PB ASSOCIATES

REVIEW OF MURRAYLINK

TRANSMISSION PARTNERSHIP SERVICE STANDARDS

Prepared for

AUSTRALIAN COMPETITION AND CONSUMER COMMISSION

PB Associates *Quality System:*

Document Reference	:	158119-001 DRAFT V3a Bob S 21_12_02.doc
Report Revision	:	3
Report Status	:	Final
Prepared by	:	Bob Simpson
Reviewed by	:	Geoff Brown / Brian Nuttall
Approved by	:	Anthony Seipolt
Date Created	:	20 December 2002
Date Issued	:	23 December 2002

TABLE OF CONTENTS

SECTIONS

EXECUTIVE SUMMARY

This report presents the results of a review of the Murray Transmission Company (MTC) regulatory revenue cap application in respect of appropriate performance incentive service standards. PB Associates undertook the review at the request of the Australian Competition and Consumer Commission (Commission).

The main findings of the review were as follows:

I. The Commission's review of service performance measures for Transmission Network Service Providers (TNSP) recommended a suite of five measures. However, due to a lack of reliable historic data, differing TNSP roles, system configuration and responsibilities, it is not proposed that these be applied in an identical way to each TNSP. The measures developed were considered to be only an "initial suite" which would apply for the next 5-year period, and which could be modified for subsequent regulatory periods.

II. The HVDC technology employed is relatively new but the design has taken reliability into account, having regard to the service history of earlier HVDC technologies. MTC have procured the spares recommended by the supplier (ABB Power Systems AB of Sweden) and the link will be operated and maintained in accordance with ABB's recommendations. MTC will be contracting the necessary expertise to ensure that the link achieves its intended service levels.

III. MTC proposed using only one of the Commission's five service performance measures (circuit availability) as a basis of its performance incentive scheme. PB Associates agrees that the other four measures are not required for a transmission system comprising only a single circuit interconnector. However it recommends that circuit availability be subdivided into planned availability, forced availability during peak periods and forced availability during off-peak periods for the performance incentive scheme.

IV. PB Associates supports the adoption of the CIGRÉ reporting protocol for HVDC links as proposed by MTC. This approach enables comparisons of Murraylink performance to be made with other HVDC links.

V. MTC's proposal for defining the categories of events to be classed as Force Majeure is not supported. PB Associates recommends that the good electricity industry practice test should be applied as outlined in the code. MTC should not be able to claim relief for Force Majeure to the extent that the impact of an incident is influenced by a failure to adopt sound asset management practices.

VI. MTC proposed a target availability of 97% with 1% deadbands and maximum reward levels of 100% and a maximum penalty level of 94%. The 97% level is conservative when compared with ABB reliability studies for Murraylink, which estimated planned plus forced availability at 98.2%. It is also significantly lower than the performance of similar HVDC links, as reported by CIGRÉ. In this report PB Associates has proposed targets for each of the three proposed availability measures. PB Associates proposes three individual performance targets, rather than a single overall target. Taken together, the three targets represent a cumulative unavailability of 1.77% compared 3.0% proposed by Murraylink. A total of 1% of base revenue is proposed for the incentive scheme.

VII. MTC has proposed calculating availability on a monthly basis for performance incentive purposes. PB Associates does not support this approach as it allows a very poor monthly performance to be capped whereas when adopting a twelve-month approach the full impact of the poor performance would be reflected in the performance incentive financial impact. The approach proposed by MTC is also inconsistent with the Commission's current proposals for monitoring the performance of other TNSPs.

VIII. In their application, MTC proposed that the targets set would apply to 2012. PB Associates does not support this approach as it is not consistent with the approach taken with other TNSPs and does not recognise the lack of historical data on the operational performance of Murraylink. It is recommended that performance incentive targets be reviewed prior to 2012, when the actual performance history of Murraylink can be taken into account.

1. INTRODUCTION

On 18 October 2002, the Australian Competition and Consumer Commission (Commission) received an application from the Murraylink Transmission Company (MTC), on behalf of the Murraylink Transmission Partnership (MTP), requesting the Commission determine that:

- The network service provided by the Murraylink interconnector be classified as a prescribed service for the purposes of the National Electricity Code (Code); and
- For the provision of this prescribed service, MTP be eligible to receive the maximum allowable revenue from transmission customers, through a coordinating transmission network service provider (TNSP), for a regulatory period commencing from the date of the Commission's final decision to 31 December 2012.

The Commission expects to release a draft decision on the MTC application in February 2003.

As part of its consideration of this application, a review of MTC's proposed service standards is required to assist the Commission in assessing the performance of Murraylink relative to the requirements of the Code. In particular, Part B of Chapter 6 of the code requires, inter alia, that in setting a revenue cap for a TNSP, the Commission must have regard to:

- The service standards referred to in the Code applicable to the regulated transmission network; and
- Any other standards imposed by agreement with relevant network users.

PB Associates has been engaged to carry out this review of MTC's proposed service standards.

1.1 TERMS OF REFERENCE

The terms of reference required a review of the:

- Service standards proposed in the MTC application in accordance with the requirements of the Code;
- Proposed service standards in the context of the work conducted by Sinclair Knight Merz, which was recently completed for the Commission, a review of appropriate benchmarks for monitoring the performance of TNSPs; and
- Adequacy of the benchmarks proposed by MTC in relation to SKM's proposed service standards. If necessary the Consultant is required to identify appropriate benchmarks to apply to Murraylink in line with the proposed performance incentive (PI) scheme.

1.2 REVIEW

PB Associates in carrying out this review, examined the application by MTC, supporting information provided, discussed with MTC particular aspects of Murraylink and reviewed an external study on HVDC link reliability performance comparisons.

PB Associates notes that this review and ensuing report is based on information provided to PB Associates by MTC. This report relies on the said information and PB Associates has not undertaken any form of audit to confirm the data collection processes or verify the authenticity of the data.

1.3 ACKNOWLEDGEMENTS

PB Associates acknowledges the assistance from MTC and ACCC in carrying out this review.

2. COMMISSION SERVICE STANDARD REVIEW

2.1 CODE REQUIREMENTS

The Code requires that, in setting the transmission revenue cap, the Commission is to have regard to the service standards referred to in the Code (clause 6.2.4 (c)(2)) and any other standards imposed on the network by agreement with the relevant network users.

Clause 5.2.3 (b) and schedule 5.1 of the Code specify the minimum quality of supply to be achieved by the networks. Networks are required to comply with the service standards specified in schedule 5.1 or in a connection agreement. If a connection agreement adversely affects any third party users, then it would be superseded by schedule 5.1.

