

**BEFORE A BOARD OF INQUIRY  
EAST WEST LINK PROPOSAL**

**IN THE MATTER** of the Resource Management Act 1991 (**RMA**)

**AND**

**IN THE MATTER** of a Board of Inquiry appointed under s149J RMA to consider notices of requirement and resource consent applications made by the New Zealand Transport Agency in relation to the East West Link roading proposal in Auckland.

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**SUPPLEMENTARY STATEMENT OF EVIDENCE  
OF JAMES KENNEDY FLEXMAN  
FOR MERCURY NZ LIMITED**

**DATED 30 JUNE 2017**

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## Executive Summary

1. This supplementary statement is filed in response to recent requests from counsel for the New Zealand Transport Agency (**NZTA**) for further information about matters arising from the evidence of Mercury NZ Limited (**Mercury**).
2. The gas-fired thermal station (**Southdown Power Station**) on Mercury's site at Southdown (**Southdown Site**) has established, operated and continues to be maintained under implemented resource consents. There should be an assessment of the safety risks of NZTA's current East West Link proposal on it and the rest of the Southdown Site.
3. The possibility of generators at the Southdown Site being used as synchronous condensers (explained below) does not preclude thermal power generation re-starting at Southdown. What it does do is increase the probability of the Southdown Power Station generators restarting.
4. Mercury understands that First Gas could re-install gas pressure regulation equipment at the Southdown Site within 3-4 months. First Gas has also advised me that First Gas would not want its gas infrastructure to be re-located away from the Southdown Site if that would prevent it supplying gas to the Southdown Power Station in future.
5. In the past, Mercury has undertaken a number of assessments of safety risks in relation to its infrastructure at the Southdown Site. However, those assessments were all undertaken in a different context to one in which an elevated highway and shared pathway would be built directly adjacent to/on top of that infrastructure.

## Introduction

6. My full name is James Kennedy Flexman.
7. I have the qualifications and experience set out at paragraphs 12 to 15 of my statement of evidence dated 10 May 2017.
8. I am authorised to present this supplementary evidence on behalf of Mercury, in support of the company's submissions on the East West Link proposal.

### **Scope of this evidence**

9. In my evidence I will:
  - (a) Explain the context in which this supplementary statement is provided;
  - (b) Discuss aspects of the current Southdown Power Station relevant to a safety risk assessment of NZTA's proposal to locate the East West Link immediately adjacent to that power station;
  - (c) Explain the possible option of using generators at the Southdown Power Station as synchronous condensers and what implications that would have in relation to NZTA's East West Link proposal;
  - (d) Outline my understanding of First Gas' views following a recent discussion I had with First Gas' Chief Executive; and
  - (e) Discuss previous safety risk assessments Mercury has undertaken in relation to its infrastructure at the Southdown Site.

### **This supplementary statement is filed in response to requests for further information from NZTA**

10. In an email dated 16 June 2017 and a subsequent letter, dated 20 June 2017 sent to Counsel for Mercury on 26 June 2017, Counsel for NZTA requested additional information from Mercury in relation to the safety risks raised in Mercury's submission and statements of evidence in relation to NZTA's East West Link proposal.
11. Due to confidentiality of information and irrelevance to the proceedings, this supplementary statement of evidence provides information in response to those information requests for the benefit of the Board of Inquiry, NZTA and all of the submitters on the East West Link proposal.

### **In the first instance, the consented Southdown Power Station is the station that a safety risk assessment of the current proposed location of the East West Link should consider**

12. NZTA has asked for "specific details of the assumptions that underpin [Mercury's] witness' risk evidence in respect of the turbines" and a number of

specific questions were listed relating to the current, or a future “assumed”, power station on the Southdown Site.

