

APPENDIX 1 The Inquiry Process

The Inquiry work and approach was based on the Ministerial Terms of Reference for the Ministerial Inquiry into Aspects of the Auckland Power Supply Failure.

The Inquiry was given the power to develop its own procedures in the Terms of Reference. The procedures adopted are outlined in this appendix.

To meet the Terms of Reference:

The Minister of Energy, Hon Max Bradford, appointed the following Inquiry members:

- Mr Hugh Rennie QC, MBE, Chairman
- Dr Keith Turner
- Mr Don Sollitt.

Inquiry Secretariat

To service the Inquiry the following Secretariat members were appointed to provide the necessary professional and administrative support to meet the Inquiry Terms of Reference:

- Mr John Gilbert, Inquiry Manager
- Mrs Diana Barker, Inquiry Secretary
- Ms Paula Rebstock, Inquiry Analyst.

The Inquiry Secretariat office was at the following address:

Level 5
Ministry of Commerce Building
33 Bowen Street
PO Box 1473
Wellington

The Inquiry Secretariat provided the following services:

- Established the Inquiry Office and notified this by public advertisement
- Distributed information to the public
- Provided administrative support to the Inquiry members
- Placed public notices, received and recorded public submissions
- Provided, where necessary and as appropriate, administrative support to professional contractors retained by the Inquiry
- Arranged for draft material to be circulated to Inquiry members
- Arranged Inquiry sittings and site visits for Inquiry members
- Arranged travel for Inquiry members
- Reviewed and arranged for payment of accounts, fees etc.

Inquiry Website

The Inquiry set up a Website: <http://www.moc.govt.nz/inquiry>. This proved to be a very satisfactory way to communicate information generated by the Inquiry members and Secretariat. It was a means of making the Technical Report by Integral Energy available within 24 hours of its completion.

Website Information Provided

Technical Reports

Integral Energy Australia reports:

- Distribution Planning Review – 8 May 1998
- Cable Failures – 8 May 1998
- Summary of the above two reports – 8 May 1998

General Information

- List of Submissions – 22 May 1998
- Summary of the Establishment and Corporate Governance Structure of Mercury Energy Limited – 15 May 1998
- Procedure for Inquiry – 13 May 1998
- Public Notices in the *New Zealand Herald*
 - 1 April 1998
 - 8 May 1998
- Background on Inquiry Members
- Media Releases
 - Integral Energy Australia Technical Reports – 9 May 1998
 - Technical Consultants – 9 April 1998
 - Electricity Inquiry Opens to Public Submissions – 2 April 1998
 - Max Bradford, Minister of Energy – 12 March 1998
- Inquiry Terms of Reference.

Management of Consultants

- Consultants appointed by the Inquiry covered the following areas:
- Provision of technical reports: Integral Energy Australia
 - Distribution Planning Review
 - Technical Report – Cable Failures
- Review of Integral Reports: EA Technology, UK
- Supporting consultancies covered the following areas:

- Media Analysis
- Submissions Review
- Editorial and Publication Design
- Document printing and dissemination
- Actuarial assessments.

Communications

The Inquiry used the following approaches to communicate the Terms of Reference, procedure, information requested and received and public sittings.

Public Notices

Two public notices were placed in the *NZ Herald*. These were:

1. 2 April 1998

- Inquiry Members
- Inquiry Process
- Submissions and provision of information
- Advance notice of intended submissions
- Access to submissions and information
- Sittings of the Inquiry
- Notice of submission closure and public sittings dates
- How to contact the Inquiry

2. 9 May 1998

- Technical report
- Report order details
- Submissions process and closure
- Sittings dates and procedures.

Press Releases

The Inquiry issued three press releases:

1. 2 April 1998

- Electricity Inquiry opens to public submissions

2. 9 April 1998

- Technical consultants appointment.

3. 8 May 1998

- Integral Energy Australia Technical Reports

Media covered were:

- NZ Herald
- Wellington Dominion
- Wellington Evening Post
- Reuters
- Radio NZ
- NZ Press Association
- Christchurch Press
- TV3
- TVNZ
- Manukau Daily News
- Independent Radio News
- National Business Review
- Independent
- Dow Jones
- Newstalk ZB

Information Availability

The following reports and information associated with the Inquiry have been printed by:

Plan & Print
 2 Gillies Avenue
 Newmarket
 PO Box 9887
 Auckland
 Telephone: (09) 523 1023
 Fax: (09) 523 3114
 Email: copy@planandprint.co.nz

- Integral Energy Distribution Planning Report
- Integral Energy Cables Failures Report
- Integral Energy Summary Report
- EA Technology Report
- 23 Submissions to the Inquiry
- Transcripts of Inquiry Sittings – week 1 (26–29 May)
 – week 2 (2–5 June)

Inquiry Report

A decision on the publication of the Inquiry Report will be made by the Minister of Energy.

Procedure for Inquiry

The Inquiry set out the following procedures for its investigations:

This statement of procedure has been adopted by the Inquiry pursuant to authority, delegated from the Minister in the Terms of Reference, to determine the procedure and practice of the Inquiry.

It is intended to provide both a guideline and an operative statement, but the procedure may be varied in particular instances.

General procedure

The Inquiry has notified its programme of work by public notices inserted in the *NZ Herald* and posted this on the website. Having obtained and published a technical report, as directed by the Minister, submissions have been invited, and the Inquiry will consider those submissions.

The Inquiry will hold public sittings in Auckland. The Inquiry may also seek information from persons, whether they have made submissions or not. Information may be sought and obtained by correspondence, or by personal communication. This may occur before, during, or after the public sittings.

The Inquiry will obtain and consider such technical, expert, and other advice as it thinks appropriate. Where necessary this will be referred to those affected by it for response.