Schedule 5.1 outlines the planning, design and operating criteria that a network must achieve. Clause 4.4.2 of the Code defines "satisfactory operating state." Essentially the system is considered to be in a satisfactory operating state when the service standard indicators in schedule 5.1 are met or exceeded.

2.2 CHARACTERISTICS OF TNSP SERVICE STANDARDS

The Commission is reviewing possible transmission service standards to identify standards that would form the basis of a scheme that will provide incentives for all TNSPs to maintain or improve their service quality. The Commission intends that the final incentive scheme should be simple, practical and effective.

The characteristics for the final incentive scheme, as defined by the Commission are[1]:

- TNSPs will be held responsible for the outcomes that they can control or are best placed to manage;
- Simple measures of constraints, outage times and restoration times will be used as a proxy for TNSP performance;
- A TNSP's benchmark performance will be developed using its own historical data. Where historical data is not available, the Commission may
  - use national and international data to set a benchmark, and / or
  - collect data and implement particular measures over time, which seems to be the preferred option.
- Improvements upon the benchmark will result in addition to the maximum allowable revenue (MAR)
- Reductions below the benchmark will result in a penalty that will reduce the MAR
- Insubstantial improvements or reductions in service will not affect MAR
- The expected value of the extra revenue should be zero, i.e. the scheme will be revenue neutral
- Maximum incentives or penalties will be small, yet sufficient to change behaviour. They are likely to be around one per cent of the total MAR.

It is therefore important that the service standards applied to a TNSP supports the Commission's objectives in developing a performance incentive scheme and are also compatible with the characteristics of the final scheme.

[1] ACCC Draft Victorian Transmission Network Revenue Cap 2003-2008 Service Standards 1 November 2002

2.3 SKM SERVICE STANDARD REVIEW

The Commission engaged Sinclair Knight Merz (SKM) to assist it with the above service standards review. In particular, SKM was required to develop a range of measures and targets for each TNSP. The high level principles on which the service standards recommended by SKM and presented in their final report were[2]:

- There should be a sound accountability regime in which a TNSP should only be accountable for outcomes that it can control or which it is best place to manage;
- Performance measures should recognise individual TNSP accountabilities including structural differences between jurisdictions and relative "powers to act" such as planning powers;
- Performance measures, standards and incentives should only be applied after explicit consideration of the cost and risk impacts on revenue caps;
- Performance incentives should be positive and not punitive by providing an opportunity for a TNSP to earn additional revenue over and above its revenue caps;
- Performance measures should be statistically sound. While there is an element of variability to any measure that may be adopted, this variability should not be so great that it overshadows the underlying level of performance being delivered by a TNSP;
- Performance measures should be auditable in that they should be relatively easy to measure and easy to check;
- Performance targets should be carefully aligned with desired outcomes;
- Performance measures should be significant in achieving the desired outcomes and preferably few in number. This requires the relative importance of each measure to achieving desired outcomes to be taken into account; and
- Service standards should mesh in coherently with other legal and regulatory requirements applying to the TNSP and the Commission.

The initial performance measures recommended by SKM in its final report[3] for inclusion in the TNSP Performance Incentive schemes were:

- Circuit Availability;
- Loss of Supply Event Frequency Index;
- Average Outage Duration;
- Minutes Constrained - Intra-regional and
- Minutes Constrained – Inter-regional.

In its final report SKM recognised differences between individual TNSPs. The measures proposed for each TNSP as recommended by SKM is shown in Table 2-1.

[2] Transmission Network Service Provider (TNSP) Service Standards ACCC November 2002 – Report prepared by SKM
[3] ACCC TNSP Service Provider Standards – SKM – November 2002

Table 2-1 Proposed Initial Performance Measures

No	Services Standards Measure	ElectraNet SA	Energy Australia	Powerlink	SMHEA	SPI PowerNet/ VENCorp	Transend	TransGrid
1	Circuit Availability	✓	✓	✓	✓	✓	✓	✓
	- Various Sub-measures based on criticality, circuit type, and/or peak/off peak timing	F	N/A	F	✓	✓	✓	✓
2	Loss of Supply Event Frequency Index	✓	F	✓	N/A	F	✓	✓
3	Average Outage Duration (unplanned)	✓	✓	✓	F	✓	✓	✓
4	Hours Constrained pa. - Intra-Regional	F	N/A	F	F	F	F	F
5	Hours Constrained pa. - Interconnector (Importer)	F	N/A	F	F	F	N/A	F

SKM Notes on table:

1. *"✓" indicates measures is applicable to the relevant TNSP, historical data is available, and targets can be set in the Performance Incentive (PI Scheme).*
2. *"N/A" indicates measure is not applicable to the relevant TNSP.*
3. *"F" indicates measure is applicable to the relevant TNSP, but adequate data is not currently available, and it is recommended as a "future" inclusion in the Performance Incentive scheme.*

SKM noted that information on measures 4 and 5 is only just becoming available from NEMMCO, and that there is insufficient historical data to enable meaningful target levels to be set. SKM therefore recommended that the necessary information and analysis be put in place to provide information on which to base future targets for these measures. SKM also recommended that further development work be done to agree, define and record "market impact" performance measures that were more specific than those included in the initial suite of measures.

SKM did not apply the measures in an identical way to each TNSP due to data reliability, differing roles, responsibilities and system configurations. The targets were recommended for a 5-year period. It is expected that after that period, more data would be available which could result in either the targets being refined and possibly further or replacement measures being adopted.