13. While it is not entirely clear from the request, I am working on the basis that NZTA is seeking this information to inform an assessment of the safety risks of its current proposal to locate part of the East West Link road and shared pathway on an elevated structure immediately adjacent to the Southdown Power Station.
14. The Southdown Power Station is established on the Southdown Site under already implemented resource consents. Therefore, Mercury considers that, in the first instance, that consented power station is the station that is affected by the proposed location of the East West Link. Mercury agrees that there should be a risk assessment of effects of the proposal on that station and the other activities on the Southdown Site.

#### **Characteristics of the current Southdown Power Station**

15. My team and I identified to NZTA representatives (including Mr Wickman and Mr Nancekivell) many of the characteristics associated with Southdown in meetings, in evidence to this Board, and during a site visit on 2 June 2017 and at the facilitated meeting on 8 June 2017. As NZTA has asked for more information for the Board of Inquiry to understand how the Southdown Site works, Mercury is happy to supply that.
16. While I am not an engineer who undertakes safety risk assessments, in response to NZTA’s requests I have undertaken extra enquiries of Mercury employees to obtain the additional information sought about the characteristics of the Southdown Power Station relevant to safety risks that is not already before the Board of Inquiry in my first statement of evidence or the statement of evidence of Damian Phillis.
17. In addition to my statement of evidence, the Southdown Power Station has the following seven characteristics that may be relevant to the Board and for a safety risk assessment.

### ***Generation capacity***

18. As noted in my evidence in chief, the Southdown Power Station has a nominal generation capacity of 135 MW.<sup>1</sup>

### ***Irregular hours of operation***

19. The operating hours when the Southdown Power Station was running were, apart from maintenance requirements, entirely market and/or power system security driven. This will also be the case in the future whether the generators are used for electricity generation or as synchronous condensers to provide voltage support. Mercury responds to market signals or requests from the System Operator to maintain security of supply and therefore the running hours can be entirely variable. For example, the Station could be operated to coincide with the morning and evening peak demand periods, or it could be run as a baseload generator (i.e. operated at steady output 24 hours per day). It is also possible that it could sit idle (but available to run at short notice) for days on end. However, there have been periods where [GE105] has been started and stopped over 15 times a day and this could be a requirement in the future.
20. At present Southdown Power Station is not generating electricity for the grid but the generators are being preserved to ensure they remain operable in the future. For example, heaters for armature windings throughout the generator stator remain on, the lubricating oil is heated to operating temperature and is circulated to maintain machine condition, the generators are rotated every two weeks to preserve bearings and rotor alignment, the generator package remains dehumidified to minimise corrosion and deterioration and we continue to inspect and complete scheduled maintenance activities throughout the equipment to preserve it in optimal condition. This is a costly exercise but ensures the generators remain available for when they are required to operate again to either generate electricity or to be run as synchronous condensers to provide voltage support to the national grid.

### ***General Electric Gas Turbines***

21. The Southdown Power Station previously used General Electric LM6000 PC gas turbines and, therefore, to the extent that it is relevant, it would be

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<sup>1</sup> Statement of Evidence of James Flexman, para. 38.

appropriate to assume that type of gas turbines in the safety risk assessment. A cut away picture of an LM6000 PC gas turbine similar to those used at the Southdown Power Station is **attached** as **Appendix A**.

***Turbines have a risk of failure***

22. NZTA has asked for information on the “normal failure, and catastrophic failure, probability” of the relevant gas turbines. So far as Mercury is aware, General Electric has not released any information on the rates of disc, or other, failures for its LM6000 gas turbines. However, like any mechanical equipment failures do occur and there is a risk that equipment might fail in the future. A failure mode of gas turbines is disk rupture as I have outlined in evidence in chief. A photograph of a disk that has failed (from an LM6000 turbine) is **attached** as in **Appendix B**.
23. The LM6000 turbine is a very common gas turbine (there are in excess of 1000 of these units in service in industrial applications globally and aeronautical versions of the same have been installed on Boeing, Airbus and McConnel Douglas aircraft for many years throughout the world. There is a considerable difference between the units used in each application. Those on aircraft generate thrust to propel aircraft forward whereas the turbines used for electricity generation generate torque and drive a shaft that turns the rotor within a generator. When used to generate electricity the units are built considerably more robustly and are a lot heavier which means when they fail the consequences are more significant due to the inertia (i.e. energy) released.
24. A number of mechanisms are used to manage the risk from generators and gas turbines including vibration, temperature, and pressure sensors which provide inputs to an engine management control system that monitors machine condition. There are scheduled inspections to check instrument calibration, system functionality, and to visually check the integrity of the machines (which includes boroscopic inspections of the internal components of both the generator and turbine packages).
25. However, as was explained to NZTA at a meeting on the Southdown Site on 2 June 2017, these mechanisms do not guarantee that an imminent disc failure or rotor end cap rupture will be identified before it occurs. For example, even