Except where the Inquiry determines otherwise, the technical reports, supporting documents held by the Inquiry, submissions, and other communications to the Inquiry will be publicly available. Where possible, information in full or summary form will be published on the website established by the Inquiry (www.moc.govt.nz/Inquiry).

Sittings of the Inquiry

It is already apparent to the Inquiry that information from the technical reports, written submissions received and to be received, and other material will need to be considered at meetings with persons providing that information, and others affected by it.

To undertake this in an organised manner, and one which is publicly accessible, the Inquiry has decided to hold public sittings at The Sorrento in the Park Conference Centre in Auckland between 26 May and 5 June.

Daily Sitting Times

Mornings: 9.30 am – 1.00 pm
 Afternoon: 2.00 pm – 4.30 pm.

The Inquiry is an investigation not a Court. The public sittings it holds are for its purposes in considering information and submissions presented to it.

In general, the Inquiry intends to follow a similar procedure in these sittings to that followed by select committees of Parliament. Where this procedure does not provide for a matter, the Inquiry will consider the practices adopted by select committees as a guide.

The Inquiry will invite persons to attend, at stated times, to support, discuss or respond to matters raised in the submissions or by the Inquiry. There is no power to compel attendance, or to compel the production of any documents or other information.

It must not be assumed that any particular persons will be invited to attend, or given an opportunity to meet with the Inquiry. All relevant information must be included in the written submissions lodged with the Inquiry. This will ensure that all matters are brought to the attention of all persons affected by the investigation, and that they have an opportunity to respond to this material. Such response may be in writing, or by requesting time at the public sittings, or both.

Persons attending the public sittings may be accompanied by legal or other advisers. Such persons are there to advise and assist those attending. The sittings are not hearings, there are no parties to the process, there are no rights of appearance, and there will be no cross-examination or other interchange between the different persons involved. However, the role and value of expert counsel in the presentation of material is acknowledged, and legal advisers may participate in such presentations accordingly.

If a person invited to attend the Inquiry desires to make an opening statement, this must be arranged in advance. Persons may be requested to return from time to time to assist in respect of further issues and lines of inquiry. It is intended to allow those directly affected by the Terms of Reference to present any additional material arising from the sittings at the conclusion on 5 June.

Procedure at sittings

Sittings of the Inquiry are conducted by the Inquiry under the delegated authority of the Minister. They will be open to the public, but entry is on condition that those attending conform to the Inquiry procedure. The Inquiry may hold all or any part of any sitting in private, or with the attendance of nominated persons only. The Inquiry may sit in private with or without recognised journalists present. Any person present may be directed to leave, for stated reason, by the Inquiry.

A real time electronic transcript will be available. Where any person attending the sitting wishes to obtain electronic access to that transcript, arrangements must be made with the contractor providing the transcription service. The contractor details can be obtained from the Inquiry Secretariat.

Copies of the technical reports, submissions, and a transcript of the sittings of the Inquiry can be obtained from the appointed document copying agents of the Inquiry, Plan and Print, PO Box 9887, Newmarket, Auckland. Phone (09) 523 1023, fax (09) 523 3114. Email: copy@planandprint.co.nz on payment of copying and delivery charges.

Persons providing information at the sittings will do so voluntarily. They will not be sworn, and there are no special statutory provisions as to confidentiality, privilege, or immunity. The general law on these matters applies and any person concerned as to their position should take their own advice. If a person wishes to take an oath or make a declaration, this will be

permitted. The Inquiry may ask that information given orally be committed to writing; and that copies of the transcript of evidence or written submission be signed correct by the person or persons who gave the information.

Persons particularly affected by the Terms of Reference who wish to be present throughout the public sittings may make reasonable arrangements with the secretariat for a position in the conference room, and where possible a table and other suitable facilities will be provided.

The media may attend. Unless otherwise directed by the Inquiry, all matters may be reported without restriction. It will be the responsibility of the media to ensure that it holds consent of those appearing before the Inquiry to the use of their material. If such consent is not given in any case, then that limitation will have to be accepted by the media. Subject to this, electronic media may tape the sound content and visual content occurring in the conference room. One television camera per television organisation will be permitted, to be operated from a single fixed position to be agreed in advance with the Inquiry. Any lighting or sound equipment must be so placed as not to obstruct or otherwise affect the work of the Inquiry.

While the Inquiry expects that all three members will be present during sittings, this is not a requirement of the Terms of Reference and particular aspects of the investigation may be conducted by two or one members of the Inquiry.

APPENDIX 2

Submissions and Correspondence

Company/Private Citizen	Contact	Position	Formal Written Submission Received No.
Auckland City	Bryan Taylor	Chief Executive	10
Auckland Energy Consumer Trust	A G M Kermode	Secretary to the Trust	20
Auckland Energy Consumer Trust	Peter F O'Brien	Chairman Interim Trustees	
Auckland Regional Council	Jo Brosnahan	Chief Executive	23
Barrington-Wellesley Group Inc	Michael A Laros	Managing Director	
Braithwaite W R			3
Brierly L			
Building Code Consultants Ltd	Kelvin Walls	Principal	17
Cardwell Geoff			2
Connell Wagner Limited	Eric Engelbrecht	Principal	
Dwyer Tim			4
Electricity Engineers' Assn of NZ	Peter Berry	Executive Director	
Energy Efficiency & Conservation Authority	Dr A J Ellis	Chairman	19
Engineers for Social Responsibility	Prof J L Woodward	Convener ESR Working Party	6
Gardenier Consulting	John Gardenier	Risk Assessment Consultant	5
GEC Alsthom	Geoff Hunt	Managing Director	
Green Mark			
Hulme P D			12
John Collinge, Barrister and Solicitor	John Collinge	Barrister and Solicitor	8
Jones Fee Barristers & Solicitors	Greg Jones	Partner	
Leyland Consultants	Brian Leyland	Electrical Engineering Consultant	15
Major Accommodation Providers of NZ	David Campbell	Executive Officer	16
Mercury Energy Limited	Dr Patrick Strange	General Manager – Future	21
Mercury Energy Limited	Rosanne Meo	Independent Director	
Mercury Energy Limited	H C Keyte QC	Legal Counsel	
Ministry of Civil Defence	Ron Pilbrough	Commissioner	
Ministry of Consumer Affairs	Keith Manch	General Manager	7
Nunns Denis		Retired Consulting Engineer	
Odyssey Energy Ltd	Roger J Loveless	Director	14
Pirelli Cables Ltd	Dr S R Norman	Engineering Director	
Power for Our Future	K H Peter Kammler	Spokesman	1
R B Arlidge & Assoc	Robert Arlidge	Director	11
Retail Merchants Association of NZ	Barry Hellberg	Government Relations Consultant	9
Sprott T James	James T Sprott	Consulting Chemist, Forensic Scientist	18
Sustainable Energy Forum	Ken Piddington	Convener	13
Transpower NZ Ltd	Bob Thompson	Chief Executive	22
Western R C		Consulting Electrical Engineer	
Williams Derek			