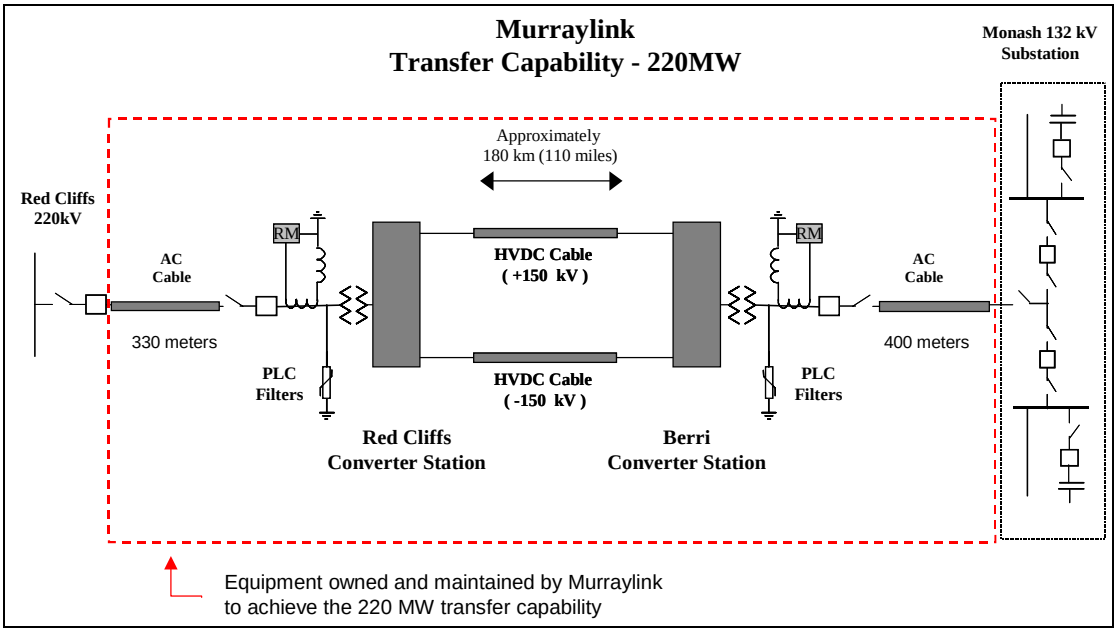
3. OVERVIEW OF MURRAYLINK

3.1 LINK OVERVIEW

Murraylink has a nominated capacity of 220MW and links SPI PowerNet's Redcliffs 220kV substation in Victoria with ElectraNet SA's Monash 132kV substation in South Australia. The links operates using 180km route length of cable running at +150 and –150kV DC with converter stations at each end. The link can operate in either direction and transmit power from Victoria to South Australia or vice versa.

The area within the dotted box in figure 1 shows the equipment that would be part of the MTC's service standard performance incentive regime. Performance of the connecting equipment owned by SPI PowerNet and ElectraNet SA is not included in determining Murraylink's service levels although there may be times when this equipment impacts on the ability of Murraylink to transfer its full rated power capacity.

Figure 1 Murraylink Simplified Single Line Diagram



3.2 MURRAYLINK TECHNOLOGY

The HVDC Light technology adopted for the Murraylink interconnection is relatively new. The design objective was to minimise the number of forced outages and the down time due to forced outages and scheduled maintenance. ABB advises that this is achieved by adopting a simple station design using components of proven high reliability, automatic monitoring, redundant and/or back up control systems and readily availability of spare parts.

The HVDC Light cables are triple extruded solid-dielectric insulation engineered, design, manufactured and installed by ABB and designed for a 40-year life. Cables are direct buried at a depth of 1 metre with a hard plastic warning tape. The cable was installed in open trenches or pre-installed ducts and not subject to stress due to being ploughed in.

The HVDC Light technology is based on modular enclosures. Most of the equipment is installed in enclosures in the factory, making filed installation quicker and more efficient. This should also result in a more reliable installation as a significant amount of equipment has been assembled and tested in a factory-controlled environment.

The scheme adopts a compact arrangement with less AC filtering than conventional HVDC systems. Each end operates independently, with one end controlling the power

flow and the other the voltage. Consequently, there is less reliance on communications between each end, thus further improving reliability.

The converters consist of a number of Insulated Gate Bipolar Transistors (IGBTs) whose failure rate is expected to be 0.5% per year based on design considerations and factory tests. The converters can operate at their rated transfer capacity with up to 3% of the individual IGBTs out of service. Hence, a forced maintenance outage would be required when the number of IGBTs out of service exceeded 3%.

The link is dependent on a number of key components. In service redundancies include valve cooling pumps, closed circuit water-cooling fans, transformer cooling systems, HVDC Light controls with failsafe checking and auto transfer, protection and telecom system. Station services are available from two sources with an automatic transfer scheme. MTC advises that the link would normally be available at full capacity of 220 MW. Availability would not be restricted to below rated capacity unless there was a thermal constraint on an item of plant. However, this is considered an unlikely scenario.

As discussed in the MTC application, external network constraints can limit the transfer capability under certain transmission system operating scenarios. These constraints are problems associated with the transmission networks and are not directly relevant to consideration of the service levels provided by MTC in its operation and management of Murraylink.

3.3 MURRAYLINK RELIABILITY

MTC advises that there have been no cable, joint or termination failure on Murraylink since commissioning in early October 2002.

ABB developed their reliability assessment[4] based on MTC holding certain key spares[5]. MTC advises that they have adopted ABB recommendations. Some of the keys spares held are 2km of HVDC Light cable, AC cable (100m each of 220 and 132kV), joints and terminations for cables, single phase transformer at each end, wall bushing, capacitors, filters, surge arrestors, current transformers, control equipment etc.

MTC state they have confidence in the HVDC Light technology applied in Murraylink even though there is limited historical data on the operation of HVDC Light systems. Murraylink uses a more advanced design from that used on Direct Link and other HVDC Light projects. Three converter bridges are now used instead of two and a lower switching frequency is used to reduce losses. ABB literature notes that their XLPE cables have overcome problems with XLPE insulation in the past (e.g. space charges in the insulation leading to uncontrolled fields and uneven stress distribution).

MTC advise that Murraylink will be operated and maintained in accordance with the recommendations of ABB's availability and reliability plan. Two consecutive 24-hour outages would be required per year for scheduled maintenance, co-ordinated with local TNSPs as much as possible.

MTC also propose either an on-site operator at the Red Cliffs converter station (staffed 24 hours per day 7 days per week), or an arrangement with the local TNSP with staff and resources in the Red Cliffs area. They are also arranging emergency response with local service providers for responding to forced outage events. MTC also envisages NEMMCO coordinating Murraylink's maintenance outage scheduling with the needs of the NEM.

[4] ABB Power Systems Technical Report "Reliability and Availability Prediction" for Murraylink 27 September 2001
[5] ABB Spare Parts List

4. MURRAYLINK SERVICE STANDARD PROPOSAL

In their application to the Commission, MTC discuss each of the five service standards developed by SKM and presented in the Commission's draft revenue cap decision for South Australia. The final SKM report on service standards was only available after MTC presented their application, but the same five measures are still proposed. As noted in Section 2.3, these are:

1. Circuit availability;
2. Loss of supply event frequency index;
3. Average outage duration;
4. Minutes constrained – intra-regional and
5. Minutes constrained – inter-regional.