by using specialised boroscopes, it is not possible to visually inspect all the relevant parts of a gas-turbine to identify cracks or defects as the clearances are just too small to access. This level of inspection can only be performed during a major overhaul where the gas turbine is fully dismantled in a workshop environment where additional non-destructive testing techniques such as ultrasonic and radiographic testing can be carried out.

26. Despite all the above mechanisms and maintenance practises used by Mercury, following a routine inspection Mercury shut down the Southdown Power Station for a period of time in late 2014 due to risks of catastrophic failure resulting from compromised end caps.

***Gas releases occur***

27. NZTA has asked for information on “the frequency of valve release from turbine per hour of operation”. Southdown Power Station would only release material amounts of air and gas during start-up and shutdown. As outlined above the frequency of these releases depends on how often the Southdown Power Station is started or shut-down and, as discussed above, that would be entirely market and/or power system security driven. An image of a rotor end cap is **attached as Appendix C.**
28. NZTA has also asked for information on “attenuation around release valves”. So far as I can determine NZTA wants to know if there are mechanisms that could be put in place to reduce the noise that would be made when the Southdown Power Station was started up and shut-down. Because the Southdown Power Station is currently located well away from members of the public Mercury has never had to investigate noise mitigation measures for the power station.

***Gas pressure station***

29. NZTA has asked Mercury for information on the current and “possible new location” of the gas equipment at the Southdown Site.
  - (a) The current location of the First Gas infrastructure at Southdown is shown on the plan in Attachment Two of my evidence in chief (marked on the diagram as “First Gas Piging Station”).



- (b) Mercury has no information about a change in the location of the First Gas infrastructure on the Southdown Site. Gas supply to a gas fired power station is a critical operational issue and any changes to that supply would need to be studied carefully to ensure they were viable.

***Other matters of concern***

30. NZTA has also asked Mercury to provide information on “any other material issues of concern, with associated probabilities”. A number of matters of concern are outlined in Mercury’s submission, paragraphs 79-94 of my evidence in chief, and paragraphs 28-46 of Damian Phillis’ evidence. The safety risk assessment which NZTA agreed should be undertaken at the facilitated site meeting on 8 June 2017 may also identify other matters of concern.
31. As agreed at the facilitated site meeting on 8 June 2017, the Terms of Reference for that safety risk assessment should be developed collaboratively by NZTA together with Mercury and all the other infrastructure providers at or relying on the Southdown Site. I had anticipated the process for developing these Terms would have commenced the week following the facilitated meeting on 8 June 2017 but at the time of drafting this supplementary statement I have not received any invitation to participate in any such discussion. Once convened, however, this process will ensure that all relevant risks are identified and that the assessment is based on a fully-informed understanding of the infrastructure at the Southdown Site.
32. Unfortunately, due to my belief that NZTA did not act on Mercury’s advice (from as far back as January 2016) that the Southdown Site was being retained by Mercury for the development/reinstatement of electricity generation and due to the timing of NZTA’s BOI process, there has not been enough work done to date on the significant effects on the Southdown Power Station or on the users of the proposed road associated with co-locating the two activities to be satisfied that the road should be introduced into this area. I followed up with Mr Wickman on 23 June 2017 regarding the risk assessment process in the letter **attached as Appendix D.**