APPENDIX 3 Technical Terms & Glossary

Term	Simplified Description
AEPB	Auckland Electric Power Board
Amperage	Strength of electrical current measured in amperes
Cable	A network connection element, usually buried underground
Capacity	The electrical rating of an item of equipment. Indicates the maximum continuous amount of electrical energy which the equipment has been designed for
Circuit	Electrical apparatus connected in a configuration such that current will flow if an EMF is applied
Circuit breaker	A switch used to isolate sections of the network
Conductor	A material that has the property of allowing current to flow easily through it. A part of a cable, switch or transformer which has the specific function of carrying current
Contingency Event	A failure of a network element (e.g.: cable, transformer, etc) which causes a circuit to fail
Control Cable	A cable which does not carry electricity for distribution to customers, but which allows the control, monitoring and protection of the electricity network
Cyclic loading	A load profile whereby the load is not constant over a period of time, but rather varies between time periods
Degree of Polymerisation	A test undertaken to measure the length of the chains of cellulose molecules. This gives an indication of mechanical strength of insulation papers and is linked to electrical performance, age and condition of the cables
Dielectric losses	Electrical losses caused by the physical properties of the insulator. These predominantly manifest themselves as heat
Differential protection	A circulating current system that senses electrical faults on items of equipment by monitoring for the imbalance in the current flowing through the equipment
Distribution	The conveyance of power to consumers by means of low voltage networks
Distribution System	The local electricity network which delivers electricity to individual streets and buildings
Double contingency event	The concurrent loss of two circuits supplying a single load, or area of load
Duct	A channel or tube for conveying a cable (usually buried)
ECNZ	Electricity Corporation of New Zealand
EHV	Extra high voltage
Emergency Rating	The electrical rating of a network element or item of equipment which the item of equipment can be subjected to for short periods of time
EMF	Electromagnetic field – the electric field arising from the presence of voltage and current
Fault Current	Maximum current that can flow through the cable or equipment in the event of a fault such as a short circuit occurring
Feeder	An overhead line or underground cable which provides supply to a load or part of the distribution network
Frequency	Frequency is the number of cycles per second and expressed in Hertz (Hz)
Generator	A generator produces electrical energy. Most generators are driven by a source of mechanical power such as a diesel engine, a hydro-turbine or a steam or gas turbine
HV	High voltage
Insulation	Insulation of a cable Insulating materials incorporated in a cable with the specified function of withstanding voltage Conductor insulation Insulation applied on a conductor or a conductor screen Impregnated Paper insulation Lapped insulation consisting of paper impregnated with an insulating material
Insulation Oils	Oil is often used as it is a better insulator than air. Also, convection currents in the oil help carry heat away from the windings and core of transformers. The oil is not used as a lubricant
Insulators	Devices that are made of a material which does not allow current to flow through them
Isolate	To physically separate electrical equipment from the supplying network
kPa	Kilopascal, a measure of force per area or pressure. The “k” represents one thousand
kV	Kilovolt, an SI unit of apparent power

kVA	Kilovolt amperes, an SI unit of reactive power
kW	Kilowatt, an SI unit of active power
kWh	Kilowatt-hour, a unit of energy
LV	Low voltage
Maximum Continuous Rating	The maximum current that equipment or cables can carry indefinitely
MEL	Mercury Energy Limited
MVA	Megavolt ampere, an SI unit of apparent power. The "M" represents 1,000,000
Network Element	A discrete item of equipment which forms a part of the electricity supply network
Network System	Generally operates at a lower voltage than the Transmission System and will include multiple voltages. The Network System provides the equipment to transform the voltage to required supply levels. Used to distribute electricity to end users
Normal Rating	The electrical rating of a network element or item of equipment for which the item of equipment has been designed to operate continuously
NZED	New Zealand Electricity Department
Over-current	A current above the maximum continuous rating. Short-time rating levels are typically much higher than the maximum continuous rating
Over-voltage	Voltage above the normal limit for voltage supply
Overhead line	A power transmission line that is suspended from insulators that are themselves supported by towers or poles
Overload	A load on the system which exceeds the rated value for the equipment
Power Factor	The ratio of active power (kW) to reactive power (kVA)
Protection	Equipment added to the network to (a) isolate faulty equipment so that the remainder of the system can continue to operate successfully, (b) limit damage due to overloading, overheating, and mechanical forces, and (c) to ensure public safety
Rating	The electrical capacity of a network element or item of equipment, usually expressed in MVA
Reclose	Reconnect a circuit. Automatic reclosing is commonly done by circuit breakers. When a fault is detected the breaker opens the circuit and a short time later attempts to reclose. If the fault persists the circuit breaker stops trying to reclose
Resistance	The resistance determines the current that will flow when a voltage is applied. As the resistance increases the current will decrease if the voltage is constant. Resistance is measured in Ohms Ω
SCADA	Supervisory Control and Data Acquisition. Mercury Energy uses such a computer system to collect data about the state of its network
Short Circuit	Circuit where a fault causes a low resistance path between conductors. Current flows through this path rather than to the intended load. Short circuit currents are very much greater than the normal current supplied by the circuit. Voltage problems also result
SI Units	International system of units of measurement (Fr Systeme Internationale)
Single contingency event	An independent event which causes the loss of a single circuit or network element. For planning purposes the loss of the circuit with the highest capacity is assumed
Single Core Cable	A cable having only one core or conductor
Soil Thermal Resistivity	The resistance to heat flow of soil is its resistivity. A low soil resistivity ensures that heat is rapidly conducted and hot spots do not form
Subtransmission System	Localised transmission of power from grid exit points through to the distribution network [excluding 110 kV circuits, as defined in report]
Switchgear	Electrical equipment that provides switching, i.e. opening or closing a circuit
Transformer	Electrical equipment that transforms voltage and current from one level to another
Transmission	The bulk transfer of power by high voltage links
Transmission Line	An electricity line, constructed with poles, pylons or towers (or all three) which forms a part of the transmission system
Transmission System	The "national grid". This is operated by a company called Transpower. They manage the transmission system voltage level and frequency throughout New Zealand
Voltage	Electromotive force expressed in volts
Watt	SI unit of power
Zone Substation	A zone substation in the Mercury Energy network is a substation which provides supply to the distribution network at either 6.6 kV or 11 kV