The measures developed by SKM for TNSP Performance Incentive scheme were considered appropriate for TNSPs that operate meshed networks systems connecting generation to loads. They were not designed to apply to a single dedicated circuit such as Murraylink. The performance measures used for Murraylink in any revenue cap decision need to take account of the special characteristics of the asset, particularly the fact that it is a single circuit, which is not used directly to supply customer load.

MTC's application states that, as Murraylink is an interregional transmission link that does not directly supply load, the loss of supply event frequency index and the minutes constrained – intra regional performance measures are not relevant. PB Associates accepts this as reasonable.

MTC's application further states that, although Murraylink is an inter-regional interconnector, it is a stand-alone asset. They consider that it cannot control the presence, absence, magnitude, calculation or reporting of any interregional constraints in the upstream and downstream networks that could impact on the inter-regional constraints. MTC also state that any constraints over Murraylink are fully reflected in circuit availability calculation. PB Associates supports the approach of not using the inter-regional minutes constrained performance measure for assessing Murraylink's service standards.

It should also be noted that neither of the constraint performance measures have been adopted by SKM for other TNSPs in the proposed initial service targets for their Performance Incentive measures. SKM chose not to adopt constraint measure, initially, because historical data was not available. However SKM concluded that the measure should be implemented when the data is available and meaningful targets could be set.

MTC does not propose the use of average outage duration as Murraylink does not supply load and that circuit availability accounts for outage duration. PB Associates agrees that this approach is reasonable.

Therefore, in its application MTC proposes that only circuit availability be used as a performance measure for revenue cap determination purposes. The circuit availability would take into account both the capacity unavailable and the duration of any unavailability. The availability index is therefore really a measure of equivalent energy unavailability and the approach proposed is consistent with the way availability of HVDC links is measured internationally, for example using the CIGRÉ protocol discussed in Section 6. While PB Associates generally supports the approach proposed by MTC, it considers that further subdivision of circuit availability should be made.

The final SKM report identifies the following possible sub-measures for circuit availability:

- Critical circuits;
- Non-critical circuits;
- Peak periods;
- Intermediate periods;
- Transmission lines; and
- Transformers and reactive.

Peak includes 7:00am to 10:00pm weekdays or as otherwise defined by the TNSP/NEMMCO with off peak all other times. Intermediate periods could also been defined along with seasonal periods although none were recommended at this stage by SKM.

In the case of Murraylink, the link is a single circuit and circuit availability and PB Associates believes that it should incorporate all plant owned by MTC with no subdivision into the availability of individual components.

PB Associates recommends that Murraylink's circuit availability should be subdivided into planned and forced availability. MTC have defined the number and duration of planned outages, which could be used as the basis of a planned availability service measure.

While there is no substantive historical performance information for Murraylink, ABB have carried out studies[6] for MTC to determine project reliability. This ABB analysis provides an assessment of the number and duration of forced outages.

While the time in the day when a forced outage occurs is more difficult to forecast as against the expected number of forced outages in a year, weighting could be given to those occurring at times of critical periods.

Information for the performance from other HVDC links can also be used to validate outage projections calculations as reported by CIGRÉ studies on HVDC links.

PB Associates' proposed performance measurement regime for Murraylink, based on the above general considerations is presented in Section 7.

[6] ABB Power Systems Technical Report "Reliability and Availability Prediction" for Murraylink 27 September 2001

5. CIGRÉ REPORTING PROTOCOL

In their application, MTC propose to use the CIGRÉ protocol for reporting the operating performance Murraylink[7]. This scheme is widely used for monitoring and reporting availability of HVDC transmission schemes. Companies report on a voluntarily basis their energy transfer, utilisation, availability, unavailability due to scheduled and forced outages, forced outages, commutation start failures and forced outage severity.

CIGRÉ (International Council on Large Electric Systems) is a permanent non-governmental and non profit-making International Association based in France. It was founded in 1921 and aims to facilitate and develop the exchange of engineering knowledge and information, between engineering personnel and technical specialists in all countries as regards generation and high voltage transmission of electricity.

CIGRÉ has established a number of Study Groups that focus on particular aspects of generation and high voltage transmission of electricity. One group, HVDC links (Study Committee 14), considers the planning, design, performance, control, protection, construction and testing of converter stations, i.e. the converting equipment itself and also the equipment associated with HVDC links. A Working Group (14.04) within Study Committee 14 was established to collect information on all HVDC transmission systems in commercial service.

Performance of HVDC links is collected annually (since 1995) and the results summarised every two years in a CIGRÉ conference paper. This information can be used to compare the performance of different HVDC links although, if used in this way, care needs to be taken to ensure different technologies and installation methods are taken into account. Links with solid-state power electronic based valves (as in the case of Murraylink) are more reliable than those with mercury valve converters. The same applies to links with underground cables (as in the case of Murraylink) compared with those with an overhead line between the converters.

The CIGRÉ protocol measures availability in terms of capacity unavailable and the duration of this unavailability to determine energy unavailability. For example if over a year Murraylink had 48 hours of planned outages when the full capacity was unavailable, 3 forced outages of 100 hours where full capacity was unavailable and 2 forced outages of 50 hours where 50% capacity was available, then the total circuit energy unavailability would be calculated as follows:

100x(48 + 3 x 100 + 2 x 50 x 0.5)/(365 x 24) = 4.54% for the year

MTC advises that the number of duplicate in service components affecting capacity is minimal resulting in Murraylink most likely either being available at full capacity or zero capacity and not at part capacity.

The CIGRÉ reporting protocol is compatible with the Commission's principles and PB Associates supports the adoption of this protocol for MTC's Performance Incentive.

Figure 2 shows HVDC link (converter and transmission line) forced outages for 1999 and 2000 based information reported using the CIGRÉ reporting protocol to the 2002 CIGRÉ Paris session.[8].

[7] Protocol for reporting the Operational Performance of HVDC Transmission Systems CIGRÉ Working Group 14-04 1997.
[8] A Survey of the Reliability of HVDC Systems throughout the World during 1999-2000 paper 14-201 CIGRÉ Paris 2002 session.

Data for companies G, H and Q is not shown as their forced energy unavailability was significantly higher than that reported by all others (ranging up to 22.9%). These companies either experienced a converter transformer or bushing failure, resulting in prolonged outages. Company U experienced 35 transmission line forced outages out of the total of 50 reported forced outages in 1999 and 31 out of the 48 reported forced outages in 2000. For each of 1999 and 2000, the average number of forced outages, excluding transmission line events, is 5 forced outages per year, consistent with the ABB Murraylink reliability study results.