**The possibility of generators at the Southdown Site being used as synchronous condensers does not preclude power generation re-starting at Southdown but does increase the probability of the generators restarting**

33. As I noted in my evidence in chief, the Southdown Power Station could in future support continuity of electricity supply not only by re-starting power generation but also, potentially, by providing reactive power support via the operation of existing generators on the site as ‘synchronous condensers’.<sup>2</sup>
34. Mercury is in discussions with Transpower New Zealand Limited about using the Southdown Power Station to provide voltage support to benefit electricity consumers in Auckland and the wider Upper North Island region (north of Huntly) through using its generators as ‘synchronous condensers’.
35. In the wake of the decommissioning of the Otahuhu power station and the closing of the Southdown power station, Transpower has identified that “the power system will not be able to supply the peak Upper North Island load from winter 2021 ... under the N-G-1 security standard.”<sup>3</sup> The supply problem becomes even more acute for winter 2023 following the announced retirement of the remaining Huntly “Rankine” generator units in December 2022.
36. The “N-G-1” security standard requires the grid to be robust to a single asset failure whilst one generator is out of service. A prudent transmission grid owner plans to such a criterion because, in the first instance, a given generating unit may be out of service at any point in time due to necessary planned or unplanned maintenance – “N-G.” The grid, absent said generating unit, should also withstand a credible “N-1” contingency in real time such as the sudden failure of a transmission line or another generating unit. Managing for a credible contingency (“N-1”) whilst a generator is out of service (“N-G”) gives rise to the “N-G-1” nomenclature.
37. This concept is also reflected in the Electricity Industry Participation Code’s “grid reliability standards.” If Transpower reasonably expects the standards not

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<sup>2</sup> Statement of Evidence of James Flexman, para. 29(b).

<sup>3</sup> Waikato and Upper North Island Voltage Management Long-List Consultation, p. 5. See [https://www.transpower.co.nz/sites/default/files/projects/resources/Waikato%20and%20Upper%20North%20Island%20Voltage%20Management%20long-list%20consultation\\_2.pdf](https://www.transpower.co.nz/sites/default/files/projects/resources/Waikato%20and%20Upper%20North%20Island%20Voltage%20Management%20long-list%20consultation_2.pdf)

to be met on the grid over the next five years, it must seek to address the issue.<sup>4</sup>

38. The peak Upper North Island supply issue described in paragraph 42 stems from the risk of voltage instability and blackout following an N-G-1 event. This can be mitigated through generation investment at or north of Huntly, increased reactive power support in the Waikato and/or Upper North Island, and/or reduced winter peak load in the Upper North Island.<sup>5</sup>
39. Transpower considers that mitigation is “unlikely to be met by a single solution” and that a “range of components commissioned at various locations and over time” will be necessary.<sup>6</sup> Transpower has sought expressions of interest (EOI) from parties who consider themselves capable of providing “non-transmission solutions” to address the issue and Mercury has responded to this EOI. A copy of this response is **attached as Appendix E**.
40. In its response Mercury has proposed to provide reactive power support in the Upper North Island by operating its generators as ‘synchronous condensers’ where the Southdown generator shafts would rotate in the absence of gas turbine power. They would be synchronised to the alternating current frequency of the grid. In essence, the generators would function like electric motors drawing power from the grid. However, instead of converting electric power into mechanical work, synchronous condensing generators make use of an automatic voltage regulator to export or import “reactive power” so that voltage on the grid is maintained within safe operating parameters.
41. No decision has yet been made by Transpower on whether or not that would occur. However, it is clear that voltage support at Southdown could be highly effective. Transpower observes that “connecting the reactive devices in the Auckland region generally gives greater benefit... The further the device is embedded in the Waikato region, the less effective the device for voltage support.”<sup>7</sup>

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<sup>4</sup> <https://www.ea.govt.nz/operations/transmission/grid-reliability-standards/>

<sup>5</sup> Waikato and Upper North Island Voltage Management Long-List Consultation, p. 5.