Source: *Mercury Energy, 1998;*
Integral Energy, 1998;
Inquiry members, 1998.

APPENDIX 4

Technical Reports Terms of Reference

As part of the Inquiry's initial work, technical reports were commissioned from Integral Energy on two aspects:

- A review of the distribution planning that gave rise to the installation and ongoing management of the assets that failed; and
- The causes of the cable failures themselves.

After receiving the reports there was a process of review and examination of the reports, including a further overseas review by EA Technology and examination at the Sitings and through other communications. In addition the material in the reports was further developed by Integral Energy during presentations to the Sitings.

The Terms of Reference for the technical reviews are provided below. For the sake of brevity, only the sections of the Terms of Reference that contain specific tasks are provided.

Distribution Planning: Specific Tasks

- i. Undertake a review of the distribution planning process undertaken by Mercury Energy and undertaken by the Auckland Electric Power Board (AEPB, Mercury's predecessor). The AEPB's planning process should be reviewed back as far as the dates when the cables were initially installed (subject to the availability of adequate information from AEPB files). The planning process should be compared to international practice of a reasonable and prudent operator (e.g. in the UK, Australia, Canada).
- ii. Review the distribution plans that were prepared relating specifically to the power supply of the central business district. These plans should be benchmarked against those that would be expected by a reasonable and prudent operator adopting internationally acceptable and prudent practice, as would be the case for a city the size of Auckland (both in geographical area and population).
- iii. Identify the specific technical arguments that gave rise to Mercury Energy's commitment to a tunnel for replacement 110 kV cables in 1995 or thereabouts. Consultants should specifically comment on the analysis of the existing CBD supply capacity, demand projections for the CBD and the failure risk of the existing cable supply system.
- iv. Evaluate Mercury's contingency planning for failure risk of the CBD power

- supply. Compare this contingency planning to that which might be expected for a city of a size similar to Auckland. Specifically identify contingency planning which covers the loss of all four cables and identify the extent of preparedness for such a loss.
- v. Review the operating practices utilised by Mercury in relation to power supply to the CBD. Identify operating standards and compare those standards with internationally accepted reasonable and prudent practice for the assets that were in place.
 - vi. Comment on the specific plant operating capacities of the CBD supply system and in particular the seasonal variation of those operating capacities. Compare the operational capacity with historical and forward demand projections and evaluate the capability and risk associated with the supply system to the CBD.
 - vii. Review the integration of Mercury's planning process with that of Transpower in regard to the establishment of both acceptable risk management for CBD power supply and cost optimisation of that power supply. Specifically comment on the degree of integration between the distribution and the transmission planning process, particularly as it compares with international practice for a city of similar size to Auckland.
 - viii. Identify if there have been any regulatory impediments to achieving secure power supply to the CBD.
 - ix. Identify any systematic or systemic change to distribution planning procedures, plans and standards that can be identified over the past 25 years."

Cable Failures: Specific Tasks

- "i. Report on the common causes of cable failure in gas and oil 110 kV cables similar to the ones installed in Auckland.
- ii. Identify any internationally known weaknesses or inadequacies that might be associated with the type of cables utilised by Mercury for the CBD supply (both gas and oil cables).
- iii. Identify and evaluate the failure history of the current cables, any trends in that failure history, the suitability of repair methods and whether previous failures have been a contributory cause to the current failure.
- iv. Review Mercury's evaluation of the cause of the cable failures.
- v. Review the suitability of the design and manufacture of the four cables, their fitness for purpose, maintenance standards, and the asset management practices

in place. Identify any other organisational practices that could influence their life and performance, recognising the technology available at the time they were installed.

- vi. Comment on the suitability of the cables for the Auckland geological conditions.
- vii. Comment on the ground conditions in which the cable has been laid, the quality of the materials used for backfill and any risks that might be associated with those materials.
- viii. Determine if meteorological conditions were a contributory or major factor in the cable failure. Specifically identify whether adequate ground water measurements have been taken and whether Mercury's monitoring procedures were sufficient to identify failure risk due to the meteorological conditions prevailing at the time the failures occurred.
- ix. Review Mercury's cable monitoring procedures and the data on cable performance over time, covering the period since the cables were installed.
- x. Comment on the actual mechanism of the failure for each cable and whether there are common elements associated with the mechanism for each cable.
- xi. Identify whether appropriate expertise has been available when critical decisions have been taken with regard to the management of these cables, taking into account their age and condition, specifically covering the last 10 years up to 1998.
- xii. Any other factors that the consultant considers important to identifying the cause of cable failure."