Figure 2 CIGRÉ HVDC Link Forced Outage Rates

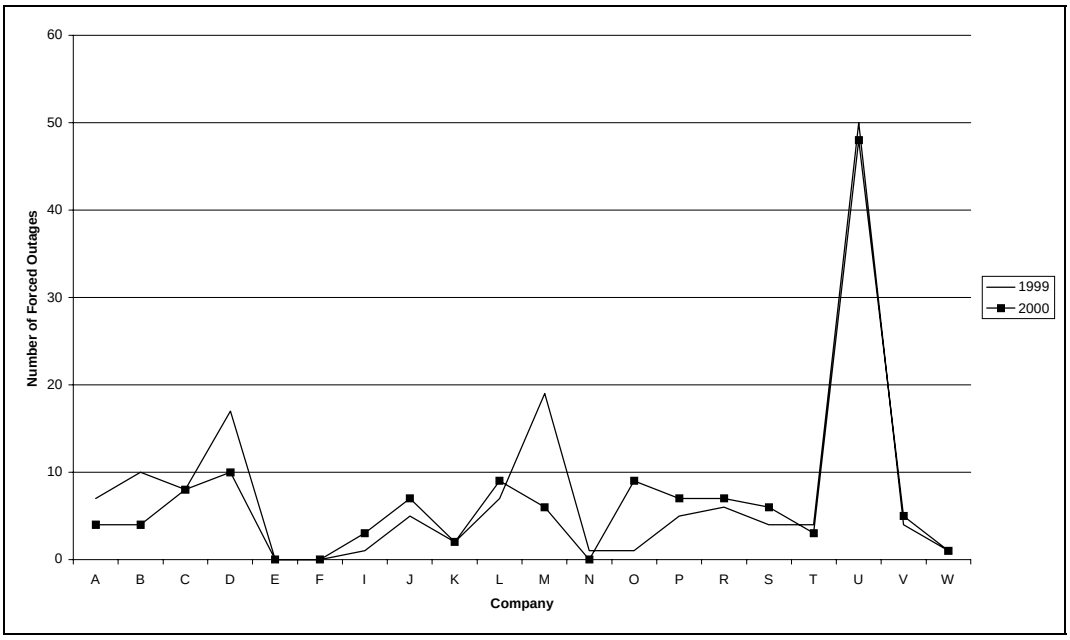
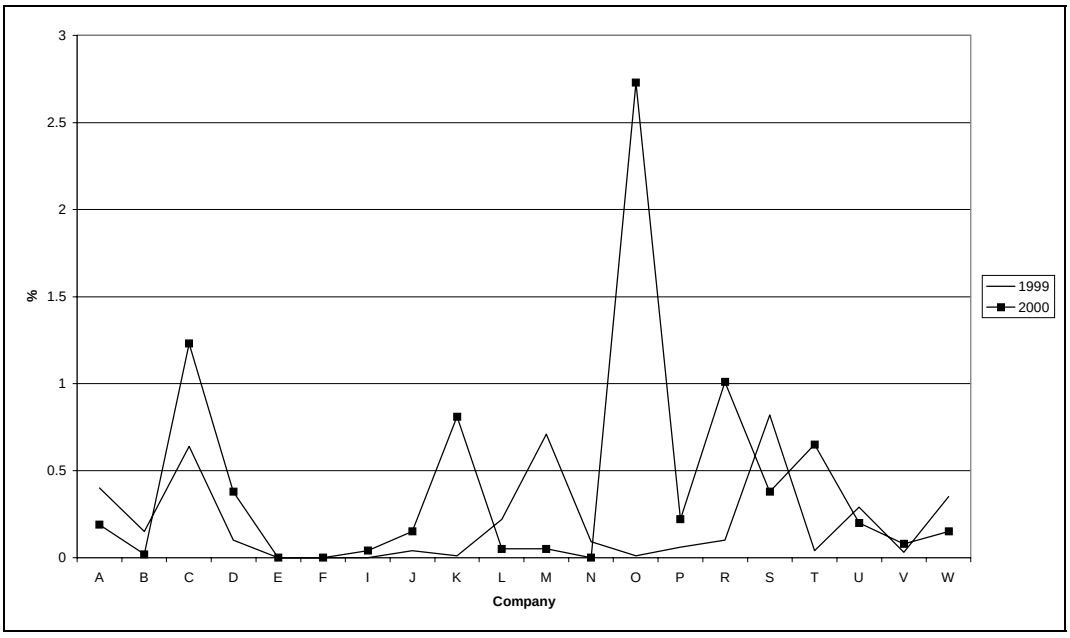


Figure 3 shows converter forced energy unavailability for 1999 and 2000 based on the same data source as figure 2 (again excluding companies G, H and Q). The average converter forced energy unavailability in 1999 was 0.2% and in 2000 0.4%. Data ranged from 0 to 2.7%

Figure 3 CIGRÉ Converer Energy Unavailability



6. PROPOSED SERVICE MEASURES FOR MURRAYLINK

6.1 RECOMMENDED MEASURES

The recommended service measures for Murraylink are:

- Planned circuit energy unavailability;
- Forced outage circuit energy unavailability in peak periods and
- Forced outage circuit energy unavailability in off-peak periods.

CIGRÉ reporting protocol defines a scheduled outage (planned) as one that is planned or which can be deferred until a suitable time. These are outages, which can be planned well in advance, primarily for preventative maintenance. If a scheduled outage is extended due to additional work, which would have otherwise necessitated a forced outage, then the excess period is counted as a forced outage.

The outage planning notification period would normally be determined by NEMMCO in line with practices adopted for other transmission lines. MTC states that the estimated maintenance requirement is approximately 2x24 days per year and would be scheduled during off-peak periods or as otherwise directed by the NEMMCO. Planned outages should be those that satisfy the approved NEMMCO planned outage process, otherwise the outage would be classed as forced.

Forced outage availability is split into peak and off-peak to reflect the affect that the unavailability of Murraylink would have on the market participants. This would also enable forced outages in peak periods to have a financial impact in the Performance Incentive scheme higher than those in off-peak periods. SKM in its final report define peak period as being from 7:00am to 10:00pm weekdays. This time frame would be used to determine forced outage unavailability in peak and off-peak periods.

Availability performance would be determined using the capacity available to NEMMCO offered by Murraylink. Failure of equipment not needed for power transmission, which does not result in a reduction of available Murraylink capacity, should not impact on the service measure. Planned availability performance is not split into peak and off-peak as the outage periods would normally be approved by NEMMCO and selected to minimise the overall impact on the operation of the grid.

