an additional level of protection for the PCS units from fires caused by batteries.

Environmentally indoor storage is likely to contain contaminants principally to the room of the fire, whereas outdoors there will be a greater spread with dispersal by wind. The potential contaminants that might be vented by Lithium based batteries during a fire are dependent on the battery chemistry and would need to be verified by the battery suppliers.

Larsson et al (2016)[15] note that the gases released from a Li-ion can be toxic (e.g. CO), but fluoride emissions such as Hydrogen Fluoride (HF) and phosphorous oxyfluoride (POF_3) are of most concern. These are formed from the fluorine content used in the Li-ion cell – the binder (PVdF) and commonly used Li salt hexa-fluorophosphate ($LiPF_6$). Mercury note that the batteries being offered by suppliers are based on [redacted] type.

5.4 Fire Extinguishing Systems

The battery modules under consideration come with built in fire suppression systems. These are likely to be effective in containing the fire to a single battery module / rack, rather than losing the whole storage unit by applying a suppression agent at a temperature below that at which thermal runaway occurs. [redacted]

[redacted]

Interconnection should be made between the storage module alarm systems and the Power Station control room to allow for appropriate response. Fire detection external to the battery units should be connected to the building fire alarm panel and alarm to the Fire Service.

Once thermal runaway has occurred extinguishment is very difficult and effectively the fire continues to burn until the fuel is burnt out but the container will limit fire spread. Conversely the container prevents application of water as an extinguishing agent.

Provision of water spray or foam extinguishing within each individual unit to cool and supress a post thermal runaway fire in other than controlled environment spaces is untested technology. A watching brief on developments should be kept for possible later installation.

5.5 Conclusion

On balance it is considered that siting the storage units outdoor in containers would provide less risk to Mercury. Given the potential for hazardous gases to be released in a battery cell fire, battery suppliers should be required to provide an assessment of potential gases that could be vented in a fire, as well as providing a safety manual which would include appropriate emergency procedures during a fire. This may include keeping people away and allowing the smoke to disperse.

[15] Larsson, F., Andersson, P., Mellander, B., "Lithium-Ion Battery Aspects on Fires in Electrified Vehicles on the Basis of Experimental Abuse Tests", http://www.mdpi.com/2313-0105/2/2/9/htm