Integral Energy Australia Technical Consultants

Jeff Allen managed the Integral Energy Australia technical team contracted to prepare the Planning and Cable Failures Reports. Mr Allen, General Manager Integral Energy, has 35 years' experience within the electricity supply industry. He is a Fellow of the Institution of Engineers, Australia, and holds the office of Chairman of the National Committee on Electrical Energy. He is currently responsible for the overall planning, design, development, construction, maintenance and operation of Integral Energy's electrical network from the grid exit points to customer meters.

Michael Tamp led the team on distribution planning. He has 20 years' experience in the electricity supply industry, both with TransGrid at the transmission level and with Integral Energy at the distribution level. Mr Tamp is currently the convenor of the NSW Electricity Industry, Demand Side Management Code Working Group and has been a member of the ESAA Reliability Subcommittee of the Planning, Operations and Control Committee that prepared the SAA Guidelines for Reliability Assessment Planning.

Ty Christopher worked in association with Mr Tamp on the Distribution Planning Report. Mr Christopher has over 10 years experience in the electrical supply industry. Mr Christopher is at present responsible for the Asset Management of Integral Energy's Transmission and Distribution network.

Henry Kent led the team for the investigation of the technical aspects of the work on the cable failure. Mr Kent is currently Manager Transmission Mains, responsible for the management of the branch involved in the design, construction and maintenance of Integral Energy's overhead and underground transmission system, including Survey and Mechanical Design. He has 27 years experience in the planning, design, asset management, maintenance and construction of transmission and distribution system infrastructure and components.

George Bucea worked in association with Mr Kent on the Cable Failures Report. Mr Bucea is TransGrid's Senior Engineer HV Underground Cable Projects. Mr Bucea is responsible for the design, route investigation, specification and contract administration of HV cable installations up to and including 330 kV, throughout TransGrid's transmission system.

Both Mr Kent and Mr Bucea are recognised internationally for their knowledge of high voltage insulated cables. They are both members of the International Conference on Large High Voltage Electric Systems (CIGRE). CIGRE is an international organisation founded in France in 1921. The objective of CIGRE is the development of technical knowledge and information exchange between countries regarding generation and high voltage transmission of electricity.

EA Technology Technical Consultants

George Balcome, Group Director, Substation and Cable Services, EA Technology, oversaw the preparation of the report Review of the Integral Energy Technical Report – Cable Failures, following the Auckland Power Failure. George Balcome is a Chartered Engineer and Fellow of the Institution of Electrical Engineers. He has had over 30 years' experience in three UK electricity companies, most of which has been associated with the specification and maintenance of network assets. Prior to joining EA Technology in January 1995 he was a senior engineering manager at a number of UK electricity companies. This experience includes management of the restoration process for a UK REC after the 1987 hurricane that devastated southern England.

Barry Harrison, Principal Cables Consultant, EA Technology, was the author of the EA Technology Consultancy Report Review of the Integral Energy Technical Report – Cable Failures, following the Auckland Power Failure. He has wide experience and knowledge of the design, manufacture, installation, operation, maintenance, failure examination and repair of both gas and oil supertension cables, gathered during 20 years of responsibility for such cable systems during his service within the UK electricity sector. He personally carried out failure investigations on supertension cable systems and his work on the multiple failure of gas compression cables supplying the City of Liverpool (similar in size to Auckland) led to a major programme of cable replacement and provided the most complete explanation of the failure mechanism to date.

Since joining EA Technology in 1995, he has investigated several supertension cable failures, and provided consultancy services with regard to supertension cable systems to loss adjusters, insurance companies and major cable manufacturers. A recent consultancy involved the design, specification, type testing and installation of a 2000 sq mm 132 kV cable system rated at 460 MVA.

APPENDIX 5

Integral Energy Reports Conclusions

Note: *The Integral Energy Reports were commissioned at an early stage in the Inquiry's investigations and were further elaborated on and explored during the Public Sittings. Where there is any conflict between Integral Energy's conclusions and the findings of the Inquiry, the latter represent the Inquiry's view.*

Investigation Methodology

To answer the questions posed by the Inquiry, Integral Energy Australia used the following investigation process:

- Integral Energy first established the industry standard practice appropriate for supplying electricity to a city the size of Auckland using where appropriate published data and drawing upon industry practice and experience;
- Integral Energy then established the practices applied in supplying electricity into Auckland CBD and the events surrounding the power supply failure; and
- Integral Energy compared industry standard practices with those applied in the CBD, enabling conclusions to be drawn on the cause of the power supply failure.

In determining the facts surrounding the power failure Integral Energy established its findings based on site visits, examination of documentation and technical records, examination of the failed cable components and discussions with relevant people from Mercury Energy, Transpower New Zealand and others as required.

Based on the investigations and the technical assessments undertaken, Integral Energy concluded the following:

1. “The load forecasting methodology used by Mercury Energy was not highly sophisticated but is consistent with internationally accepted practice.
2. Mercury Energy's approach to systematic reviews of the electricity supply network is in accordance with industry practice.
3. The general approach to the planned evolution of electricity supplies into the CBD is consistent with industry practice and has led to an electricity supply network appropriate for a CBD area the size of Auckland.
4. Delays were experienced in securing a route for the cable tunnel that would carry additional 110 kV cables into the CBD. Based on recent load forecasts

the fifth cable from a planning perspective will now not be needed until the year 2000. However, if the project had been completed to the original timetable the power supply to the CBD would have been more secure.