6.2 FORCE MAJEURE

The National Electricity Code defines Force Majeure as follows:

“Force Majeure events means any event, act or circumstance or combination of events, acts and circumstances which (notwithstanding the observance of good electricity industry practice) is beyond the reasonable control of the party affected by any such event, which may include, without limitation, the following:

- Fire, lightning, explosion, flood, earthquake, storm, cyclone, action of the elements, riots, civil commotion, malicious damage, natural disaster, sabotage, act of a public enemy, act of God, war (declared or undeclared), blockage, revolution, radioactive contamination, toxic or dangerous chemical contamination or force of nature;

- Action or inaction by a court, NEMMCO, Government agency (including denial, refusal or failure to grant any authorisation, despite timely best endeavour to obtain same)

- Strikes, lockouts, industrial and/or labour disputes and/or difficulties, work bans, blockades or picketing

- Acts or omissions (other than a failure to pay money) of a party other than the TNSP which party either is connected to or uses the high voltage grid or is directly connected to or uses a system for the supply of electricity which in turn is connected to the high voltage grid

- Where those acts or omissions affect the ability of the TNSP to perform its obligations under the service standard by virtue of that direct or indirect connection to or use of the high voltage grid.

In the Commission's draft service standards decision for Victoria [9], the following events were specifically included as Force Majeure:

- The collapse of three or more consecutive intermediate transmission towers;
- Loss or damage to more than one switch bay in a terminal station or
- Loss or damage to transformers, capacitor banks, reactors, static var compensators, or synchronous condensers, which loss or damage is not repairable on site according to normal practices.

PB Associates does not consider in the case of Murraylink, that events where plant is not repairable on site should be classified as Force Majeure. MTC has carried out a reliability assessment and provided local on site spares accordingly.

In the South Australian draft revenue cap decision[10] Force Majeure was also considered to include third party and natural events for which the TNSP cannot reasonably be expected to cater for.

In the case of Murraylink, if a cable failure occurred due to a third party cutting the cable, then MTC would need to establish that they had adopted good electricity industry practice in the installation and management of the scheme before it could claim relief on the basis of Force Majeure.

The intent of "beyond the reasonable control of the party affected" should be read to only exclude most severe events, which is unreasonable for MTC to plan and design the link to protect against. Events such as fire, lightning, storm etc would not normally be classified as Force Majeure unless MTC could demonstrate that the event was a most severe event beyond their reasonable control to plan and design for through the application of good electricity industry practice.

MTC proposed that "Force Majeure would include events that are beyond the control of MTC, of for which protections (in the form of over-design) are not practical and/or not reasonably cost-effective." This definition is considered broader than that specified by the code where good electricity industry practice is to be applied. This provides for consideration of operational as well as design issues. In a situation where MTC wanted a particular event excluded due to Force Majeure, MTC would have to satisfy the Commission that the requirements of the Code were satisfied.

[9] ACCC Draft Victorian Transmission Network Revenue Caps 2003-2008 Service Standards 1 November 2002
[10] ACCC Draft Decision for South Australian Transmission Network Revenue Cap 2003-2007/08 11 September 2002

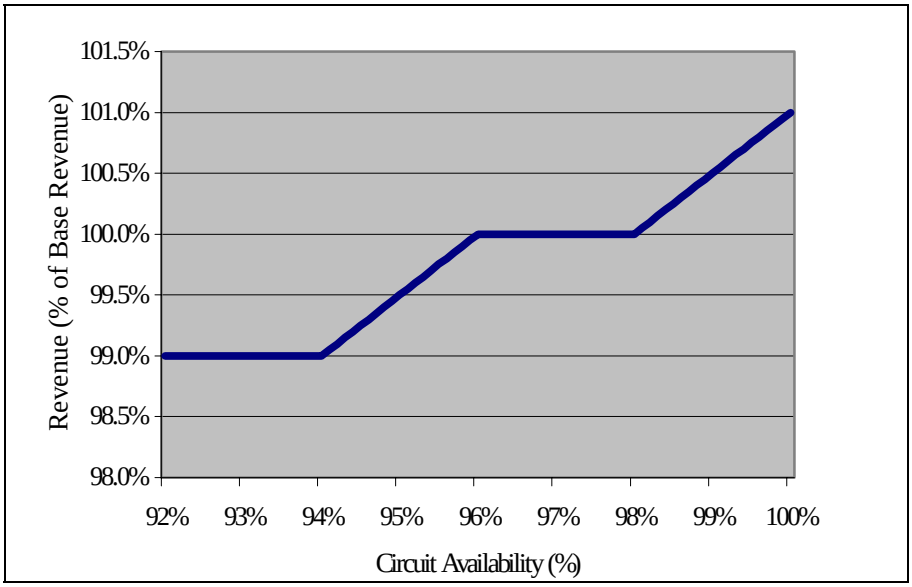
MTC also proposed that unavailability resulting from compliance with any directive from NEMMCO or a TNSP be considered as a Force Majeure. This is assumed to apply to situations for example where Murraylink's transfer capacity was limited because of external system constraints. It is not clear why this needs to be considered as Force Majeure as MTC would offer a defined capacity capability to the NEM but NEMMCO would determine that actual transfer required based on market and system considerations. The defined capacity capability would be used to determine that energy unavailability in the Performance Incentive scheme as against the dispatch transfer by NEMMCO.

7. MTC BENCHMARKS

7.1 PROPOSED MTC BENCHMARK

In their application, MTC proposed using only the overall energy availability with a target of 97% for the Performance Incentive scheme. +/1% deadbands around this 97% service standard were also proposed. 1% of base revenue would apply outside the deadband period such that maximum incentive would be achieved with an availability of 100% and minimum incentive (penalty) with an availability of 94%. Figure 4 shows this graphically.

Figure 4 MTC Proposed Benchmark



No deadband has been incorporated in availability targets for other TNSPs and the use of a deadband in the case of MTC is not supported by PB Associates. A deadband is incorporated when there is variable performance around the target measure that is not directly attributed to the performance of, or improvements by the TNSP. MTC proposed the deadband for simplicity and to avoid the administrative burden of recalculating MTC's revenues for small deviations from the target availability.

MTC proposed a 2% range above and below the deadband range i.e. an overall range of 6%. The typical range for converter on HVDC links as reported by CIGRÉ (see figure) is 0.5%. The performance of the cable should not add significantly to this. Limiting the range to nearer +/-1% is considered more appropriate until a reasonable service history is available. This would then provide a more appropriate protection for both the customer and MTC.