<sup>6</sup> Waikato and Upper North Island Voltage Management Long-List Consultation, p. 5.

<sup>7</sup> Waikato and Upper North Island Voltage Management Long-List Consultation, p. 31.

42. I note that, if it did occur, using the generators at the Southdown Site as synchronous condensers to provide voltage support would not prevent the generators at the site being later returned to service for power generation. This is because when generating electricity it is possible to make adjustments to the generator operation to influence the characteristics of the power being exported to the grid to ensure that voltage stability remains within the parameters set for the safe operation of the grid.
43. Therefore it is entirely possible that the generators will be returned to service as synchronous condensers before the Southdown Power Station is restarted for electricity generation. However, due to the requirement for voltage support being determined by market and/or power system conditions, the timing of when this may happen remains unclear as outlined earlier.
44. If the generators were being used as synchronous condensers the timing for restarting the Southdown Power Station would remain unchanged from the base case scenario where the generators are being maintained as they are currently. (i.e. within the 3-4 month restart period outlined in my evidence in chief). If the Southdown Power Station was generating electricity there would be no need to use the generators as synchronous condensers.
45. The risks to public safety from running the generators as synchronous condensers would be lower compared to running the Power Station as there would be no gas turbines operating, nor would there need to be natural gas re-established onto the Southdown Site. However, the risks associated with catastrophic failure of the generator (i.e. following end cap rupture that I outlined in my evidence in chief) would still exist.

**First Gas could re-install gas pressure regulation equipment at the Southdown Site within 3-4 months and would not want to be re-located away from the Southdown Site if that would prevent it supplying gas to the Southdown Power Station in future**

46. Mercury was not aware that there was any proposal to move the First Gas infrastructure either within, or away from, the Southdown Site until NZTA's rebuttal evidence was lodged on 20 June 2017. (The issue was not mentioned

at the facilitated meeting in relation to the Southdown Site that was held on 8 June 2017).

47. I have subsequently personally spoken to the Chief Executive at First Gas, Paul Goodeve who has confirmed to me that should Mercury need to restart the Southdown Power Station it would be possible to reconnect the Southdown Site's gas supply to the First Gas high pressure pipeline within the 4 month timeframe I have outlined in my evidence.
48. When I spoke to Mr Goodeve he also advised that:
  - (a) If Mercury decided to re-start thermal power generation at the Southdown Site in future First Gas would be willing to supply gas to Mercury to enable that generation to occur.
  - (b) There are safety risks associated with co-locating the proposed road and the existing gas lines. If the road went ahead they would have to be moved and that would have to work in with the Power Station. In particular, First Gas has advised NZTA that, if the East West Link was constructed in the location it is currently proposing, First Gas would want the gas infrastructure on the Southdown Site to be relocated (at NZTA's cost) so that it was not directly underneath the proposed road/shared pathway structure as that would not be consistent with its safety requirements.
  - (c) While NZTA has raised the possibility of relocating the First Gas infrastructure away from the Southdown Site, First Gas would not want to do that if it would prejudice its ability to supply gas to a Mercury power station at Southdown in the future.

**Historical assessments of safety risks have been undertaken in relation to infrastructure at the Southdown Site**

49. In the past, Mercury has undertaken a number of assessments of safety risks in relation to its infrastructure at the Southdown Site. However, those assessments were all undertaken in a different context to one in which an elevated highway and shared pathway would be built directly adjacent to/on

top of that infrastructure. I have reviewed a number of these assessments. They make statements like:

- (a) The site has a remote location away from large concentrations of people.
50. Mercury has identified the risks to the public it considers to be relevant to the location of the proposed road within the Southdown Site. Mercury has not undertaken an assessment of the identified risks and does not seek to limit the risks to those identified in the Company's submission.
51. Mercury identified relevant risks to people, property and the environment from its activities in Section 7.4.3 of the AEE submitted in August 2003 before the variation to Mercury's land use consent was granted in January 2004. That variation concerned the GE105 expansion at Southdown Power Station. Of course this assessment was undertaken in a different context to one in which an elevated highway and shared pathway would be built directly adjacent to/on top of that infrastructure.
52. Section 7.4.3 of the AEE addresses relevant risk assessment matters and a copy of it is **attached** as **Appendix F**. The primary focus was on risks and management protocols associated with handling of hazardous substances. Underpinning this risk assessment (which focuses on environmental risk) are a list of assumptions, including the assumption that the separation distance between GE105 to people and sensitive activities, which appears to be a mitigating factor, when considering health and safety risk to people. For example, it states:

***"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."*

53. From my perspective any change to the receiving environment and sensitive receptors in terms of proximity to the authorised Power Station activities, which could have a material effect on the ability for Mercury to use the current land use consent, should be re-addressed.
54. NZTA has also expressed an interest in Mercury's maintenance regime. Of course Mercury has undertaken a maintenance program to ensure risks associated with mechanical plant are minimised. The scope and number of the maintenance assessments that have been undertaken in the past for mechanical processes associated with the operation of the thermal power station at Southdown are extensive. Mercury does not consider that mechanical reports outlining wear and tear, plant reliability or product defects will be of any use to the Board or assist with assessing risks other than to acknowledge that routine maintenance is a mitigating factor for the uncertainties around the probability and impact of catastrophic failure.
55. NZTA has requested the risk assessment Mercury undertook before it recently installed a grid-scale batteries trial at the Southdown Site. As part of a wider prefeasibility study, Mercury engaged Jacobs to undertake a fire risk review of that proposal. A copy of that fire risk review (with some commercially sensitive information redacted) is **attached** to this evidence as **Appendix G**.

## Conclusion

56. I note that NZTA's information request focuses quite heavily on the "probabilities" of certain things happening. However, a risk assessment has to consider two aspects of a risk – both the probability of it crystallising and the potential consequences if it does crystallise. Mercury has always acknowledged that some of the safety risks Mercury has identified (e.g. disc failures and rotor end cap ruptures) are of low probability. However, the potential impacts of those risks are very high, particularly if an explosion or a discharge of metal projectiles occurred right next to a busy highway.
57. Mercury acknowledges that it would have been better if the safety risks of NZTA's current East West Link proposal had been identified earlier in its discussions with NZTA. However, given the nature of the risks, once Mercury had identified those safety risks it could not really do anything but raise them.

Mercury is not seeking to sensationalise the risks, but it is very concerned about them.

58. Mercury remains willing to work with NZTA to avoid the road creating these problems. However, as NZTA is the one proposing to change the current situation at the Southdown Site, now that safety concerns have been identified, it is NZTA's responsibility to provide evidence to the Board of Inquiry that its current East West Link proposal is capable of being constructed and operated in a way, and (if so) would be constructed and operated in a way, that would have an acceptable level of safety for both East West Link users and workers and visitors at the Southdown Site. It is not appropriate for NZTA to place the obligation of undertaking that assessment on Mercury and it is not appropriate for NZTA to place the risk of the East West Link not being able to be safely co-located on the Southdown Site with the existing infrastructure on Mercury.



**James Kennedy Flexman**

30 June 2017

### **Appendices**

- (i) **Appendix A** – Sectionalised Diagram of an LM6000 PC Gas turbine.
- (ii) **Appendix B** – Example of a failed gas turbine disk.
- (iii) **Appendix C** – Schematic of a Generator showing the Retaining Ring (which Mercury refer to throughout its evidence as End Caps).
- (iv) **Appendix D** – Letter to Scott Wickman dated 23 June 2017.
- (v) **Appendix E** – Mercury response to Transpower's expression of interest.
- (vi) **Appendix F** – Section 7.4 of the AEE submitted in August 2003.
- (vii) **Appendix G** – Jacobs Fire Risk Review - battery trial.