5. The problems associated with the reliability of the gas cables did draw the focus of Mercury's network planners away from a more comprehensive understanding of the total supply security issue. This distraction is not considered to be a direct contributor to the loss of supply.
6. Mercury Energy's network planners made judgements based on the information provided by the cable asset managers. If the network planners had been aware of the actual loading capability of the underground cables the network planning and contingency planning approaches may have been different. This may have avoided the loss of supply to the CBD. This is considered to be one of the central issues related to the failure in supply.
7. The risk management and contingency plans established by Mercury to manage the supply security risks appropriately reflected the reliability concerns of the gas cables. Mercury, in recognition of previous service reliability with the oil cables, did not have a specific risk management and contingency plan to cover the failure of these cables.
8. There was insufficient technical expertise related to cable technology and insufficient appreciation of the importance of soil conditions within Auckland Electric Power Board (AEPB) at the time of preparing the specifications for the gas cables and the oil cables, and later during installation.
9. Cable manufacturers supplied, and AEPB accepted, cables that were in accordance with AEPB specifications. Both the gas and oil cables were installed in soil conditions that did not allow the cables to achieve their specified rating.
10. The two gas cables were installed contrary to good engineering practice. In at least one location ground stability was inadequate for the purpose of properly supporting the joints and the cables leading into them. A number of electrical faults subsequently occurred at that location.
11. AEPB/Mercury undertook insufficient investigation in assessing the causes of repetitive electrical faults on the gas cables. Most of these faults were as a result of poor installation.
12. Not all of the 'low gas pressure' alarm functions provided as part of the gas cable installations were appreciated nor exercised by Mercury at the time of Integral Energy's investigation. No automatic cable disconnection facilities were in place in case of 'extremely low gas pressures' within the cables.

13. Mercury assigned a low reliability to the gas cables and did not place emphasis on improving the condition of these cables.
14. Mercury had a view that the two oil cables were fully reliable – up to their full nominal rating of 60 MVA (Mercury Energy Limited 113, page 23). In fact the rating of these cables was much lower due to the ground conditions in which they were buried. When they were loaded to more than half their nominal rating they would have started to overheat. Once the cables were installed most of these problems would not be detected by conventional routine cable maintenance practices and there are grounds to believe that Mercury Energy may have been lulled into a false sense of security. Mercury’s false sense of security is confirmed by an apparent lack of precautions that other operators may have taken following the failure of the two gas cables. For example:
 - a. securing these now critically important oil cables from external damage by arranging regular route patrols, and,
 - b. monitoring for possible overheating by installing and interrogating temperature-monitoring devices at known, or suspected, hot spots along the oil cable routes.
15. When the two gas cables failed, additional load was placed on the two oil cables. The first oil filled cable failed due to thermo-mechanical reasons. This means that the higher than allowable cable temperature helped the metallic conductors move with respect to their insulation and metallic sheath. This movement caused a joint to be compressed internally, resulting in the electrical failure of that joint.
16. The remaining oil cable then took on additional load and became overheated, to the extent that it failed under ‘thermal run-away’ – meaning that the cable generated more heat than its environment could dissipate, causing the insulation to break down and the cable to fail electrically.
17. Mercury does not have an adequate maintenance policy for 110 kV gas and oil cables. It did not comply with manufacturers’ recommendations in regard to the routine testing of gas-pressure and oil-pressure alarms and accuracy of their initiating devices, and electrical checking of the integrity of the outer coverings of the cables.”

APPENDIX 6

Governance and Accountability Issues Relevant to the Auckland Power Inquiry

by **Henry Bosch**

1. Corporate governance is the system by which companies (and similar organisations) are directed and controlled. Nearly all of the powers stemming from ownership are delegated by the shareholders to the board of directors through the Constitution or the Articles of Association, with a few being retained by shareholders to be exercised by them in general meetings. The directors are accountable to the shareholders for the management of the company. Since boards share a collective responsibility and act collectively, and since they meet only periodically, they must delegate a substantial part of their powers to the management of the company. This is usually done through a statement of delegations, the position description and objectives of the CEO, a statement of matters reserved for the board, or a similar procedure. Whatever method is chosen management, through the CEO, is accountable to the board for the day to day operation of the company and the board is responsible for seeing to it that management is managing properly. Thus the directors are accountable to the shareholders for management's actions, or lack of action.
2. Over the last decade there has been a very great increase in the attention paid to corporate governance which has stemmed from the principal causes:
 - New legislation which has raised the standards expected, both in the area of company law and in a wide variety of other fields such as the environment, employee health and safety and consumer protection;
 - Rising standards required by the courts. This was well summarised in an important Australian judgement (the National Safety Council case, in which a director was found personally liable for \$97 million) by Mr Justice Tagell who said:

“As the complexity of commerce has gradually intensified . . . the community has of necessity come to expect more than formerly from directors . . . In response, parliament and the courts have found it necessary in legislation and litigation to refer to the demands made on directors in more exacting terms than formerly; and the standard of capability required of them has correspondingly increased”; and
 - The growing power of institutional shareholders and the increasing readiness of all shareholders to assert their rights and to demand better performance from companies and higher standards from directors. In recent years a consciousness that knowledgeable shareholders may bring pressure to bear and, if unsatisfied, may force changes in board membership, has become the most potent single factor in raising standards of governance.

In response, a great deal of thought has been given to the way boards operate; directors are spending much more time on their duties, and techniques have been developed which enable them to discharge their duties more effectively. The composition of boards and the selection of directors have become matters of concern and many board changes and a reduction in the average tenure of directors have become apparent. Much information is now available on ways in which boards have improved their performance and it has become common for directors to seek guidance on these matters.

3. In public companies directors owe their duty to the company as a whole and not to any individual shareholders, or groups of shareholders. They must take into account the longer term interests of the company, including the interests of future shareholders, as well as the immediate situation, and this requires that directors strive to enhance shareholder wealth in perpetuity rather than maximise short term benefits or satisfy the particular demands of individual shareholders or classes of shareholders.