MTC also propose that availability would be calculated on a monthly basis. If the Murraylink availability in any month was greater than 98%, then MTC allowable revenue would increase at a rate of 0.05% of the baseline allowable revenue per 0.1% additional availability above 98%, up to a maximum increase of 1% of the baseline allowable revenue.

PB Associates does not support the monthly calculation of Performance Incentives as only 1/12 of the 1% is at risk in any one month. If there was a significant outage that extended over week in one month, then the penalty would only be 1/12 of 1% if calculated on a monthly basis. If calculated on an annual basis, then the full 1% would be affected. Adopting an annual calculation of Performance Incentives is also consistent with the principles applied to other TNSPs.

MTC based their proposed 97% availability target on ABB's reliability and assessment report[11]. Using statistics of identical or similar equipment used in HVDC converter stations and assuming on site spare converter reactor, power transformer, zero sequence smoothing reactor, redundant auxiliary power feeder and control system, a predicted energy availability of 98.16% was calculated for the whole transmission. ABB notes that predictions were made using pessimistic values. Table 1 summarises the results of the analysis.

Table 7-1 ABB Reliability and Availability Estimates

Number of forced outages	5.25 per year
Equivalent forced outage hours	100.8 hours
Forced energy unavailability	1.151%
Equivalent scheduled outage hours	60 hours
Scheduled energy unavailability	0.684%
Total energy unavailability	1.835%
Energy availability	**98.16%**

ABB assumed 60 hours for planned (schedule) outages but MTC advised in their application that 48 hours would be required. This reduces the target planned energy unavailability to 0.55% instead of the 0.68% assumed by ABB.

MTC propose a total energy unavailability of 3%, assumed to be 0.68% planned and 2.32% forced. This forced rate is 1.17% higher than the estimates provided by ABB. MTC stated that the increased forced rate is to allow for operator errors not included in ABB analysis. PB Associates believes that this additional 1.17% for operator errors is considered too high.

MTC advised that a short restoration outage time might occur in the event of incorrect operation of a control or protection function at Red Cliffs converter station. Such a fault might be cleared, and the facility returned to service, in less than 2 hours following such an event. Assuming a worse case of 3 operator errors in a year, this would increase forced outage energy unavailability by 0.07%. In order to achieve 1% in operator errors, there would need to be 44 errors with 2 hours outage per error. The CIGRÉ average number of forced outage for converter and transmission line is in the order of 5 per year for all outages, including operator errors.

7.2 PROPOSED MURRAYLINK TARGETS

Based on the information provided by MTC on their proposed planned outages, 48 hours per year or 0.55% is PB Associates' proposed target for planned circuit energy unavailability. Maximum reward would be achieved if planned outages were achieved in 30 hours (0.34%) and maximum penalty if they required 60 hours (0.68%).

PB Associates proposes that the overall unavailability target due to forced outages be 1.22%. The target is based on the studies carried out by ABB.

[11] ABB Power Systems Technical Report "Reliability and Availability Prediction" for Murraylink 27 September 2001

MTC's proposed target is significantly more conservative than PB Associates would consider appropriate on the basis of the CIGRÉ survey, where the average forced energy unavailability for converters for 1999 was 0.2% and 0.4% for 2000. Forced outages due to cable faults would need to be added to the CIGRÉ results, although this is not expected to significantly impact the interconnector performance. Based on the CIGRÉ results, and making allowance for operator error, an overall forced energy unavailability target of the order of 0.6% could be justified. However, PB Associates considers that a more appropriate approach to setting targets is reasonable at this stage on account of the lack of performance history of Murraylink.

On the basis that there are 85 hours in the critical period (hours between 7:00am and 10:pm Monday to Friday), the peak forced outage unavailability is proposed to 0.62% (1.22 x 85/168) and 0.60% for off peak periods. The performance incentive range for forced outage energy unavailability is proposed to be 0% for maximum reward and 1.24% at peak and 1.20% off peak for maximum penalty.

Table 7-2 summarises the recommended targets, penalties, rewards and weighting factors.

Table 7-2 Recommended Performance Incentives

Measure	Target	Performance for maximum penalty	Performance for maximum reward	Weighting factor
Planned energy unavailability	0.55%	0.68%	0.34%	0.4%
Forced outage energy unavailability in peak periods	0.62%	1.24%	0%	0.4%
Forced outage energy unavailability in off-peak periods	0.60%	1.20%	0%	0.2%
Total				**1.0%**

PB Associates proposes three individual performance targets, rather than a single overall target. Taken together, the three targets represent a cumulative unavailability of 1.77% compared 3.0% proposed by Murraylink. The weighting factor represents the potential impact of each target on base revenue. The lower weighting factor for off peak represents the lower market impact of off peak events. The maximum penalty/benefit of the incentives taken together is 1% of base revenue.

Weighting factors applying to each of the measures reflects the lower importance of forced outages during off-peak periods. However planned outages will generally be set by agreement with NEMMCO and are likely to occur over periods when the availability of Murraylink is not expected to be critical to the operation of the grid. There is therefore some justification for reducing the weighting of the planned energy unavailability measure. PB Associates recommends that the Commission consult further with stakeholders on the relative weighting of the three measures.

Figure 5 shows the performance incentive for planned outage energy unavailability, Figure 6, the performance incentive for force outage energy unavailability during peak periods and Figure 7 the performance incentive for forced outage energy unavailability during off peak periods.

Figure 5 Planned Outage Energy Unavailability

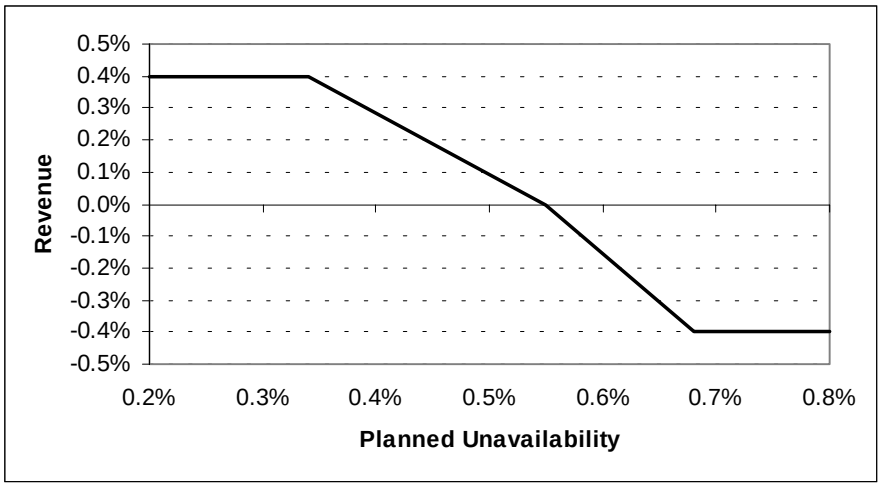


Figure 6 Forced Outages Energy Unavailability - Peak Periods

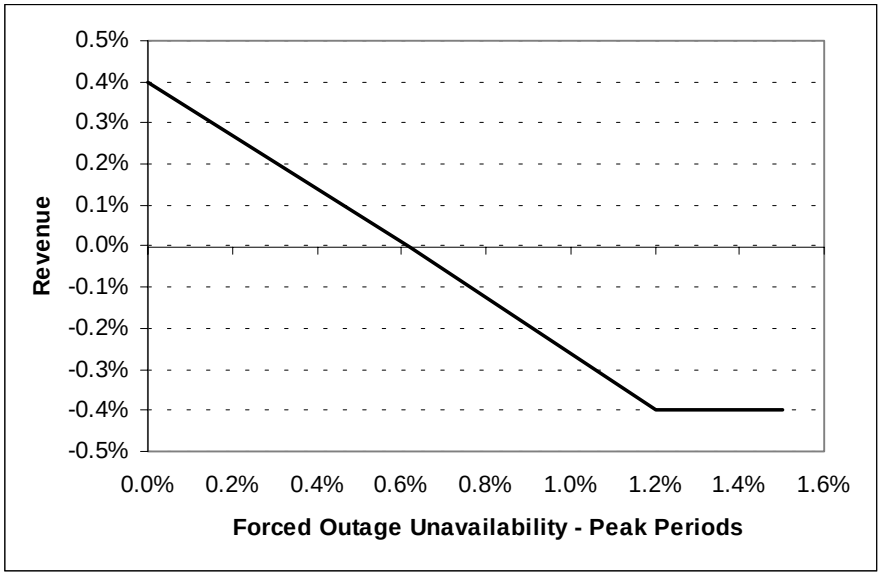
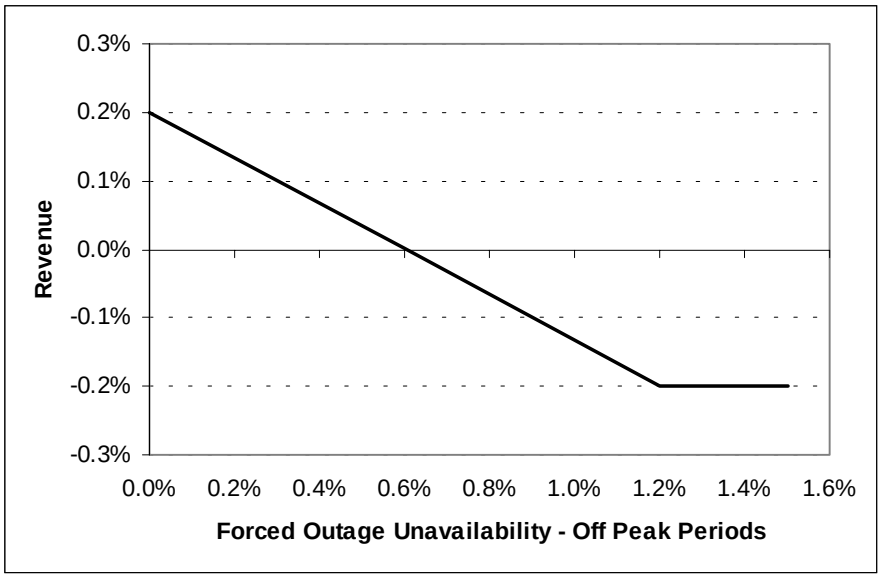


Figure 7 Forced Outage Energy Unavailability - Off Peak



7.3 ADJUSTMENT OF TARGETS

MTC proposed the same targets apply until 2012. In the case of other TNSP, the Performance Incentive targets were classed as interim and expected to apply for about 5 years. The targets and measures are to be refined as further data was collected.

Murraylink does not have operational performance sufficient to be used as a basis for establishing targets. In the case of other TNSPs, if there was no credible performance information for a measure, the measure was not used in the Performance Incentive scheme. Targets for Murraylink have had to be based on ABB simulations and surveys of the performance of other links due to the lack of direct operational performance information.

MTC propose an automatic adjustment mechanism through a mathematical correlation to adjust the target availability based on historical performance, without the need for an administrative review, or subjective consultation on the revised target. MTC do not favour any adjustment to the target availability in the middle of the regulatory period, if such adjustment would be made via an administrative proceeding. They consider the administrative benefits of the transparent performance incentive mechanism proposed by MTC would be lost in such a scenario.

PB Associates does not support setting targets at this stage until 2012 due to the limited historical performance information for Murraylink. A review prior to 2012 is recommended, which would then set targets until 2012. This would ensure that the targets maintained the appropriate balance and were seen as positive and not punitive.

8. GLOSSARY OF TERMS AND ABBREVIATIONS

ABB	ABB Power Systems AB of Sweden
ACCC	Australian Competition and Consumer Commission (the Commission)
Code	National Electricity Code
IGBT	Insulated Gate Bipolar Transistor
MAR	Maximum allowable revenue
MTC	Murraylink Transmission Company
MTP	Murraylink Transmission Partnership
NEMMCO	National Electricity Market Management Company
TEA	TransÉnergy Australia
TNSP	Transmission Network Service Provider

9. REFERENCE DOCUMENTS

- ABB Papers on HVDC Light Technology www.abb.com
- ABB Spares Parts list for Murraylink
- ABB Power Systems Technical Report “Reliability and Availability Prediction” for Murraylink 27 September 2001
- A Survey of the Reliability of HVDC Systems throughout the World during 1999-2000 paper 14-201 CIGRÉ Paris 2002 session
- ACCC TNSP Service Standards Stage 1 – SKM – March 2002
- ACCC Draft Victorian Transmission Network Revenue Cap 2003-2008 Service Standards 1 November 2002
- ACCC TNSP Service Standards – SKM – November 2002
- ACCC South Australian Transmission Network Revenue Cap: Draft Decision 11th September 2002
- CIGRÉ Working Group 14-04 1997, *Protocol for Reporting the Operational Performance of HVDC Transmission Systems, 14-97 (WG04)*
- Murraylink Transmission Company Application for Conversion to a Prescribed Service and a Maximum Allowable Revenue for 2003-12 18 October 2002