This has recently been well expressed by the Hampel Committee in UK (January 1998) which stated “The basic legal duties of directors are to act in good faith in the interests of the company and for a proper purpose; and to exercise care and skill. These are derived from common law and are common to all directors. The duties are owed to the company, meaning generally the shareholders collectively, both present and future, not the shareholders at a given point in time.”

However, since the ongoing prosperity of a company depends, to a large extent, on its stakeholders being content with its performance, and having confidence in its future, directors and management must have continuing regard to the interests of stakeholders such as creditors, employees and the community in which it operates. In particular companies depend on their customers for their revenue and it is essential that they strive to maintain and increase customer satisfaction as far as is consistent with their other responsibilities.

4. In order that they can discharge their duties effectively it is important that directors should have access to whatever information they consider necessary and it can be expected that they will become aware of much that is confidential and sensitive. This information is the property of the company and it is improper to disclose it to any persons, including shareholders, unless disclosure has been authorised by the company. This position has been well expressed in the *Corporate Director's Handbook* published by the American Bar Association which states “A director should deal in confidence with all matters involving the corporation until such time as there has been general public disclosure. A director of a publicly held corporation is often asked by investors . . . to comment on sensitive issues . . . however an individual director is not usually authorised to be a spokesperson for the corporation and . . . should avoid responding.”

Where large shareholders, including institutions and corporate shareholders, have a powerful position on the share register, and particularly when they have nominated directors to represent them, the question of confidential information can cause serious problems. Where there are only a few shareholders a joint venture agreement, which may

be reflected in the constitution of the company, may be drawn up to protect the position of each party, but such an arrangement becomes impracticable if the shareholders are numerous, and particularly if the company is to be listed.

5. There is no simple formula or blueprint for good governance. Companies vary so greatly in size, complexity, ownership structure and in the quality and experience of the people involved that it is necessary for each board to develop workable systems which meet the needs of the organisation and enable it to discharge its responsibilities effectively. In any single company these systems are likely to develop as circumstances change. However certain basic requirements must always be met and there are principles and practices that have been found to be valuable in all or most circumstances.
6. One of the most important requirements is that a company manages its risks. The board is responsible for the stewardship of the company's assets, for its reputation and for arranging its affairs so that its ability to generate profits and to grow are not undermined. The importance of this responsibility has been widely recognised by bodies that have set standards for corporate conduct and provided guidance for directors. For example:
 - The Australian Stock Exchange requires all listed companies to make an annual statement about the main corporate governance practices that they have in place and its Listing Rules indicate the major matters which it expects such statements to cover. These include: "The Board's approach to identifying areas of significant business risk and putting arrangements in place to manage those risks".
 - In the UK the Hampel Committee (the successor to the Cadbury Committee) has included in its principles of corporate governance: "The board should maintain a sound system of internal control to safeguard shareholders' investment and the company's assets. This covers not only financial controls but operational and compliance controls, and risk management, since there are threats to shareholders' investment in each of these areas".
 - In Canada the guidelines of the Toronto Stock Exchange identify managing risk as one of the five principal responsibilities of the board. They state "The board must understand the principal risks of all aspects of the business in which the corporation is engaged and, recognising that business decisions require the incurrence of risk, achieve a proper balance between the risks incurred and the potential returns to shareholders. This requires the board to ensure that there are in place systems which effectively monitor and manage these risks with a view to the long term viability of the company."
 - In the USA the Business Roundtable, in its Statement on Corporate Governance, includes as one of the principal board functions:

"Oversee processes for evaluating the adequacy of internal controls, risk management, financial reporting and compliance, and satisfy itself as to the adequacy of such processes."

There is general agreement that the board must satisfy itself that the risks facing the business have been identified and evaluated, and that those which are likely to occur and/or which carry the most serious consequences if they do occur, have been adequately dealt with. This must involve satisfying itself that appropriate policies are in place and that management is complying with them. It is likely to involve agreeing with management performance indicators that are related to the principal policies, and monitoring them periodically. The frequency, method and style of the monitoring will vary according to the circumstances of the company and the nature and seriousness of the risk but no board could be considered to be discharging its duties properly if it did not set aside time to consider risk, or if it did not adopt a system appropriate to its circumstances and to the risks identified.

7. The Australian/New Zealand Standard on Risk Management (AS/NZS 4360:1995) sets out a generic framework for risk management. It recommends, inter alia, that all managements:

- identify risks by asking what can happen and how it can happen;
- analyse risks by determining the likelihood of their occurrence and the consequences if they do occur;
- assess risks against previously established risk criteria to decide whether the risks can be accepted;
- identify treatment options under four headings: reduce likelihood, reduce consequences, transfer in full or in part, and avoid;
- prepare and implement treatment plans;
- monitor the risks and the effectiveness of the risk treatment plan; and
- document each stage of the risk management process.

In view of the great differences between companies and the circumstances within which they operate it is not suggested that good governance requires any individual board to adopt in detail the processes set out in the Standard. There is room for selection and adaptation, but the Standard provides a benchmark against which individual company processes can be judged and, in the absence of good reasons for departing from it, it would be prudent to conform to it. If significant parts of the process have not been followed it would be reasonable to seek reasons. There is no suggestion that a board needs to carry out the detailed process itself, but it has a clear responsibility to decide what process the company should adopt and to ensure that it is implemented properly.

Henry Bosch

Henry Bosch is a recognised Australian authority on corporate governance. The author of several published studies in this area, during his career he has both private sector commercial experience as chairman or director of 30 companies in Australia, Asia and the USA. He served five years as the Chairman of the Australian Securities Commission's predecessor, the National Companies and Securities Commission. After completing that appointment in 1990 he returned to the private sector. In 1990 he became Chairman of the working group that produced the book *Corporate Practices and Conduct* and has since played a leading part in the debate on issues of corporate governance and other issues of concern to directors. He has been active, in association with organisations such as the Australian Institute of Company Directors, in encouraging the study and the enhancement of the governance of both public and private sector corporations.

APPENDIX 7

Cable Fault History

INCIDENTS ON THE PENROSE-QUAY 110 KV CABLES

Cable	Date	Cause	Outage Duration
No. 1	23/08/63	Mechanical damage, Michaels Ave., JB 10A & 10B	
No. 1	15/11/65	Mechanical damage, Tamaki Drive, JB 45 & 45A	
?	23/05/66	No specific account found, but cable was out of service	23/05/66–24/09/66
No. 2	15/03/67	Compression seal, JB 2	
No. 1	06/02/68	Compression seal, JB 14	
No. 1	27/02/68	Compression seal, JB 7	
No. 2	27/02/68	Compression seal, JB 7	
No. 1	06/03/68	Pressure wipe on flange end, JB 17	
No. 2	01/03/68	Mechanical damage, JB 11A & 11B	
No. 2	09/02/71	Compression seal, JB 37	
No. 1	10/03/71	Crack in pressure wipe, JB 1	
No. 2	?/12/72	Crack in pressure wipe, JB 42	
?	18/05/73	No specific account found, but cable was out of service	18/05/73–12/06/73
No. 2	24/12/73	Leak on flange plate wipe, JB 42	24/12/73–18/01/74
No. 1	28/02/74	Leak on compression gland wipe, JB 29	28/02/74–22/03/74
No. 1	05/04/74	Leak on compression gland wipe, JB 27	05/04/74–22/04/74
No. 1	01/09/74	No specific account found, but cable was out of service	
No. 1	14/02/75	Leak on compression seal wipe, JB 29	14/02/75–22/02/75
No. 2	09/03/77	Drop in pressure, Michaels Ave., cause not found	09/03/77–10/03/77
No. 2	02/07/77	Damaged O-ring, JB 13 Unknown	
No. 2	23/01/78	Leak on seal, Tamaki Drive, JB 42	23/01/78–07/02/78
No. 1	22/05/79	Leak on flange plate wipe, JB 14	22/05/79–23/05/79
No. 1	10/07/79	Temp. repair from 22/05/79 replaced. Seal tightened, JB 22	10/07/79–14/08/79
No. 1	20/11/79	Leak on flange plate wipe, JB 10A. On regassing a leak developed, JB 12 flange	20/11/79–04/01/80
No. 2	06/04/81	Joint wipe failed (previous repair) JB Upland Rd.	06/04/81–18/05/81
No. 2	15/06/84	Joint wipe failed JB 33, Ngapipi Rd.	15/06/84–23/07/84
No. 1	05/07/87	Joint wipe failed, JB 46, Quay St.	05/07/87–21/08/87
No. 2	14/08/87	Contractor damage. Not degassed. Orakei Rd.	No outage
No. 1	10/12/87	Contractor damage. Cable degassed. Outside 53A, Abbots Way	10/12/87–12/01/87
No. 1	06/02/88	Joint wipes failed, JB 48 & 49, Quay St.	06/02/88–07/04/88
No. 2	08/04/88	Joint wipes failed, JB 22, Upland Rd.	08/04/88–12/05/88
No. 2	17/08/88	Joint wipes failed, JB Orakei Rd.	17/08/88–28/10/88
No. 1	15/09/88	Slow gas leak. Position undetected. No outage	
?	1989	Contractor damage	
?	1990	Out of service for gas leak repair	
?	1993	Out of service for gas leak repair	

Cable	Date	Cause	Outage Duration
?	1993	Contractor damage	
No. 2	1994	Contractor damage	?-30/01/95
No. 2	13/02/95	Out of service for gas leak repair	13/02/95-09/04/95
No. 1	09/04/95	Out of service for gas leak repair	09/04/95-19/04/95
No. 2	19/04/95	Cable fault (first electrical fault)	19/04/95-18/12/95
No. 1	15/12/95	Cable fault	15/12/95-25/04/96
No. 2	09/02/96	Out of service for gas leak repair	09/02/96-11/02/96
No. 2	16/02/96	Out of service for gas leak repair	16/02/96-18/02/96
No. 2	24/02/96	Out of service for gas leak repair	24/02/96-25/02/96
No. 2	28/04/96	Out of service for gas leak repair	28/04/96-15/05/96
No. 2	20/05/96	Contractor damage	20/05/96-26/09/96
No. 2	12/10/96	Out of service for gas leak repair	12/10/96-19/10/96
No. 2	17/02/97	Cable fault	17/02/97-08/05/97
No. 1	01/03/97	Out of service for gas leak repair	01/03/97-02/03/97
No. 1	27/03/97	Out of service for gas leak repair	27/03/97-31/03/97
No. 2	22/01/98	Cable fault	22/01/98-01/03/98
No. 1	09/02/98	Cable fault	09/02/98-08/03/98

INCIDENTS ON THE ROSKILL-LIVERPOOL 110 KV CABLES

Cable	Date	Cause	Outage Duration
No. 2	02/02/84	Unknown	
No. 2	21/05/85	Leaking wipe	
No. 1	09/10/86	Leaking wipe JB 3	
No. 2	10/01/87	Contractor damage – Ferncroft Ave.	
No. 1	11/09/93	Leaking wipe JB 3	
No. 1	20/12/93	Leaking wipe JB 1	
No. 2	03/08/94	Leaking band wipe JB 21	
No. 1	05/02/95	Leaking wipe JB 4	
No. 1	08/11/97	Leaking wipe JB 10	
No. 1	19/02/98	Cable fault	
No. 2	20/02/98	Cable fault	
No. 2	03/03/98	Failed testing	
No. 1	04/03/98	Failed testing	
No. 1	19/04/98	Failed testing	
No. 2	10/05/98	Cable fault	

Source: Mercury Energy Limited, 1998.

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